

Review Paper

Ergo-Aesthetic: A Systematic Review of the Synergy between Ergonomics and Aesthetics in Product Design

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Abstract

Ergonomics and aesthetics are two critical factors in the product design process that can influence the quality and efficiency of products. Since a comprehensive and systematic framework for examining the synergy between ergonomics and aesthetic criteria in product design has not yet been presented, this review study aims to explore this dual relationship. This research employs a systematic review method, utilizing the Scopus and Google Scholar databases. Out of an initial 262 articles, after several stages of evaluation, 44 articles were selected for the final review. The insights and findings from the literature review in this field and various research methods were combined and categorized into a conceptual framework. The results of this review article can provide designers with new insights into the design of ergonomic and aesthetically pleasing products. Additionally, it can pave the way for new research studies for researchers interested in product design research methods.

Keywords: Ergonomics, Aesthetics, Product design, Industrial design.

INTRODUCTION

This study investigates the interplay between two critical components of product design: ergonomics and aesthetics. Undoubtedly, with intense competition in the commercial market, meeting customer needs is gradually becoming more complex. On one hand, changes in social norms and lifestyle make this complexity even greater. Therefore, not only functional features but also the implementation of impactful elements, such as appearance design (Braun et al., 2020), scientific ergonomic structure, the pleasant feel of touch, and consumer perception (Chen et al., 2019), regarding quality, among others, are essential for customer satisfaction (Stauss et al., 2019; Umami et al., 2021). Additionally, in recent

years, emotional perception features in products have played an even more significant role in creating competitive advantages, due to the high cost of improving functional features (Jin et al., 2022). Together, ergonomic design and the integration of sensitivity to aesthetic design contribute to improved user involvement and satisfaction and the market opportunity for products (Ding et al., 2024; Jafarnejad Shahri et al., 2024; Shi et al., 2021). Evidence shows that more than two-thirds of dissatisfied customers (Walker, 2017) do not necessarily express their dissatisfaction with service or product providers, nor do they file complaints, but some dissatisfied customers may negatively impact the provider's reputation and income through negative word-of-mouth advertising (Azemi et al., 2020; Kwok, 2021). Consequently, a high level of customer satisfaction

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has substantial ramifications for the company, including the protection of current market share, the enhancement of financial performance, the reduction of complaints, and the increase in customer loyalty. The 21st century will see a major advancement in the emphasis on aesthetically pleasing product and system design due to the advancements in design and manufacturing technologies, as well as the sophistication of the market (Zazarida Rifin, 2024). As a result, it is essential to understand the factors behind how customer satisfaction evolves (Hallencreutz & Parmler, 2021). The current review article aims to highlight and study patterns in earlier research on aesthetics and ergonomics. This systematic gathering and analysis of the relevant literature has been done in this article for a better understanding of user needs and experiences that could serve as a basis for further studies in industrial design and ergonomics. These could help designers, producers, and researchers improve product development and enhance customer satisfaction.

Aesthetics and User Perception

Aesthetics is the study of the impact of product gestalt on human emotions (Shi et al., 2021). "Perception of product utility value" is one of the key criteria designers consider when designing products to meet user needs. Senses such as vision, hearing, and touch (Hekkert & Schifferstein, 2008; Parras-Burgos et al., 2021) gather the physical characteristics of stimuli, and the brain processes them using stored knowledge and information in long-term memory (Wickens et al., 2003), leading to a perception (Kapkin & Joines, 2018; Mishra, 2016) that enables us to interpret and recognize environmental stimuli (Branaghan & Lafko, 2020). Functionality is also considered an external value of product perception (Iftikhar et al., 2020),

which may result in impulse buying behavior (an unplanned and spontaneous purchasing action) triggered by certain factors throughout the consumer purchasing process (S. Yang et al., 2021). The perception of quality is connected to the primary human senses, which carry out the first level of perceived quality characteristics (Braun et al., 2020). Around the 1970s, American psychologist and cognitive science expert Donald Norman spoke about products that simultaneously engage human emotion and spirit (P. Liu et al., 2020). He categorized the emotional responses evoked by users through products during different stages of interaction into three levels (Table 1).

Consumers' reactions to products are so complex that it becomes pretty challenging to understand their negative or positive experiences (Fenko & van Rompay, 2018). This emphasizes the need to focus on the affective dimensions of users' interaction and engagement with products as suggested by Desmet and Hekkert (2007). The shape of a product influences the consumer's first impression, so designers must create products that meet consumers' aesthetic preferences (Lu et al., 2021). For this reason, aesthetics has become a critical competitive factor in distinguishing products during decision-making and purchasing behavior (Zhou et al., 2021). Figure 1 illustrates that the aesthetic experience of a product is the capacity of the product to evoke one or more senses (Desmet & Hekkert, 2007). A product may appear beautiful to sight, pleasant to touch, or even smell. Furthermore, the cognitive processes of meaning creation mainly rely on perceptions, where cognition may help an individual retrieve memory, make associations, and interpret the signals so that they can create links among metaphors, attributes, and symbolic identities of products.

Table 1. Three Levels of Users' Emotional Responses in the Stages of Interaction with Products

First level	Visceral	It has a direct connection with emotional experience: smell, sight, hearing, touch, and taste, which together define the perceived appearance of the product.
Second level	Behavioral	It is determined by evaluating the product's performance and usability (how easy it is to use). At this level, regardless of prior experience, the user's response may range from frustration to satisfaction.
Third level	Reflective	The reflective aspect refers to a longer-term experience that can evoke more objective feelings about what the product creates for the user, as it can be linked to their culture, identity, education, and memories.

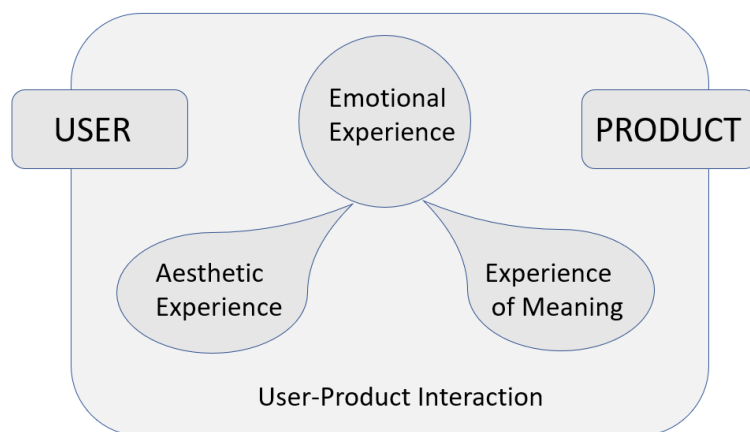


Fig 1. Product Experience Framework (Desmet & Hekkert, 2007)

Ergonomics

Ergonomics is defined by the International Ergonomics Association IEA¹ (as "the scientific discipline concerned with understanding the interactions between humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance" (Salmon et al., 2020). Higher levels of productivity and health are the objectives of this interdisciplinary investigation (Naeini et al., 2014). Ergonomics is an essential part of research in product development, using anthropometric data to determine the optimal size, shape, and form of a product to make it easier to use. The relationship between individuals (working as users) and their environment or products is the primary concern of ergonomics and its related subdisciplines (Sadeghi Naeini, 2020b). For example, the application of cognitive ergonomics in the design of systems and equipment can reduce errors (Hollnagel, 1997), thus enhancing user safety while interacting with products and creating overall user satisfaction. It should be noted that satisfaction is one of the features of product usability and is related to the pleasure of using the product. "Usability" (Hashim et al., 2021) and the functionality of a product are essential factors that contribute to a good user experience. User experience refers to the overall impact a user feels before, during, and after interacting with a product (or system) in a given environment (Hartson & Pyla, 2018). In other words, user experience (Alechnavicius, 2021) is creating and synchronizing elements that influence users' perceptions and behaviors.

