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TYPOLOGICAL – ERGONOMIC EXPERIMENT

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ABSTRACT

This applied research, "A Typology and Ergonomic Experiment", is focused on the development of ergonomic seating solutions tailored for young people working and studying from home. With the rise of remote work and education, informal environments often fail to provide adequate support for healthy posture. Users commonly adopt non-ergonomic positions, such as sitting on sofas, beds, or floors, which can lead to significant health issues. The research is centred on analyzing and optimizing design forms that integrate both aesthetic and functional criteria. Problems associated with non-ergonomic positions are identified in the study, and solutions are proposed to support healthy posture during extended periods of sitting in home environments. These findings have the potential to enhance user comfort, reduce health risks, and guide the future development of seating design for informal settings.

Keywords: design; ergonomics; experiment; innovation.

INTRODUCTION

The design of seating furniture has traditionally been shaped by established ergonomic principles and conventional typologies, particularly in office spaces, educational institutions, and domestic environments. Despite advances in materials and technology, standard seating-most notably office chairs-often fails to accommodate the needs of contemporary users. Extended periods of sitting in such rigid and outdated furniture can lead to physical discomfort, back pain, and long-term musculoskeletal issues. With the increasing prevalence of hybrid and remote work models, users are more frequently working and studying in informal environments that lack adequate ergonomic infrastructure. This disconnect between evolving user behavior and static design standards highlights the urgent need for innovative seating solutions combining aesthetic appeal and functional support.

Recent studies and observational research have shown that young people, particularly those aged 20 to 35, are especially affected by non-ergonomic conditions in home-based environments. These users tend to adopt postures such as sitting on beds, sofas, or floor surfaces not designed for prolonged desk-based tasks. These informal behaviors, while reflective of lifestyle flexibility, often result in unhealthy spinal loading, forward head posture, and muscular imbalance. Although ergonomic guidelines are widely available, they

are primarily tailored to traditional office contexts and do not adequately address the spatial and behavioral complexity of modern domestic interiors. Current ergonomic research provides extensive solutions for structured workspaces; however, a critical gap remains in addressing the needs of informal, mobile, and multipurpose work settings. This study responds to that gap.

This paper aims to explore the intersection between visual identity, functional utility, and user health through a typological–ergonomic experiment focused on seating design. The experiment hypothesizes that analyzing non-ergonomic behaviours and postures adopted by users in informal settings will reveal opportunities to improve comfort, reduce health risks, and support long-term well-being. The primary objective is to develop seating that meets the physiological needs of users while contributing aesthetically to the visual language of contemporary living spaces. Unlike traditional design approaches that prioritize either form or function, this research seeks to establish a holistic model in which the two are inseparably integrated.

The proposed design process begins with the observation and evaluation of common postural patterns in informal working environments, followed by the development of a series of material and morphological experiments. These experiments are intended to test not only the physical characteristics of novel materials – such as air-filled components and advanced foams – but also their psychological and sensory impact on the user. Emphasis is placed on user-centred evaluation criteria, including postural support, visual feedback, and comfort perception over time. Each prototype is approached as both a functional product and a visual composition, reflecting a design philosophy that places equal value on aesthetics, interaction, and human well-being.

Historically, the field of ergonomics has evolved from practical wartime applications to a sophisticated interdisciplinary science encompassing biomechanics, psychology, design, and engineering. The formal establishment of ergonomics as a discipline occurred in the 1940s when growing system complexity demanded more human-centered design thinking (Chapanis, 1951). In 1949, the Ergonomics Research Society was founded in the United Kingdom, formalizing the field's scientific legitimacy (Singleton, 1982). Today, ergonomics is no longer viewed merely as a tool for increasing productivity; it is recognized as a framework for enhancing comfort, reducing physical strain, and improving the overall quality of life across all aspects of daily function.

