

COMMENTARY ON CASE STUDIES

Form Swallows Function: Design for Ergonomics and Aesthetics in the Application of Human Factors through the Perspective of Anthropometry

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Abstract: This article considers the application of the principles of ergonomics in examining contemporary furniture design. The study probes how aesthetics and ergonomics have shifted design thinking from the previous century. The objective of research is to examine user experience and how these are translated into appeals based on understanding anthropometric values of comfort and functionality. Some issues of aesthetics will be highlighted through two case studies of chair designs. The aim is to critique the importance of relationships between aesthetics, ergonomics, and user experience, through assessments of anthropometric values such as comfort and posture, against visual characteristics. Findings indicate that chair design solutions must prioritise ergonomics in achieving the goals of commercial design. This should not mean sacrificing aesthetics, but an integrated approach that applies human-centred design principles whereby consumer perceptions of design comfort are as important as visual aesthetics.

Keywords: Aesthetics, Anthropometrics, Ergonomics, Furniture Design, User Experience

1.0 INTRODUCTION

The fundamental human pursuit of happiness, according to ancient Greek philosophers, is the strive for truth, beauty, and ethics [1]. These correspond with the three branches of philosophy: metaphysics, aesthetics, and ethics, which gave birth to other scientific disciplines of inquiry seeking to interpret these philosophical in developing their ideologies [2]. Literature shows close affinities between these philosophies with engineering, medical, architectural, environmental design, and ergonomics research [3].

As modern architecture, art, and design underwent radical changes in the last century, design scholarship sought to integrate research through cognitive, social, and behavioural theories.

Anthropology, psychology, sociology, and cultural knowledge were increasingly determinants of the ways society responded to aesthetic stimuli through historical, mental, and emotional associations [4]. Social and economic changes as well as technological shifts impacted 20th century designs. It is unsurprising how much of the traditional judgements of aesthetics which the legacy of 20th century modernism has left behind in its wake.

Today's architects and designers find alternative inspirations in postmodern ideologies that unshackle the rules of functionalism in lieu of promoting aesthetics for its own sake [4]. Aestheticists move away from utilitarianism to translate and transform environments and materials into distinct, recognisable expressions of art. Consequently, many practitioners decry utility in favour of aestheticism. Evocativeness is celebrated over function. The needs of diverse communities are under-appreciated when commercial pressures arise [5]. Being counterculture proponents, they are more interested in adapting to innovative (often untested) materials and methods, and to emphasis on individualistic expressions in these stimuli.

Successful modern designing integrates *aesthetics* (appearance, features of attractiveness found in colours, shapes, and textures), *ergonomics* (designing for durability, efficiency, safety, risk reduction, performance, ease of use, etc.), and technological consistency in commercial designs [5].

There is increasing awareness towards ergonomics as a field that unlocks knowledge about human capacities and limitations through investigating and learning people's needs before developing accessible and replicable design solutions. Engineering a balance in efforts and effects should be viewed as part of designers' core values and social responsibility to meet consumers' needs for diversity in product designs and solutions [5].

2.0 BACKGROUND OF THE STUDY

Ergonomics is a field of applied engineering where designs are created based on systematically observing and exploring possible scenarios in problem-solving. Doing so means holistically understanding variable human factors before fine-tuning solutions for products, spaces, and systems [6].

A sub-discipline of the study of ergonomics is anthropometry, which refer to a set of fundamental principles of measuring human body and spatial dimensions such as body size, height,

shape, posture, etc., in creating design solutions that minimise user effort and enhances user fit and control without compromising space and environmental conditions [7].

2.1 Principles of Anthropometrics in Ergonomics

Ergonomists aim to manipulate designs based on understanding datasets from anthropometric research. These data provide suggested measurements derived from studying and comparing the common physical and anatomical dimensions of human users. Ergonomics references such as the *Business and Institutional Furniture Manufacturer's Association (BIFMA) Guidelines* describe these datasets as “anthropometric values”, measurements used to determine the appropriate design of working components and interfaces such as table counters, work surfaces, stairs, and the seats of chairs [7]. Anthropometric values become even more helpful and important if users are to function for a long period of time in interacting with those surfaces, equipment, objects, and tools.