¹ International Ergonomics Association

² Smell-O-Vision was a system that released a scent associated with a scene during a movie so the viewer could "smell" what was

These would include, but are not limited to, tangible products and packaging that users can touch, commercials and sound effects that they can hear, and even scents—like the smell of freshly baked bread. It also contains elements users interact with beyond physical means, such as digital interfaces through websites and mobile applications, and people represented through customer service representatives, vendors, and friends and family. A significant advancement observed in recent years is the capacity to synthesize factors influencing these different sensory modalities into a more unified and enhanced experience, exemplified by the initiative termed "Smell-o-vision"² during the film production in 1960 (Unger & Chandler, 2023). Achieving higher levels of pleasant emotional experiences in customers is one of the main concerns for product manufacturers.

Companies like Frog Design, Alessi, and Swatch are prime examples of this approach. Each generation of designers is presented with new opportunities to transform human experiences in a manner that is more straightforward, safer, more pleasurable, and even more persuasive than ever before (Parush, 2015).

METHODS

This investigation examined Persian and English articles that addressed the integration of ergonomics and aesthetics within the context of "product design" between 1991 and 2023. Google Scholar was used for Persian articles, and the Scopus database was used for English articles. Table 2 shows the searched keywords. Keyword combinations were made to cover all relevant articles, and to simplify the research, exclusion criteria were applied to articles that were not

happening in the film. Hans Laube developed this technique, and it was only performed in the 1960 film *Scent of Mystery* by Mike Todd Jr.

explicitly related to product design (Fig. 2). We identified 114 and 152 articles in English research works, respectively. Based on the abstract reading and screening, reading the selected articles, and considering the inclusion and exclusion criteria, 103 Persian articles and 118 English studies were

excluded, and 33 English articles and 11 Persian articles were selected for review (Fig. 2). In the next stage, a complete analysis of the selected articles was conducted, and their descriptive information is presented in Table 3.

Table 2. Search Results of Articles in "Ergonomics and Aesthetics in Product Design" (1991-2023)

Search query	period Time	Number of papers
TITLE-ABS-KEY (ergonomics) AND TITLE-ABS-KEY (aesthetics) AND TITLE-ABS-KEY ("product design")	1991-2023	SCOPUS= 148 documents found
(Ergonomic + aesthetics + "Product Design") and (Ergonomic + "Product Design") and (aesthetics + "Product Design") and (aesthetics + "Product Design")	2008-2023	google scholar=114 documents found

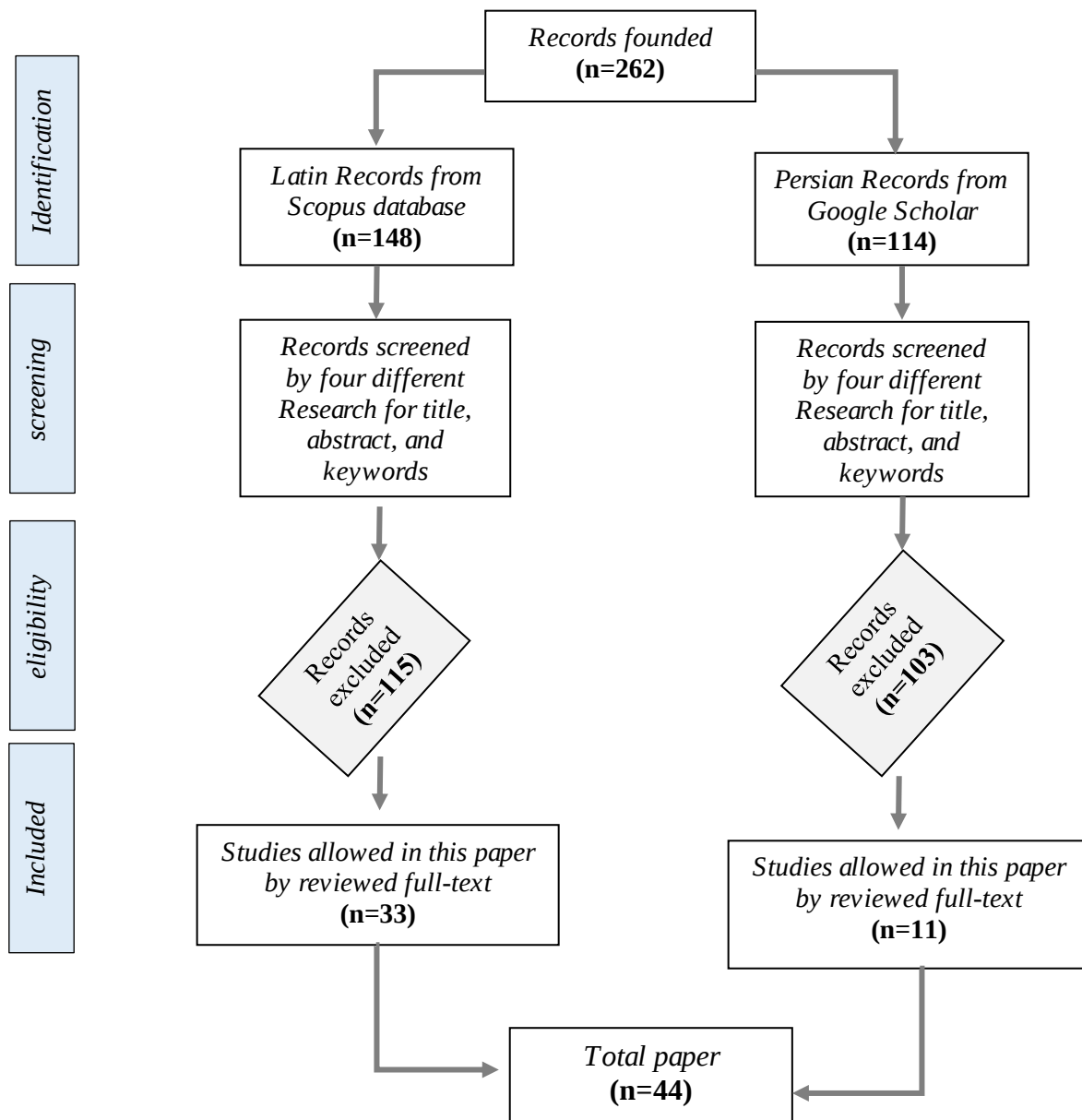


Fig 2. Flow Diagram of the Search Strategy and Exclusion Criteria

The information from English articles was obtained from the Scopus citation database output (based on a search of three keywords: "product design," aesthetics, and ergonomics in the TITLE-ABS-KEY field, with a year range of 1991–2023, yielding 148 documents). Upon reviewing the output in the VOS viewer software, it was determined that 39 countries were active in this field. After filtering for

countries with at least two articles and a minimum of 10 citations, 18 countries were visible on the map (Figure 3). It can be observed that China and the United States have had the most activity in this field, while Italy and Sweden have increased their activity in recent years, according to the timeline. Additionally, as shown in Figure 4, most studies in this field were conducted between 2019 and 2021.