The Importance of Ergonomic Comfort

Ergonomics, as a scientific discipline, aims to create environments that support the physiological and psychological needs of users. In non-traditional workspaces, this goal becomes more complex due to the variability of furniture and spatial conditions. Ergonomic comfort encompasses a wide range of elements, including maintaining a correct body posture, adjusting screen and desk heights to proper levels, providing arm support, and optimizing lighting conditions. The absence of these elements can lead to musculoskeletal disorders, including lower back pain, neck tension, wrist fatigue, and general discomfort caused by prolonged incorrect sitting positions (Bridger, 2008).

A particularly relevant issue is the widespread use of non-ergonomic furniture in domestic environments, such as sofas, beds, or kitchen chairs, which are not designed for long-term desk work. These environments often lead to harmful postures such as slouching, forward head posture, lack of lumbar support, or bent wrists, which substantially increase the risk of chronic pain and spinal issues.

Although implementing ergonomic standards in such spaces may seem challenging, small interventions can significantly improve the situation. Using laptop stands, external

keyboards, adjustable chairs, or even makeshift lumbar supports (such as rolled-up towels) can help improve posture and reduce strain. Alternating between sitting and standing positions, as well as incorporating short movement breaks, can also prevent overuse injuries and fatigue. In today's flexible working culture, non-traditional work environments, such as home offices, cafés, or shared co-working spaces, have become increasingly common. These environments often lack proper ergonomic infrastructure, which may lead to poor posture, discomfort, and long-term musculoskeletal disorders. Young individuals, in particular, frequently engage in prolonged work or study in non-ergonomic settings using sofas, beds, or floor seating. This study addresses these shortcomings through an applied design research approach.

The design creation is primarily oriented towards young students and creative professionals who operate in informal environments, such as living rooms or hybrid home-office spaces. Typically, aged 20 to 35, this group combines productivity with a desire for comfort, seeking adaptable furniture that aligns with a flexible lifestyle. The proposed solution addresses their ergonomic needs while maintaining visual and functional compatibility with domestic interiors. Framed by the evolution of ergonomics as a scientific discipline, this research highlights the mismatch between informal user behavior and conventional seating design. Through a typological–ergonomic experiment, user patterns are analyzed to develop design alternatives that promote postural health and integrate aesthetically into everyday living spaces.

Ergonomic Design Principles

The implementation of ergonomic principles within product design – commonly referred to as ergonomic design – plays a critical role in shaping how individuals interact with objects in their daily lives. This approach extends beyond functionality, encompassing physical, cognitive, and emotional dimensions of user experience (Dul et al., 2012). Despite its relevance, ergonomic design is often undervalued during the early stages of development due to cost constraints or limited awareness, particularly in commercial practice (Helander, 2005).

This study positions ergonomic design not only as a set of guidelines but as an evolving methodology that bridges analytical research with creative intuition. It advocates for the integration of ergonomic insights into the entire design process – from user research and material selection to prototyping and performance testing. In doing so, it supports the development of design solutions that are adaptive, emotionally resonant, and embedded with user-centered intelligence.

By leveraging experimental methods, visual analysis, and interdisciplinary thinking, the present research contributes to a more nuanced understanding of what ergonomics can offer in the context of contemporary domestic life. Rather than treating comfort and aesthetics as opposing priorities, this study embraces their interdependence as the foundation for a new generation of seating design.

Experimental part:

Typological-Ergonomic Research

The primary objective of this research is to design and optimize innovative seating solutions through a typological-ergonomic experiment, addressing the ergonomic shortcomings commonly observed in informal home-based work environments. These shortcomings are particularly prevalent among the younger population, whose work habits often involve using sofas, beds, and other non-ergonomic surfaces.