Anthropometric values consider the resources available, environmental and location choices, and calculates the positive cost-benefit trade-offs of materials related to spatial and built dimensions (termed *anthropometries*) in order to ensure comfortable, safe, and healthy long-term human-spatial interactions. Additionally, studies in anthropometries can clarify the advantages of implementing ergonomics. The final design solutions must be chosen to provide the greatest degree of adjustability of objects, tools, or products to accommodate a majority percentile of target population [8].

While different demographics and needs determine design dimensions, one of ergonomists' central roles is to empirically research and produce proper guidelines on anthropometries and to offer solutions on the acceptable range that works for majority of users, including information such as the *Range of Motion (ROM)* to measure the extremes of bodily movements [7]. Anthropometric data are applied to strategically address human factors in resolving the challenges of design by performing *task analysis* and conducting *user trials* [9]. These methodologies may be cross-referenced with other anthropometric datasets from published ergonomics and proxemics studies to understand how to manipulate design outcomes aesthetically and creatively if the right combination of technology, materials, and resources are available that optimises user experience [10].

In summary, from an industrial and human factors perspective, the science of ergonomics to make balanced interpretations from anthropometries is the beginning of designs based on examining

the variable relationships between functional efficiency, ease of use, comfort, safety, wellbeing, while calculating the costs to health and wellbeing arising from good or careless design choices [9]. As industrial awareness grows, so has published scholarship in design for human factors and ergonomics. There are landmark studies reporting on poorly integrated factors in *Design for Ergonomics* (DFE) for furniture, office equipment and accessories, workstations, and tables [6].

2.2 Human-Centred Design (HCD) and User Experience

Studies on *Human-Centred Design* (HCD) involve finding solutions, conducting user trials, and iterative designs based on user experience. This concept was birthed from the systems process of design thinking, a movement by non-profit organisation IDEO founded by engineer David Kelley, whose mission is to solve human problems through design-based social innovations [11]. HCD practitioners integrate design thinking and digital tools in field guides on manipulating products or interface systems [12]. The loop involves project planning, usability research, followed by ideation. HCD defines the users served, acknowledging environmental challenges and experiences of users through conversations, embracing ambiguities, followed by ideation and evaluation before developing prototypes. A key characteristic of HCD implementation is sharing of inspiring stories throughout the design and development process, which is part of the practice of co-creation [13].

3.0 EVALUATION OF THE CASE

Academics have undertaken extensive study to evaluate the application of anthropometrics in chair designs, and to consider the role of aesthetics in user experience [14]. The emphasis on form and aesthetics in design means integrating functionality with beauty. This balance is noticeably important among practitioners who must seek and justify rationalisation of cost, materials, and other non-ergonomics contexts. Even when designers do not strictly adhere to ergonomics principles, they must look at preventative measures such as ensuring users do not suffer strains, aches and injuries when using designed objects for long or repetitive periods of use. As such, the key for aesthetics and ergonomics is to involve an integrated framework, where costs, physical, and perceptual dimensions of appearance and visual beauty are interpreted in the environmental conditions where the designed objects will be used.

The case study in this article will help ergonomists and designers to understand aesthetics satisfaction as inherent human factors in enhancing appeal but not in providing comfort, the leading criteria of sound ergonomics design. The two examples examine how a change of emphasis in design function and aesthetics affects user experience. Two lounge chairs designed in the 20th century are analysed: The *Eames Chaise* and the *Bel Air Chair*. Anthropometric data will cite measurements from BIFMA Guidelines for ergonomics chair design [7]. These are based on: *Seat Height, Seat Depth, Seat Width, Backrest, Range of Motion (ROM)* and *Armrests*.

3.1 Furniture Design I: The Eames Chaise

The *Eames chair*, introduced in 1968, was from an industrial suite of office furniture designed by American husband and wife team, Charles Ormond Eames, Jr., and Bernice “Ray” Kaiser Eames [15]. The lounge chair (Figure 1), with dimensions of 76.5 x 18 x 29.5 inches (193 x 46 x 75 cm) and weighing 115 lbs. (approx. 52 kg), is moulded from rosewood and plywood, with polyurethane foam cushions encased in full grain, semi-aniline MCL (*Medial Collateral Ligament*) upholstered leather and supported by die-cast aluminium base [16].