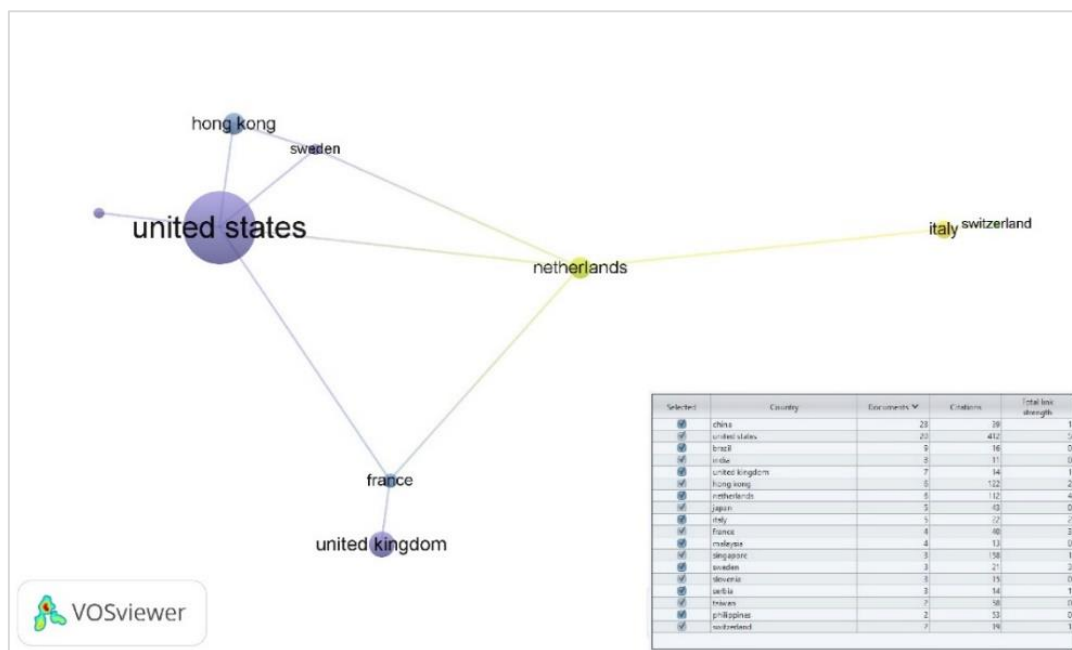


Fig 3. Vos viewer Results

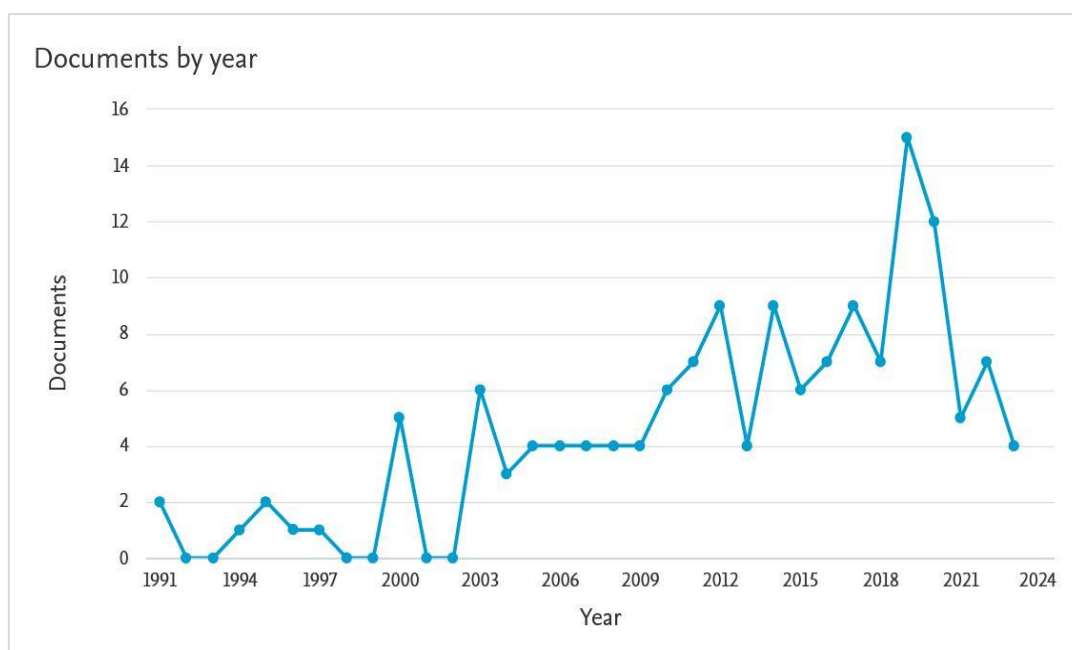


Fig 4. Number of Documents by Year

Table 3. Summary of Articles

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
1	(Akita, 1991)	Design and Ergonomics	A review of the latest product designs from annual Japanese and American design reports, emphasizing the role of ergonomics and its integration with aesthetic value in mass-produced technological products	This method includes reviewing industrial product designs from annual Japanese and American design reports, emphasizing the importance of ergonomics in product design, especially for older adults, and focusing on user-centered, solution-driven product designs	- In technological products, the integration of human-centered design and aesthetic value is essential - Design in categories such as leisure, entertainment, and DIY is essential for evoking pleasure - In modern products like cameras, audio-visual equipment, cars, and personal computers, aesthetics takes precedence over advanced technology	Evoking pleasure
2	(Trathen, 2000)	Usability and emotional responses at 3 stages of user-product interaction	Study objectives include examining the interaction between users' responses to usability and aesthetics in home electronic appliances, exploring the overlap between usability and emotional responses to products, and examining consumer emotional reactions during product selection and use	This method includes testing 180 participants using various models of two types of products across three stages of user-product interaction to explore the overlap between usability and emotional responses to products: Stage A: Evaluate product models based on 2D images Stage B: Evaluate subsets of product models based on physical inspection and handling Stage C: Evaluate similar sets of product models based on actual use	Products that were visually appealing scored high in responses during both the familiarization and usage stages. Results may well support the view that emotional responses have the potential to influence product selection. The challenge for designers, marketing analysts, and ergonomists is to find ways to exploit this potential in the design process.	Emotional responses
3	(Macdonald, 2000)	Aesthetic intelligence assists inclusive design	Study's objectives include supporting the understanding of aesthetic intelligence in	The method used in this study involves a sensory interaction	This article argues that if the concept of "aesthetic intelligence" is understood,	Aesthetic Intelligence

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			product design, enhancing inclusivity in design by considering personal, cultural, physiological, and psychological factors, and highlighting differences in sensory approaches for different individuals.	scenario to reveal aesthetic intelligence, utilizing the Dreyfus model for the safe zone.	products can be designed more inclusively.	
4	(Helander, 2003)	Forget about ergonomics in chair design? Focus on aesthetics and comfort!	Reassessment of prior research on seat design factors that are associated with user perceptions of comfort and distress, the identification of the significance of integrating ergonomics and aesthetics into seat design, and the examination of the translation of influential variables into customer needs and design parameters.	This method involved summarizing previous articles on seat ergonomics and conducting an experimental approach with seat users from IBM, assessing discomfort using the Shackel and Corlett criteria and a seat evaluation checklist, with analysis through variance assessment.	It is challenging for users to identify the ergonomic quality of seats, and they tend to prioritize comfort based on aesthetic evaluations.	Aesthetic Preference Over Comfort
5	(Russo & De Moraes, 2003)	The Lack of Usability in Design Icons: An Affective Case Study About Juicy Salif	In this study, they analyzed the impact of the absence of an ergonomic approach during the design phase on product usability, examined usability issues in products with strong aesthetic appeal, and conducted a case study on the Juicy Salif lemon squeezer to evaluate its usability.	This method included a usability test with six participants who used similar products to Juicy Salif. Participants shared their feedback and suggestions after use regarding aspects such as ease of use, ease of cleaning, and the product's aesthetics.	The Juicy Salif lemon squeezer was appreciated for its aesthetic appeal; still, it was challenging to use, leading participants to prefer their regular lemon squeezers for actual use.	Difficult to Use
6	(Y. Liu, 2003a)	Engineering Aesthetics and Aesthetic Ergonomics: Theoretical Foundations and a	The study aims to use engineering and scientific methods to study aesthetic concepts in a two-	This method involves using engineering and scientific approaches to study aesthetic	The article emphasizes the need to integrate aesthetics into ergonomics through the creation of a	Engineering Aesthetics