The study begins by analyzing the typical positions adopted by young users during remote work or study, with a particular focus on physiologically atypical or static postures that can contribute to discomfort and health complications over time. Based on observational data and ergonomic evaluation, model scenarios were constructed to simulate the most frequent non-ergonomic working positions. The goal is to critically assess these scenarios and extract key problem areas related to spinal loading, muscular imbalance, and posture deviation. Following this, the experiment aims to develop seating prototypes that strike a balance between aesthetic quality and functional ergonomics, with a focus on flexible use in home environments. These prototypes incorporate customizable elements such as adjustable lumbar supports and dynamic seat contours to encourage natural movement and varied sitting positions throughout the day.

Non-Ergonomic Posture and Its Consequences

Extended periods of static sitting are widely recognized as a significant risk factor for musculoskeletal disorders (MSDs), particularly when accompanied by poor posture. Although the biomechanical mechanisms are still debated, evidence suggests that low back pain (LBP), cervical stiffness, and shoulder tension are closely linked to improper sitting behaviors and prolonged static postures (Waersted *et al.,* 2010; Lis *et al.,* 2007).

In our previous pilot study, which involved 200 home-working students and professionals, 67% of respondents who were aware of proper posture still reported experiencing pain in the head, neck, back, or hips. This suggests a gap between theoretical knowledge and practical application.

According to the European Agency for Safety and Health at Work (EU-OSHA, 2022), the most reported contributors to MSDs include:

- Lack of sleep (85%)
- Passive load due to inactivity (70%)
- Bad posture (60%)
- Work overload (30%)

Another large-scale survey conducted in an urban academic population (N = 1,000) found that 68.7% of participants believed ergonomics is undervalued in their work settings.

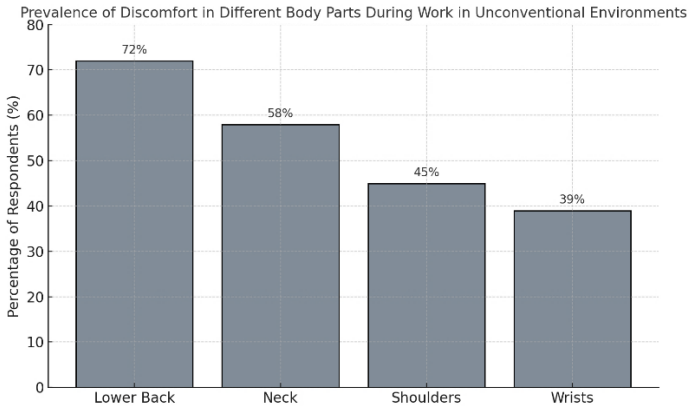

Fig. 1 Percentage of respondents reporting discomfort in different body parts during work in unconventional environments.

Design Implications and Innovative Approaches

Recent ergonomic studies indicate that traditional static sitting positions are insufficient for modern work demands. Dynamic seating that adapts to user movement, such as supportive backrests that respond to body shifts, is now considered a best practice

(Steelcase, 2020; Ergonomics Society of Korea, 2021). These solutions support greater postural variation, increase blood flow, and help prevent fatigue.

While referencing contemporary ergonomic standards from South Korea, it is acknowledged that anatomical and anthropometric differences exist between Asian and European populations due to varying somatotypes influenced by genetics, diet, and lifestyle. For example, comparative anthropometric studies indicate notable differences in sitting height, limb length ratios, and pelvic inclination across regional populations, which may affect seating ergonomics and posture tendencies. Asian populations typically exhibit lower average stature, shorter femur length, and reduced hip breadth compared to European cohorts (Pheasant and Haslegrave, 2005).

Despite these differences, the selected Asian sources were primarily used in this study for their relevance to the perceptual and behavioral aspects of ergonomics, particularly dynamic posture adaptation and design-user interaction in flexible work environments. The cited research focused less on static dimensional data and more on adaptive ergonomic strategies, which are applicable across regions when interpreted in context.

To account for variability, this study emphasized qualitative evaluation methods and user-centered testing using a European sample group. This approach ensured that design conclusions were contextually relevant, even when referencing international ergonomic literature. Future research could benefit from region-specific anthropometric databases to enhance local accuracy.