Figure 1: Eames Chaise

According to the designers, its slim proportions were intended to fit into a narrow office space and to provide a place for naps, a concept development urged on by the duo’s film director friend Billy Wilder who needed a convenient rest surface in between filming. The initial 6-ft x 12-in (183 cm x 30 cm) wooden plank perched on two narrow film studio workbenches known as ‘sawhorses’, was uncomfortable for that purpose [15]. The *Eames Chaise*, at a width of 18 inches (46 cm), was

sculptured with narrow contouring so the user would fold their arms over the chest to nap, but as soon as their arms fall to their sides, the user would be awakened just before falling into deep sleep mode, hence fulfilling the criteria of a short nap [17].

3.2 Furniture Design II: The Bel Air Chair

In the 1980s, the Italian architectural and design collective, Memphis Milano School, expressed non-conformance as a critical albeit much-derided response to mainstream European designs. The movement led by avid Utopian idealists championed by Milan architect Ettore Sottsass, became eminent through their series of reactionary pop art, outlandish furniture, textiles, wallpapers. In a short span of time, they manufactured objects considered an aberrance from commercial product designs of the late 1970s, which had become “black box” templates of shiny, boxy, mundane industrial stylings from black offices to furniture, cameras, buildings, and cars [18].



Figure 2: Bel Air Chair

The *Bel Air Chair* (Figure 2), designed in 1982 by Los Angeles-based sculptor Peter Shire, exemplifies this radical thought aesthetics. Framed in painted wood with cotton upholstery, the armchair is directly inspired by scenes reminiscent of California’s famed Malibu beach, symbolic of the spirit of creative freedom by bearing the shape of a shark’s fin for its backing. The asymmetrical silhouette expressed the spatial openness of architect John Lautner’s home, the Stevens House, a curvilinear-based architecture that bore nautical themes [19].

Function is secondary in this work where traditional furnishing and industrial design clashed intentionally. The *Bel Air Chair*'s assemblage of bright primary colours, geometrical shapes and different foot designs were clearly inspired by Art Deco, but the low height turned out an ergonomically dysfunctional product, making the armchair a visually provocative, eccentric, but ultimately user-unfriendly work. Its extraordinary form did not engineer its purpose to meet human factors of comfort and utility, nor did Shire concern himself with user experiences during the creative process [20]. The postmodern *Form Swallows Function* principle is the priority in this design, embodying the Memphis movement's unconventional stylings aimed to break away from traditional Italian furniture heritage.

4.0 PROPOSED SOLUTION

The *Eames Chaise* is an example of design offering partial satisfaction through the appeal of functional efficiency. The *Bel Air Chair*, on the other hand, symbolises a countercultural essence and postmodern expression through its form and visual evocation. Neither works showcase DFE outcomes as each provide different emphasis without assessing the role that aesthetics and ergonomics enhance the furniture's performance.

In applying BIFMA Guidelines for anthropometric values as the basis for user comfort, the two chair designs have definite issues relating to comfort. In the case of the *Eames Chaise*, user experience was not the priority. Without armrests, and by restraining the user's natural ROM, its narrow form and designing technique cannot be described as human-centred as it is unable to offer total physical and mental relaxation during naps. The *Eames Chaise* design has extremely limited ROM which could result in long term strain of the spine, back, and shoulders. It also increases the users' risk of accidental injuries from falling off in turning their bodies to either side while asleep.

For the *Bel Air Chair*, despite the inherent appeal of its unique aesthetics, users would be unwilling to be seated for too long. This is due to the unreasonably lowered seat height and shallow seat depth, and ungenerous strip of seating which cannot adjust a common percentile of users with acceptable variations of hip breadth, weight, and height. Additionally, the *Bel Air Chair* has a stiff backrest that does not support the body's natural spinal curvature, resulting in poor postural support. Essentially, the aesthetics of the *Bel Air Chair* has overtaken its functionality entirely.