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
		Dual-process Research Methodology	dimensional space defined by the aesthetic dimension and the psychosomatic health dimension. Additionally, it examines the sensitivity of perceivers in recognizing changes in aesthetic variables, their ability to perceive and judge amounts, changes in design parameters, and preferences for different levels of aesthetic variables.	concepts in design and incorporating these methods into the design and evaluation process, which is used to assess a wide range of systems and products.	new field called "Engineering Aesthetics."	
7	(Y. Liu, 2003b)	The aesthetic and the ethic dimensions of human factors and design	The goal of this study is to discuss the relationship between aesthetics, ethics, and traditional research topics in human factors. It also aims to provide a philosophical foundation for understanding the role of aesthetics and ethics in human factors and ergonomics.	This method includes the development of theoretical and methodological foundations for systematic and scientific investigations of aesthetic and ethical issues in product design, including a comprehensive understanding of measurement methods and theoretical frameworks.	The main findings highlight the necessity of integrating aesthetics and ethics into human factors research, going beyond traditional concerns of safety and usability, and recognizing that good ergonomics may not always align with economic benefits.	Aesthetics and Ethics
8	(Z. Y. Yang & Chen, 2004)	Haptic-based function analysis and shape modeling of multi-material product: A case study	- Proposes a visual interface for industrial design and the engineering analysis of multi-material products. _ Conducts design and analysis on a platform with an enhanced haptic device to provide mechanical product evaluation for designers in the early stages of product design.	_ Uses a volume-based FEM performance evaluation method for analyzing multi-material products. _ A case study on the design of a toothbrush.	_ Utilizing manufacturing processes for products made with different materials can improve the expected performance of the product. _ Adopting a volume-based FEM performance evaluation method, through a visual interface, for the engineering analysis of multi-material products	Multi-material Product

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
9	(Gotzsch et al., 2006)	Product development with a focus on attractive product expression: An analysis of case studies	Analysis of Communicative and Meaningful Aspects in Product Design During the New Product Development Process and Understanding How Companies Create Product Designs that Convey Meaningful Messages to Users	The method used in this study includes a case study approach with structured interviews using open-ended and semi-directed questions.	improves design efficiency. Developing the product's appearance for the user is an effective approach to adding value to the product. A creative focus on user preferences in the pre-design phase is critical for product appearance development. Research at this pre-development stage may use various techniques such as brainstorming, market research, budgeting, and competition analysis. Additionally, user participation can generate extra ideas for creating a meaningful design.	Communicative and meaningful aspects with product users
10	(Chang et al., 2007)	A measurement scale for evaluating the attractiveness of a passenger car form aimed at young consumers	This study aims to develop a theoretical and operational framework for hidden factors that represent the attractiveness of a product's form and to create a tool for assessing the appropriate form.	The method involves conducting surveys with experts and consumers to identify the origin of a product's attractiveness.	The study created a 22-item tool with five factors to measure the attractiveness of passenger car forms for young consumers and provided it to designers.	Form attractiveness
11	(Sala, 2007)	Complex and fractal components in industrial design	The study aims to provide examples of industrial design objects that have been analyzed using complexity and fractal geometry and to explore the relationship between complexity and fractal geometry in industrial design.	The method used in this study includes analyzing industrial design objects by searching for complex components.	- Integrating complexity and fractal geometry in industrial design introduces the concept of non-linear design and influences the work of various designers . - The advancement of intricate fractal geometry components in industrial design is anticipated to	Fractal geometry

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					significantly influence the future of this field.	
12	(Desmet & Hekkert, 2007)	Framework of product experience	The objectives of the study are to introduce a general framework for product experience, distinguish patterns in influential product experiences, and provide a structure for comparing experiential concepts in design research.	The method involves utilizing multidisciplinary skills in design research and insights from social sciences, particularly psychology, to understand the interaction between behavior, cognition, and experience in human-product interaction.	Introduction of a framework that explains the personal and layered nature of product experience, including aesthetic experience, meaning experience, and emotional experience in interaction with products.	Meaning experience and emotional experience
13	(Jiao et al., 2008)	Affective human factors design with ambient intelligence	The study aims to create a framework for designing human factors with environmental intelligence, achieving broad interactions between human factors, design, and the environment, and integrating various fields such as human factors and ergonomics, information and communication technologies, engineering design, and product innovation.	The method includes developing a comprehensive solution framework for emotional design with environmental intelligence by integrating various disciplines, discussing technical issues and proposed solutions, providing practical examples, and creating an overall roadmap for emotional mapping processes.	Development of a comprehensive solution framework for emotional design with environmental intelligence, integrating various fields and addressing technical challenges associated with the need for environmental intelligence to support emotional design.	Emotional design
14	(Antioco et al., 2008)	Integrating service and design: The influences of organizational and communication factors on relative product and service characteristics	Exploring the impact of organizational and communication factors on the relative features of a product	The study is observational and involves in-depth interviews with managers from product and service design departments (using PLS-Graph version 3.0, power test using R2, reliability assessment, and	The main findings emphasize the importance of integrating feedback into the design process, information sharing, and the significance of communication and collaboration between departments in improving product	Communication and collaboration between departments

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15	(Rahman & Jhangiani, 2008)	Ecological Aesthetics Design: Presenting a framework for product aesthetics	Providing a Framework for Product Aesthetics	validity assessment). The method includes the use of ecological psychology principles, particularly direct perception, to develop an ecological aesthetic design framework for consumers with different characteristics.	and service features. The Ecological Aesthetics Design (EDA) framework identifies three ecologies influencing consumer aesthetic judgment, a direct perception of a product's characteristics through its appearance.	Ecological Aesthetics
16	(Person et al., 2009)	It's a Honda! For me...' An exploratory student project on branding and product design for the older adult population	The objective of the project was to investigate the visual identity of brands as a foundation for the aesthetic and symbolic qualities of products when designing for older consumers.	The design process involved students solving a branding and new product concept issue for an older population, including empathizing with user needs, obtaining primary data through interviews and surveys, and conducting design format analysis on Honda products.	The ideas generated in this study suggested a variety of ways to improve the perceptual appeal of products and improve the experiences of senior individuals.	Branding
17	(Wu & Qiao, 2009)	Product form design and analyzing on image expression	The study aims to examine the relationship between product form and user needs, integrating quantitative descriptions of product form elements, and analyzing the impact of using imagery in form design on user perception.	The method used in this study includes Kansei engineering, a technique that translates emotions and personal perspectives into pathways for consumers in the product design process.	The main findings highlight the importance of integrating user needs, Kansei engineering, and ergonomic comfort in product design. In form design, it is crucial to enrich the design style, create a psychological response in users' perception of the imagery, and enhance product quality.	Integrating User Needs, Kansei Engineering
18	(Guerlesquin et al., 2011)	Multidisciplinary design methodology: An intermediate representation tool based on virtual reality	Facilitating the integration of ergonomics and aesthetics in mechanical design and human-centered design	Methodology: A design method based on a multidisciplinary approach using virtual reality tools for	This article presents a new design method based on a multidisciplinary approach using virtual reality tools to integrate	Virtual Reality