Design Development as an Experimental Methodology

The design development process in this study focuses on exploring new formal solutions through an experimental approach that both complements and transcends the boundaries of traditional design methods. The primary design stream of conventional work seating serves as the starting point and structural backbone of the creative process. In contrast, the experimental method challenges these conventions by exaggerating their formal logic, opposing standard typologies, and introducing novel associations, references, and symbolic connections.

The primary medium of this experimental exploration is authorial drawing concept sketches, which serve not only as tools for visualization but also as a method for conceptual thinking and discovering unanticipated forms. The iterative creation of material concepts and virtual visualizations enabled a dynamic reassessment of the relationship between form, function, and user experience. These sketches and renderings represent various interpretations of seating design, with their expressive and formal diversity underlining the experimental nature of the project.

A core feature of the design experiment was the integration of inflatable (air-based) components, which offered novel ergonomic properties and high morphological adaptability. These inflatable elements enable dynamic interaction between the user and the object, forming the basis for innovative seating typologies. Throughout the design process, both inflatable and foam-based materials were examined for their formal potential, drawing inspiration from organic structures and biomorphic shapes. Their aesthetic and structural qualities reflect an ability to morph and respond to the user's immediate needs, resulting in a dynamic yet intuitive ergonomic system. One of the key outcomes of this design research is the concept of formal variability. The resulting furniture prototypes demonstrate an inherent ability to transform over time through continued use. This adaptive response signifies a fundamental shift in ergonomic thinking from rigid, static structures to living, evolving systems. Notably, the presence of physical folds and surface deformations functions not only as a visual aesthetic but also as a functional indicator. These changes serve

to highlight areas of most significant stress on the user's body and can intuitively prompt the user to take breaks or adjust their posture. This feature introduces a dialogue between the object and its user, reinforcing the importance of motion and variability in ergonomic comfort.

Form Exploration and Ergonomic-Aesthetic Integration

From the beginning of the design process, emphasis was placed on integrating functional and aesthetic aspects. The main challenge was to develop a solution that would support ergonomically sound seating while maintaining visual appeal.

Form Experimentation

In the initial phases, the design focused on exploring various seating forms. The goal was to identify shapes that naturally promote proper posture while allowing for dynamic position changes during extended sitting periods. This phase involved modeling different proportions and curvatures that reflect the natural lines of the human body.

Through this process, several forms were identified that enhance user comfort and reduce pressure on critical areas such as the spine and lower back. These shape studies played a key role in establishing the design framework, offering both postural support and an aesthetic that aligns with contemporary living environments.