The Eames Chaise's central proposition resolutely prioritises designing for utility, reflecting its industrial heritage by showcasing durability and material superiority. The chair exemplifies functionalism by eschewing all pretensions of visual evocations. Symbolically, it expresses a 20th century Modernist legacy that articulates design to demonstrate purity of form and in parsing away unnecessary embellishments. This may appeal to users desiring a centrepiece in their workspace. In the same way, the Bel Air Chair showcases postmodern beauty eloquently, but from an ergonomics perspective, it is a design anomaly that makes a statement about a style movement without fulfilling comfort requirements.

The analysis focuses mainly on the designers' perspectives as documented in literature, archives, and research articles. It should be noted that there may be significant differences between intended and actual functioning from the users' point of view, such as how design aesthetics of colour, shape and texture affect users' willingness to interact with the furniture and space occupied. The anthropometric components to evaluate these two works are also dissimilar: the Eames lounge chair considers physical and environmental conditions as it was designed to offer a rest space during work, while the Bel Air chair is a highly sophisticated "conversational piece" that voids the utility criteria.

Ergonomics must consider both psychological satisfaction from fulfilling user comfort and wellbeing, as well as the effects of visual aesthetics in determining their behaviour, such as a willingness to interact with the design. A chair design's ultimate test would be a combination of ergonomics and aesthetics that regards the user as the 'master of its destiny', not its end goal. Chairs should be built on sturdy dimensions that considers user needs such as natural ROM and postural comfort without foregoing aesthetics and environmental adaptations. Anthropometrics offers room for skilful designers to produce ergonomically efficient works using anthropometric qualifiers to achieve contemporary furniture design potential.

Clearly, what has emerged from this study is that incorporating ergonomics into furniture design extends user satisfaction. Designers' aesthetics sense must not be doubted or dismissed, in gaining a balance between ergonomics design such as providing comfort and visual aesthetics

through colour, shape and texture. Another benefit is that it would directly encourage wider commercial potential among furniture manufacturers.

Furniture designing is an industrial sub-discipline of fine art. Nevertheless, furniture that does not acknowledge ergonomics through measuring comfort and postural wellbeing to prevent injuries and enhance performance, cannot be described as efficient. Aesthetics and visual evocativeness can be a powerful characteristic in creative design communication, but in the final argument, gaining user satisfaction is a result of pragmatic ergonomics blending seamlessly with contemporary design values.

5.0 CONCLUSIONS

The 20th century mass production ethos demonstrated designers' training and skilfulness manipulating forms and materials. Today, the approach has flipped to integrate cultural values, emotions are central in creating perceptions, and design techniques come from a mix of disciplines. Cognitive and behavioural sciences such as consumer behaviour, personality psychology and social studies on cultural tastes provide key information and insights for practitioners today. While formal scholarship sufficed in the past, designers must embrace complex interactions between technologies, aesthetics, and ergonomics. Industrial and product designers must integrate HCD approaches that unifies mass production techniques and technologies with consumer tastes for high quality aesthetics.

In conclusion, the integration of aesthetics and ergonomics with human factors continues to underlie designers' social responsibility in innovations which meets consumer demands for tasteful, trendy, and ergonomics design. As industrial designer Steve Jobs said: *"Design is not just what it looks like and feels like. Design is how it works."* The window to fulfilling user experience has widened from a focus on function to aesthetic satisfaction. Ergonomists are the bridge connecting aesthetics with social demands. Designers must continue to hone their craftsmanship incorporating technological tools and design skills.

Aesthetics communicate culturally but DFE will sustain and add value to the whole design process. There are remarkably few fundamental principles of ergonomics, including anthropometrics, and surprisingly little scientific rigour in merging cognitive, behavioural, and social sciences with technology, business, engineering, and the arts. This suggests tremendous opportunities for ergonomics design research applications in enhancing user experience.

Ergonomists must therefore continue to play a leading role to improve perceptions towards their practice through increasing public awareness and appreciation of ergonomics via researching its impact on health, productivity, and wellbeing.

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Images Credit

Figure 1: Eames Chaise. Online: <http://www.hermanmiller.com/products/seating/lounge-seating/eames-chaise.html>

Figure 2: Bel Air Chair. Online: <https://collections.vam.ac.uk/item/O1175028/bel-air-chair-shire-peter/>