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
			processes, focusing on DFU, DFE, DFP, and DFA. Developing a method based on different design approaches and tools.	integrating ergonomics and aesthetics in a mechanical design process.	ergonomics and aesthetics. The study emphasizes the importance of supporting collaborative decision-making during the convergence phases in design processes and the use of virtual reality tools as a solution to facilitate better collaboration and simultaneous interaction between experts during the design process.	
19	(Seva et al., 2011)	Product design enhancement using apparent usability and affective quality	Examining customer preference-related structures within the Usability Perception and Emotion Enhancement Model (UPEEM) design framework, such as apparent usability and emotional quality, is the goal of this study.	The method includes four stages: product selection, feature identification, design alternatives generation, and evaluation of design alternatives. UPEEM was validated using Structural Equation Modeling (SEM).	Product features related to form, function, and aesthetics, especially dimensional ratio, significantly influence users' perception of usability and product quality.	The dimensional ratio plays a crucial role in enhancing apparent usability.
20	(Oliveira & Heemann, 2012)	The cognitive ergonomics and the articulation of the functions of industrial products	The study aims to demonstrate the correlation and analysis of product functions about cognitive theories and propose improvements to the expression of industrial product functions alongside cognitive ergonomics.	This study employs a qualitative exploratory literature review, an analysis of the fundamental configuration functions of products, an examination of cognitive ergonomic principles pertaining to aesthetic and symbolic perception, and a proposal for improving the articulation of industrial product functions.	The main findings include theoretical contributions to the sustainable expression of industrial product functions through the evident connection between product functions and cognitive ergonomics.	User experience and function expression in cognitive ergonomics.

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21	(Mugge & Schoormans, 2012)	Product design and apparent usability. The influence of novelty in product appearance	The study aims to investigate the effects of product appearance innovation on the perceived usability of a product.	The method includes two experimental studies to examine the effects of innovation in product appearance on usability. Study 1 explores how consumers perceive a product's new appearance in evaluating usability. Study 2 investigates differences between experts and novices regarding appearance innovation as a signal for usability.	New product appearance is associated with lower usability expectations at the point of sale. Consumer expertise moderates the effects of appearance innovation on consumers' expectations of product usability. Products with innovative appearances are perceived as less usable than products with more traditional appearances.	Product innovation, consumer expertise, usability expectations
22	(Du & Pan, 2014)	Design research of novel self-propelled air railcar.	Creating a self-propelled railcar that prioritizes safety, practicality, and aesthetics to establish a secure, pleasant, visually attractive, and user-friendly entertainment hub for passengers of all ages.	The approach entails employing ergonomic and bionic principles in the construction of the self-propelled air carriage, in conjunction with utilizing 3D software for modeling.	This article presents a new design for a self-propelled railcar based on existing structures, incorporating ergonomic and bionic principles, with a focus on functionality and aesthetics to align with current trends and consumer preferences.	Ergonomic and bionic principles, consumer preferences
23	(Jeyakumar & Gandhinathan, 2014)	Industrial design of motorcycle with reference to Indian population.	The study aims to develop a purposeful design process for generating creative motorcycle design ideas, considering aesthetic and ergonomic features to improve appearance and performance.	Anthropometric data were collected from 30 male motorcycle riders in India, aged 19 to 27, who use motorcycles for commuting.	The range of comfort angles at various characteristic points was identified, and within this range, the rider's posture was adjusted to provide a comfortable riding experience.	Stylish and comfortable
24	(Kaljun, 2014)	Intelligent support for defining aesthetical, ergonomical and material	The study aims to provide insights into a prototype of an intelligent consulting system based on aesthetic	The approach stresses the significance of defining aesthetic and ergonomic elements from a	It proposes using of the AI system Oscar to support designers' decision-making during the design process.	Artificial Intelligence

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		properties of designed product.	and ergonomic factors in product design, focusing on design recommendations.	"smart design" perspective, derives guidelines from user interviews, and integrates ergonomic and aesthetic design measures appropriately throughout the product design.		
25	(Li, 2014)	Improving product appearance based on industry design	The study includes a deep examination of industrial design characteristics for electromechanical products, addressing the lack of comprehensive guidance in industrial design, overcoming challenges in brand image creation, and emphasizing the importance of industrial design in improving company efficiency.	The methodology includes discussing the industrial design characteristics for mechanical and electrical products, analyzing the development of China's industrial design industry, emphasizing the importance of industrial design in product development, and outlining key characteristics of industrial design.	The industrial design industry in China has developed slowly. Currently, people prioritize product appearance and innovation over functional requirements. At the same time, the conflict between industrial design and engineering has led to products with solid engineering but poor aesthetics, impacting market competitiveness.	Preference for product appearance and innovation over functional requirements
26	(Bornemann et al., 2015)	In the Eye of the Beholder? The Effect of Product Appearance on Shareholder Value	The study explores the impact of aesthetic, ergonomic, and symbolic value on business value in consumer electronics and automotive industries, utilizing actual data for value management.	The event study methodology was used to assess the impact of the appearance of a new product on stock value.	Aesthetic value only positively affects abnormal returns when the product has a certain functional advantage. Symbolic value negatively affects stock market reactions, which moderated by the product's functional advantage.	Functional advantage
27	(Zunjic, 2017)	Ergonomic design and assessment of products and systems	The study aims to analyze the interaction between ergonomic, safety, and aesthetic properties of consumer products, investigate how aesthetic features influence the usability and ergonomic aspects	Descriptive	The paper emphasizes the importance of considering the interaction between ergonomic, safety, and aesthetic features in consumer product design, advocating for a multidisciplinary	Interaction of ergonomic, safety, and aesthetic features

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
			of products, and emphasize the importance of considering the impact of aesthetic features on ergonomic and safety properties.		approach to address all aspects.	
28	(Kim et al., 2018)	Design constraints and their influence upon design outcome	The study aims to examine how design outcomes are achieved when two different sets of design constraints (ergonomic and aesthetic) are presented to two groups of designers and to explore how presenting ergonomic or aesthetic design constraints affects the quality and outcomes of the design.	The method involved a three-step approach: design workshop, refinement process, and evaluation sessions, with user assessment using a set of 12 bipolar SD scales. Six designer participants were divided into two groups; one focused on ergonomics and the other on aesthetics.	- User evaluation showed that design outcomes resulting from aesthetic design constraints were significantly better in terms of ease of use and design aesthetics. - The study highlighted the importance of considering ergonomic and aesthetic design constraints in influencing conceptual design outcomes.	-Aesthetic design constraints -Ergonomic design constraints
29	(Kobayashi & Niwa, 2018)	Method for grouping of customers and aesthetic design based on rough set theory	The study proposes a new method for collecting, selecting, and hierarchizing Kansei words for aesthetic design methods based on a hierarchical Kansei model.	Using text mining software, potential Kansei words were gathered. The best terms for the design goal were then chosen, and their ranking was determined by asking customers a series of questionnaire surveys.	The proposed method for selecting Kansei words can be applied to any design method based on a hierarchical Kansei model. In the case study, the proposed method was applied to the design of an office chair, and its effectiveness was confirmed.	Customer grouping and aesthetic design
30	(Shivappagoudar et al., 2020)	Design Optimization of Innovative Foldable Iron Box	The study aims to provide heat, change the ironing board's surface area, improve folding/unfolding, enhance user experience, consider weight as a criterion, and address strain and heat dissipation issues.	The method includes using CATIA for design, considering ways to fold and unfold creases, evaluating user experience, and highlighting the pressure in the ironing process.	The creative design of the folding iron body allows the surface area to be adjusted according to the fabric size, leading to more efficient ironing. The design focuses on optimizes heat supply to the required level, resulting in a cost-effective and energy-efficient solution. The new	Cost-effective and energy-efficient solutions, Effective in user experience