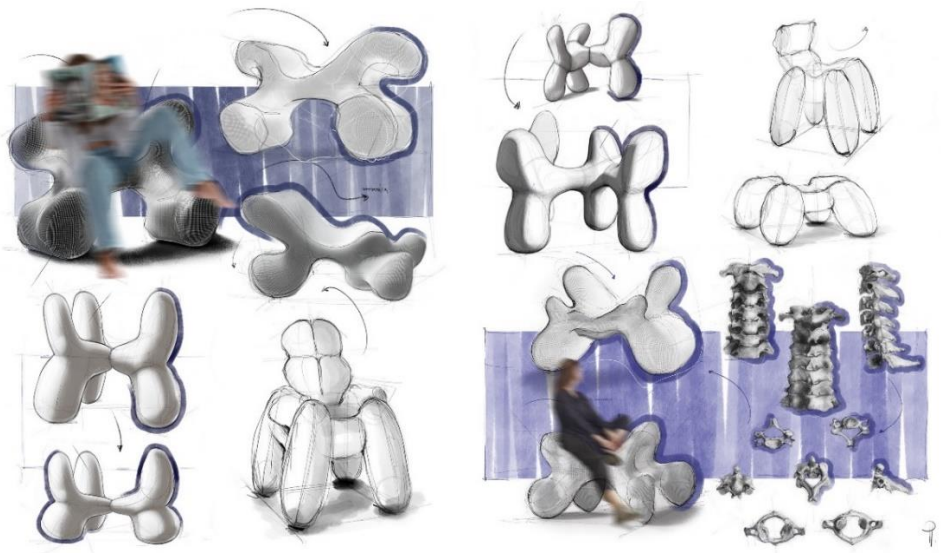

Fig. 2 Conceptual Shape Exploration Inspired by Human Spine Morphology. The sketch illustrates the evolution of form studies based on the anatomical structure of the human spine and vertebrae. These experiments focus on achieving ergonomic seating support through biomorphic shapes that respond to the body's natural posture dynamics.

MATERIALS AND METHODS

Material Exploration and Methodological Approach

In the exploratory phase of the experimental design process, the creative direction focused on the formal and sensory potential of unconventional materials, particularly inflatable (aero) and foam-based media. These materials were selected for their ability to reference both highly biological forms and abstract, non-organic mass structures. Inflatable elements, in particular, are experiencing a contemporary revival within furniture and product design. Once popularized at the turn of the 21st century, their lightweight construction, color

variety, and visual deviation from traditional upholstery have appealed to younger generations seeking flexibility and visual novelty in their domestic interiors (Tosi, 2020).

This renewed interest in inflatables aligns with a broader return to organic aesthetics and the integration of bio-based or biodegradable plastics. The environmental impact of conventional plastics has prompted continuous research into how these materials can be modified to emulate organic properties while reducing their ecological footprint (Salvend, 2012). This has led to a shift in perception, where morphology and materiality that reference the human form, such as biomorphic shapes, asymmetry, and softness, become emotionally resonant and trustworthy for the user. By incorporating human-like characteristics such as irregularity, surface flexibility, and formal imperfection, these materials acquire a layer of authenticity. Their tactile quality and perceived "softness" support more natural interactions and enhance the design's overall ergonomic potential. This shift allows designers to create seating that is not only functional and sustainable but also emotionally engaging and sensorially responsive (Blythe and Wright, 2003). From a material innovation standpoint, inflatable fabrics commonly used in logistics or healthcare (e.g., anti-decubitus mattresses) demonstrate considerable ergonomic benefits. These materials enable adaptive surface behavior, distributing pressure dynamically and responding to varying body weights and positions. Their integration into the seating design opens possibilities for new interactive ergonomic systems, where the material's response may guide users to shift positions or take breaks during prolonged sitting.

Additionally, the research examined memory foams and elastomeric compounds used in the footwear industry, known for their resistance to degradation and superior structural memory. Compared to traditional foams used in upholstered furniture, which often degrade under prolonged load, footwear-grade polymers offer greater resilience and deformation resistance. The experimental application of these non-standard materials in seating design remains underexplored but holds promise for enhancing durability and comfort in high-traffic environments. The simplicity of inflatable production technologies widely available in packaging and logistics makes them viable for adaptation into modular or adjustable seating. By exposing structural components instead of concealing them through conventional upholstery, the design highlights the material's behavior and its interaction with the user.

These material studies form a foundational component of the design experiment, highlighting new pathways for developing ergonomic seating solutions that are both functionally and aesthetically innovative.

To assess the ergonomic performance of the selected materials, a qualitative rating method was applied. Three user-centered criteria–pressure response, visual feedback, and posture support–were rated on a scale from 1 to 10, with higher values indicating greater ergonomic functionality. The evaluations were conducted by a panel of six design researchers and postgraduate students specializing in ergonomics and furniture design. Each sample was tested under controlled conditions simulating prolonged sitting, and average scores were calculated to inform the comparative analysis presented in the results.

Tab. 1 Comparison of Tested Materials by Ergonomic Criteria. These findings suggest that interactive materials with feedback capabilities can play an active role in shaping healthy postural habits, while air and soft foams remain strong candidates for immediate comfort and support. Future development could explore hybrid material compositions that combine high comfort with smart responsiveness.