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
31	(Zhu et al., 2020) This article is in (Chinese	Multi-factor Coupling Design Based on Aesthetic Measure, Ergonomics, and Performance	The study aims to propose an automated multi-factor coupling design method that intelligently considers aesthetics, ergonomics, and key functionalities, using bicycle form design as an example.	The method includes calculating aesthetic, ergonomic, and performance scores, combining them with weights, and using a genetic algorithm to optimize the design, focusing on optimal and innovative designs.	design improves the ironing process while considering ergonomics, aesthetics, and user experience. The paper introduces an automated multi-factor coupling design method that integrates aesthetics, ergonomics, and critical functionalities to address the limitations of traditional design processes, allowing for effective product design by considering multiple factors.	Multi-factor design (consideration of multiple factors)
32	(Ahmed & Rashid, 2021)	Framework to select vital product design methodologies using a multi-criteria decision tool for an industry segment	The study aims to classify and select the most critical product design methods for refrigerator production in Bangladesh based on specific criteria using the analytic hierarchy process (AHP).	The method used in this study involves using the AHP as a multi-criteria decision-making tool. Information was gathered through questionnaires and interviews with seven professional designers.	"Ease of production" was emphasized as a critical factor by most designers.	Ease of production
33	(Zhou et al., 2023)	Optimal Design of Product Form for Aesthetics and Ergonomics	The study suggests optimizing the design of a product shape with an emphasis on ergonomics and aesthetics, developing a thorough model for evaluating aesthetics, and adding sensitivity to parameter screening.	- Using the entropy technique, a thorough aesthetic assessment of the product form can be obtained. - Ergonomic evaluation measures the difference between standard and actual design parameter values. - Screening of design parameters that have more significant impact on aesthetic and ergonomic factors	- Proposing a comprehensive aesthetic evaluation model based on the entropy method and computational aesthetics theory - Introducing sensitivity to key display parameters for optimal design	Aesthetic evaluation

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
				for optimal design.		
34	(Koleini M, 2008)	Affect and the role of emotion in the product design process -an introduction to kansei engineering methodology	Examining the application of Kansei engineering in product design and how it affects users' perceptions of ergonomics and usability.	Descriptive	Design based on satisfaction, preference, and internal/emotional feeling IS an essential indicator in all areas where the user plays a role.	- Internal feeling - Kansei engineering
35	(Mahmoudi Fataneh, 2008)	Semiotics in product design	The text explores the use of language and expression in products crafted using advanced technology and semiotics tools, and their application throughout the product design process.	Descriptive	The language of the product is synonymous with product semiotics. Like any semiotic language, it has different dimensions and components: semantics (meaning of the product), syntax (relationship between components), and pragmatics (application of products). This research views the product as a sign with a language and communicates a message to the customer from the manufacturer, its time, and identity.	Interpretation of the product through Gestalt
36	(Majidi S, 2011)	Semiotics, Aesthetics, and Functionalism in Product Design with a Minimalist Emotional Approach	Study the characteristics of semiotics, aesthetics, and functionality as the main functions of minimalist products.	Descriptive	It was observed that the functions of a product always have mutual and direct relationships with each other, and each function can produce, reinforce, or destroy the opposite function.	Form and function follow each other
37	(Barani, 2014)	Liveliness in Product Design and Its Effects on Selection and Usage Experience (with an emphasis on home appliances)	The use of animation in design and how it influences consumer attraction psychologically.	Descriptive	Animation and anthropomorphism can appear in the product through form, function, color, and material, having significantly affecting on customer product selection and the use of the purchased product.	- Aesthetic design and product function - Added value

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
38	(Abdullahi, Parveen, 2015)	User-Centered Product Design with the Kano Model and Regression Method (Case Study: Writing Pen)	an approach that assesses and ascertains the variables impacting product design according to consumer expectations.	a systematic approach to multiple regression, VIKOR, and Kano methods for automatic design based on aesthetic design.	a procedure for choosing design examples based on design parameters and assessing and identifying the elements affecting product design according to consumer demands.	Functional aspects
39	(Maleki S, 2018)	Proposing the model of consumer emotions in the packaging industry using interpretative structural modeling	How to identify and classify different consumer emotions in the packaging industry.	Thematic analysis	1- Core indicators identified through interviews. 2- These indicators were categorized based on expert opinions. 3- Relationships between dimensions were identified using structural-interpretive modeling, and an interaction network among them was drawn.	The text presents a communication model that explains the interplay between various consumer emotions and their role in generating purchase value.
40	(Moghadam, Nasrin, Rahaei, 2019)	Utilizing Product Language as a Communication Interface Between User and Technology in the Design of New Products (Case Study: Home 3D Printer)	Examine sensible and workable approaches to improving the aesthetic-semantic functions and interface of a home 3D printer.	The study utilized product language as a semantic theory to analyze the 3D printer's features, focusing on their precise design from a product language perspective.	Designers use aesthetic, semiotic, symbolic, affordance, and perceptual features to create products with communicative characteristics that attract, persuade, and engage users in terms of appearance and interface.	Aesthetic functions, User interface
41	(Sadeghi Naeini, 2020a)	An Inquiry into Ergonomic Product Design with a Focus on Psychological Factors: A Combined Approach of Art and Industrial Production	This study focuses on the ergonomic design of products as a means to attract user satisfaction.	The study utilized a case study and review approach, collecting data from 31 architectural art journals in the Scientific Information Database.	Users' degree of pleasure can be determined by the role that aesthetic and hedonistic criteria play in product design in conjunction with ergonomic considerations.	Understanding customers and applying pleasure and delight criteria in the product
42	(Ahmadi E, Bahrainizad M, 2020)	Measuring the Aesthetics of Packaging Impact and Perceived Product Quality on the Intention Purchase with the Moderating Role	How does product packaging aesthetics affect sustainable consumer behavior?	Data analysis was conducted using structural equation modeling with the help of SmartPLS software.	Findings indicate the moderating role of consumer novelty-seeking on the relationship between perceived quality and purchase intention,	Packaging aesthetics, Perceived quality

No.	Researcher and Year	Research Title	Research Question (Study Objective)	Research Method	Findings	Keywords Based on Results
		of Consumer Innovativeness and Consumer Environmental Concern Background			and the moderating role of environmental concern on the relationship between packaging aesthetics and purchase intention. However, the moderating role of consumer novelty-seeking and environmental concern on the relationship between packaging aesthetics and perceived quality was not confirmed.	
43	(Zare, Sadeghi Naeini, Azdari, 2021)	Effectiveness of Positive Design in Tableware Design for Young Iranian Couples	How can positive emotions be elicited in the user through design?	This cross-sectional study employed ethnography through questionnaires, observation, and interviews with various individuals over more than one year.	The study of different types of tableware showed that form, material, color, and arrangement of tableware affect the level of interaction among people during meals and the elicitation of positive emotions, which can help improve family relationships.	Happiness, Satisfaction, Entertainment, Admiration
44	(Ghasemi, Yalda, 2023)	Factors Influencing the Purchase or Replacement of Furniture in the Contemporary Lifestyle of Tehran	Examination of the variables influencing the buying or replacement of furniture in the modern lifestyle.	The sample size of 402 people was randomly studied using a questionnaire.	Findings showed that although it was initially thought that product malfunction was the main reason for replacement, non-material factors such as aesthetics (38%), good design (45%), and memories (20%) are significant. Boredom is said to be the most important element in furniture replacement or repurchase behavior.	Boredom

FINDINGS AND ARGUMENTS

This review highlights the increasing importance of integrating ergonomics and aesthetics in product design, as evidenced by the analysis of 44 articles published between 1991 and 2023. The findings, classified in Figure 5 by product scale and complexity, reveal a shared understanding among scholars that merging usability with visual and emotional appeal leads to enhanced user satisfaction, stronger market performance, and improved design outcomes. This discussion synthesizes the reviewed literature into key thematic domains, ensuring each referenced study is incorporated into the analysis.

The Ergonomics-Aesthetics Synergy in User Experience

Effective product design must take into account both functional comfort and visual satisfaction, according to one of the most recurrent conclusions. Users expect ergonomic and aesthetic elements to be seamlessly integrated, according to studies on consumer (Bornemann et al., 2015; Mugge & Schoormans, 2012), industrial (Akita, 1991; Helander, 2003), and mobility-related products (Du & Pan, 2014; Jeyakumar & Gandhinathan, 2014). Although some studies, for example, demonstrated the danger of prioritizing aesthetics over usability, other studies demonstrated how anthropometric data and user-centered modeling can be used to strike this balance (Kaljun, 2014; Zhou et al., 2023). In wearable or handheld products, such as tools, consumer electronics, and packaging, researchers emphasized how physical form and tactile usability determine user comfort (Kobayashi & Niwa, 2018; Seva et al., 2011; Shivappagoudar et al., 2020). Ergonomic misalignment can reduce functionality even in highly attractive designs, while good ergonomic design can heighten aesthetic appreciation when well-executed.

Emotional Engagement and Aesthetic Intelligence

The affective dimension of design has grown into a central focus in recent years. The works of Desmet and Hekkert (2007), Barani (2014), and Koleini (2008), collectively argue that aesthetics are not only about appearance but about emotional resonance. This is demonstrated by the use of positive design techniques (Zare, Sadeghi Naeini, Azdari, 2021) and Kansei engineering (Wu & Qiao, 2009; Kobayashi & Niwa, 2018), which convert psychological and emotional demands into concrete product attributes. Aesthetic intelligence is a term that was used for the first time

by Macdonald (2000), and it means that inclusive designs better account for the differences in sensory, cognitive, and emotional abilities of populations. Correspondingly, studies of branding and packaging (Ahmadi & Bahrainizad, 2020; Person et al., 2009) have demonstrated that among young consumers, symbolic value and perceived beauty have a significant influence on buying decisions. To support the emotional foundations of product choice, Ghasemi (2023) and Maleki (2018) were concerned with perceptual and psychological constructs, including novelty, boredom, and sentimentality that influence when to replace or choose a particular concept. (Majidi, 2011) and (Mahmoudi, 2008) further framed aesthetics through semiotics and Gestalt theory, emphasizing the cognitive-emotional interpretation of form and function.

Cognitive Ergonomics and Semiotic Communication

Several studies examined how users interpret design beyond its physical features. For instance, (Moghadam, Nasrin, Rahaei, 2019; Oliveira & Heemann, 2012) provided evidence of the role of affordances, clarity of the interface, and symbolic meanings in the intuitive use of technology-enhanced products, such as the use of a home printer. As Mahmoudi (2008) and Majidi (2011) articulated from a semiotic perspective, the user's views and "readings" of the features of a product are equally critical to the success or failure of that product as its functionality. Cognitive ergonomics, which studies user attention, memory, and decision-making in design contexts, has a close relationship with this field (Helander, 2003; Sadeghi Naeini, 2020a). In the context of product function and expression, several researchers (Sala, 2007; Wu & Qiao, 2009; Ahmed & Rashid, 2021) emphasized perceptual consistency the idea that what a product looks like should match its function.

Methodological Innovation and Multidisciplinary Tools

Data-driven, integrated design methodologies are clearly on the rise in the reviewed literature. With the aid of technologies such as entropy-based modeling (Zhou et al., 2023), virtual reality (VR) (Guerlesquin et al., 2011), and intelligent consultation systems (Kaljun, 2014), designers can model and evaluate ergonomic-aesthetic interactions before final production. Similarly, more objective and context-specific assessments are made possible by optimization techniques like the Analytic Hierarchy

Process (Ahmed & Rashid, 2021), genetic algorithms, and multi-factor coupling (Zhu et al., 2020). Research studies led to the development of design evaluation methods. Rahman and Jahangiani (2008) made an ecological aesthetics model based on user environments. Chang et al. (2007) suggested a measurement scale for form attractiveness. These methods allow more reliable assessments of ergonomic fit, emotional appeal, and visual effect.

User-Centered Design and Cultural Relevance

The reviewed research indicates that contextual foundations are necessary for effective product design. Ergonomic preferences and aesthetic sensibilities are influenced by age, culture, and surroundings. Demographically responsive design strategies are essential, according to research on the Indian motorcycle market (Jeyakumar & Gandhinathan, 2014), young Iranian couples (Zare et al., 2021), and older adults (Macdonald, 2000; Person et al., 2009). Additionally, Abdullahi, Parveen (2015) confirmed the importance of systematic user feedback by demonstrating how regression and Kano models can directly connect user satisfaction metrics to form and function in tool design. Similarly, Li (2014), and Antioco et al. (2008) highlighted the significance of organizational and collaborative alignment between design and engineering to facilitate user-centered innovation.

Practical Implications and Future Research Directions

The convergence of results across the 44 studies reviewed demonstrates the importance of integrating aesthetics and ergonomics during the product design process. Ignoring either domain may lead to underperforming products, either functionally or commercially.

Future research should focus on:

- Developing standardized ergonomic-aesthetic evaluation frameworks,
- Integrating Neuro-design tools (e.g., eye-tracking, EEG),
- Conducting cross-cultural validation of aesthetic metrics,
- And expanding on AI-driven co-design platforms.

As design becomes more multi-sensory, emotionally expressive, and sustainability-oriented, the need for holistic, interdisciplinary models will only intensify.

In general, aesthetics deals with the perception of beauty through elements such as color and form, while ergonomics focuses on comfort, safety, and efficiency. The amalgamation of these two notions in design can provide aesthetically pleasing and practical items that enhance consumer pleasure and elevate their quality of life. Successfully combining these two concepts in design can lead to products with more outstanding quality and appeal. The optimal fusion of these two elements in the design process has been studied concerning various products in the case studies reviewed in this article. The majority of studies, using interviews and surveys with users of diverse products, have investigated the influence of merging aesthetics and ergonomics on their quality of life and contentment in numerous ways. For instance, by testing and assessing products or, in certain instances, by designing and producing items that are both visually appealing and ergonomic, followed by user testing and evaluation, hypotheses regarding the correlation between these two concepts can be validated or refuted. Figure 5 and Table 4 provide a comprehensive evaluation and categorization of case study samples from prior research papers, together with the research methodologies and statistical tools employed by earlier scholars.