Material	Pressure Response	Visual Feedback	Comfort	Posture Support
Air Cushions	9	4	8	8
Soft Foams	7	2	9	7
Interactive Foams	8	10	7	9

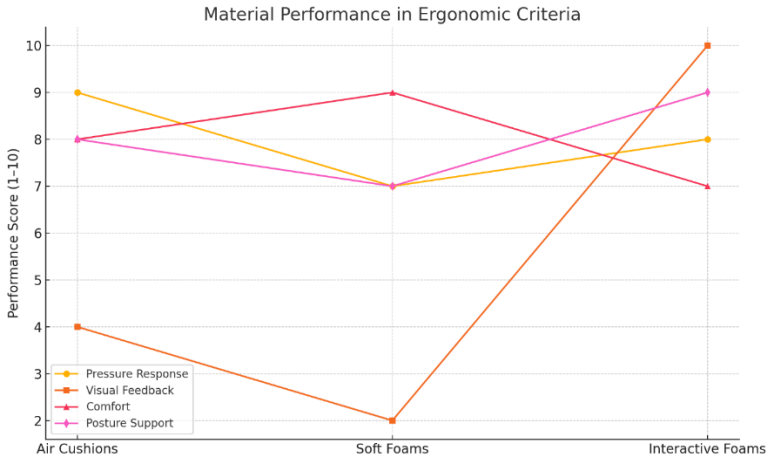

Fig. 3 Performance of tested materials in ergonomic criteria. The graph illustrates the average evaluation of three types of materials – Air Cushions, Soft Foams, and Interactive Foams – based on four ergonomic parameters: Pressure Response, Visual Feedback, Comfort, and Posture Support. Ratings were given on a scale from 1 to 10, where higher values indicate better performance in a given criterion. The results reveal significant differences among the materials, with Interactive Foams achieving the highest score in Visual Feedback and demonstrating overall balanced performance across all evaluated criteria.

RESULTS AND DISCUSSION

A practical experiment was conducted to observe the behavior of the proposed seating element's materials, forms, and functional characteristics. The focus was on analyzing how the object interacts with both the user and the surrounding environment, including the appropriateness of the proposed dimensions in accommodating diverse user needs. The aim of the experiment was to develop several design variants in terms of shape, material composition, and surface transparency while emphasizing the optimization of ergonomic performance and enhancing the object's visual identity.

Special attention was given to incorporating recognizable anthropomorphic features into the design to create a solution that is both visually appealing and functionally effective. The inclusion of human-inspired morphological elements aimed to enhance user affinity and physical comfort by aligning with the natural contours of the body.

The final design prototypes were tested in various interior settings to evaluate their practical usability, aesthetic value, and capacity to support healthy ergonomic behavior and overall user comfort. These real-world applications enabled a comprehensive evaluation of each prototype's adaptability, especially in informal workspaces such as home offices or multipurpose living areas. The results suggest that form variants which integrate subtle anatomical references are better received in terms of intuitive use, while transparent or semi-transparent materials contribute to the perceived lightness and spatial harmony of the design. These findings highlight the importance of user-centered design approaches in developing furniture solutions that are not only ergonomically valid but also capable of blending seamlessly into the visual and functional dynamics of contemporary domestic environments.

Organic Form as a Sculptural Interpretation of Comfort and Movement

The design of the seating object was guided by the intrinsic qualities of the human form, its proportions, curves, and the sculptural logic of anatomy, which served as the primary inspiration. The resulting structure reflects organic lines, soft transitions, and an

abstracted representation of bodily flow, capturing a sense of harmony and energy inherent in human physiology.

This object is not merely a passive imitation of anatomy but an active reinterpretation of its structure and function. It responds to its formal origins by transforming them into new dimensions of functionality, aesthetics, and interaction. The seating element is conceived as a medium that embodies balance between the calm visual presence it introduces into a space and the ergonomic support it offers to the user.

The result is a tangible expression of comfort that extends beyond materiality. The object subtly transforms the environment in which it is placed, creating a spatial experience where functionality merges with beauty, and the physical connection between body and form leads to a more profound sense of harmony.

Far beyond a conventional seating unit, the design becomes a sculpture in motion, a dynamic companion that bridges the user with space and time. Its abstract character invites exploration, its fluidity encourages awareness, and its organic essence restores a subtle sense of equilibrium in everyday life.

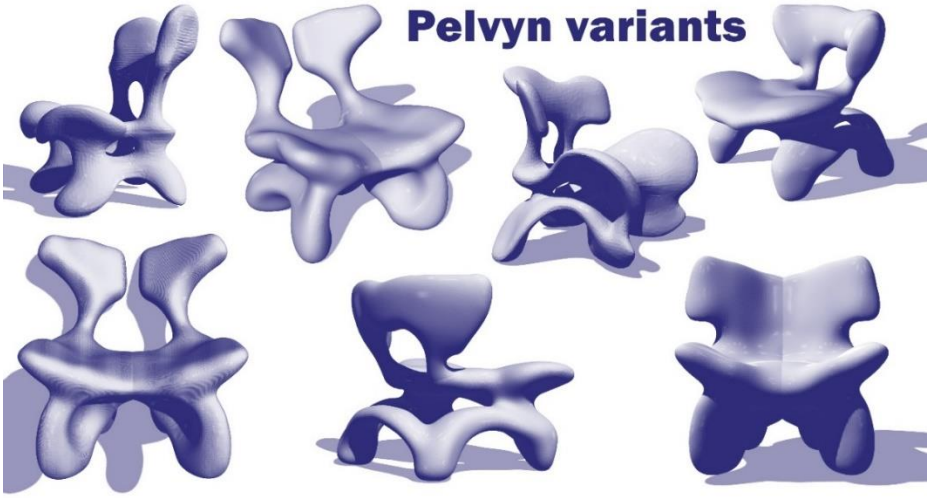

Fig. 4 Pelvyn chair – form variants. A selection of design prototypes exploring ergonomic, sculptural, and anthropomorphic qualities. Each variant represents a different approach to supporting dynamic posture and user comfort while reflecting the anatomical inspiration of the human pelvis.

CONCLUSION

Contemporary shifts in lifestyle, work habits, and even human body proportions driven by sedentary behavior and technological innovation highlight the growing disconnect between current user needs and traditional design and ergonomic standards. Despite these transformations, design practice often continues to rely on outdated methods that no longer fully reflect the demands of modern users. Furthermore, limited access to advanced tools and technologies hinders the development of more precise, adaptable design solutions.

These current design challenges underscore the need to continually seek a balance between aesthetics, functionality, and user well-being. Emphasizing ergonomics is becoming a crucial factor in creating products and spaces that respond to the dynamic nature of contemporary lifestyles. Analyzing the interaction between humans and their environment has revealed the importance of integrating physiological, psychological, and practical considerations in the design process. The aim is to create solutions that are not only visually attractive but also health-promoting.

The findings confirm that achieving harmony between functional value, visual appeal, and health-related aspects is essential for effective and sustainable design. Such solutions have the potential to significantly enhance user comfort and quality of life while shaping new standards for the application of ergonomic principles. This approach also opens avenues for the development of innovative and sustainable solutions applicable to various areas of everyday life.

Moreover, the integration of advanced technologies and modern methodologies is increasingly necessary to gain a deeper understanding of current ergonomic challenges. These tools and insights can significantly enhance the accuracy and effectiveness of design implementations, stimulating the development of experimental, innovative, and practical solutions. In doing so, a new chapter in design is an unfolding one that merges aesthetics with functionality and responds to the dynamically evolving needs of today's society.

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