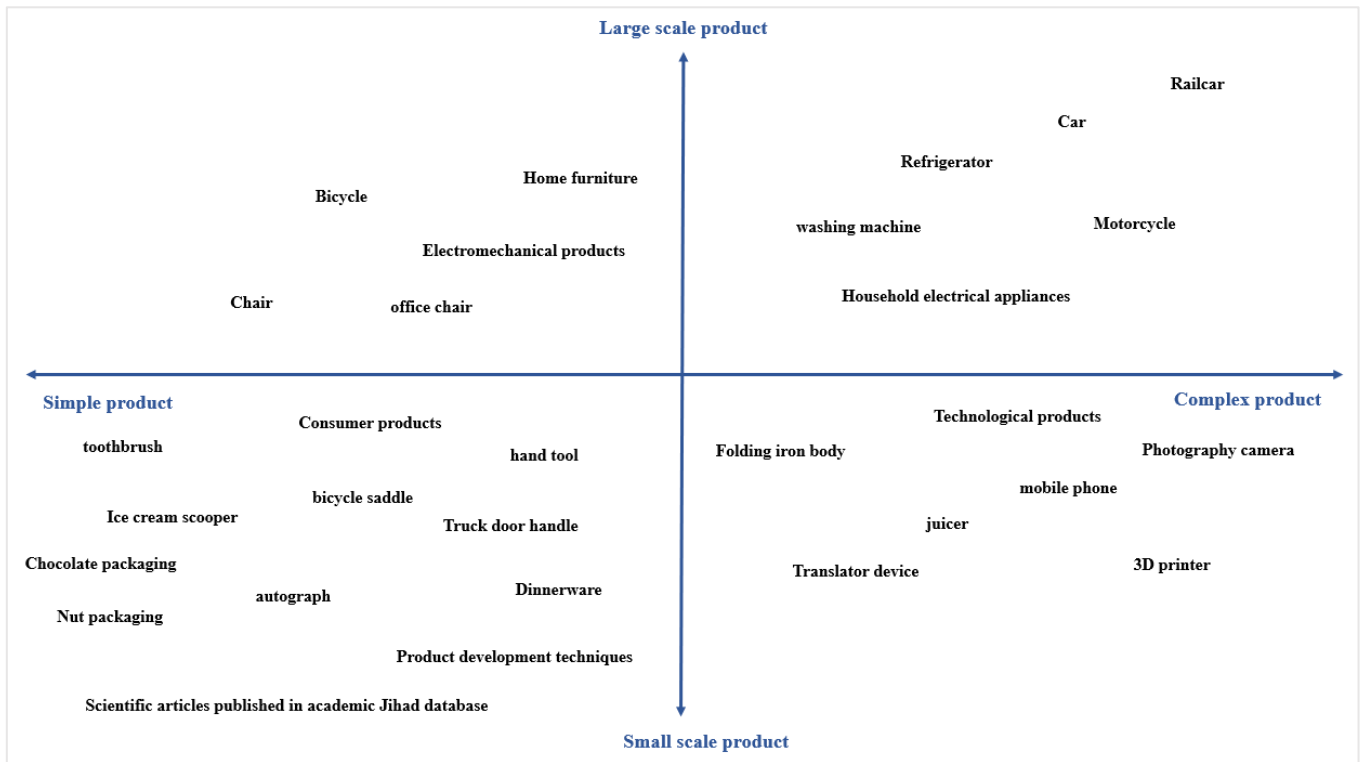


Fig 5. Classification Diagram of Goods from Prior Investigations According to Scale and Complexity Degree

Table 4. Methods of Articles

No.	Specifications of the articles	Testing Tools	Statistical population	Sample under Study			Type and Research Method			
				non-physical	Small-scale	Large-scale	Analytical		Descriptive	
							Interventional study	Cross-sectional (particular topic at a particular time)	Cross-sectional (particular topic at a particular time)	correlation method
	Researcher Name and Year of Publication	Evaluation Based on New Technologies Prototype Creation 3D Modeling Statistical Software Content Analysis Software	Manufacturer Designers Users or Consumers	Design Techniques	Technological Products Home appliances (microwave, blender, juicer, etc.) Packaging or Consumer Products Hand Tools (Industrial and Non-Industrial)	Personal Items Technological Products Household Appliances (Refrigerator, Washing Machine, etc.) Transportation	Experimental - Laboratory Structural Equations Discovery and Analysis of Relationships (Regression) Weighting of Indicators and Entropy Method Binary Dominance Matrix Kansei Engineering Weighting Coefficients and Hierarchical Process	Library Sources, References, Journals Survey Case Study and New Concept Proposal Correlation between Variables or ANOVA		
1	(Akita, 1991)								<	
2	(Trathen, 2000)								<	
3	(Macdonald, 2000)								<	
4	(Helander, 2003)		<							<
5	(Russo & De Moraes, 2003)		<		<				<	
6	(Y. Liu, 2003a)								<	
7	(Y. Liu, 2003b)								<	

No.	Specifications of the articles	Testing Tools	Statistical population	Sample under Study			Type and Research Method			
				non-physical	Small-scale	Large-scale	Analytical		Descriptive	
							Interventional study	Cross-sectional (particular topic at a particular time)	Cross-sectional (particular topic at a particular time)	correlation method
8	(Z. Y. Yang & Chen, 2004)					✓		✓		
9	(Gotzsch et al., 2006)								✓	
10	(Chang et al., 2007)		✓						✓	
11	(Sala, 2007)								✓	
12	(Desmet & Hekkert, 2007)									✓
13	(Jiao et al., 2008)									✓
14	(Antioco et al., 2008)							✓	✓	
15	(Rahman & Jhangiani, 2008)	✓		✓					✓	
16	(Person et al., 2009)								✓	
17	(Wu & Qiao, 2009)									
18	(Guerlesquin et al., 2011)	✓		✓						
19	(Seva et al., 2011)							✓		
20	(Oliveira & Heemann, 2012)								✓	
21	(Mugge & Schoormans, 2012)	✓		✓		✓	✓			✓
22	(Du & Pan, 2014)	✓	✓			✓			✓	

No.	Specifications of the articles	Testing Tools	Statistical population	Sample under Study			Type and Research Method			
				non-physical	Small-scale	Large-scale	Analytical		Descriptive	
							Interventional study	Cross-sectional (particular topic at a particular time)	Cross-sectional (particular topic at a particular time)	correlation method
23	(Jeyakumar & Gandhinathan, 2014)	✓	✓			✓			✓	
24	(Kaljun, 2014)	✓	✓						✓	
25	(Li, 2014)		✓		✓				✓	
26	(Bornemann et al., 2015)				✓				✓	✓
27	(Zunjic, 2017)				✓	✓			✓	
28	(Kim et al., 2018)	✓	✓			✓	✓			
29	(Kobayashi & Niwa, 2018)	✓	✓		✓			✓		
30	(Shivappagoudar et al., 2020)	✓			✓					✓
31	(Zhu et al., 2020))This article is in Chinese(	✓				✓		✓		
32	(Ahmed & Rashid, 2021)		✓			✓		✓	✓	
33	(Zhou et al., 2023)	✓				✓		✓		
34	(Koleini M, 2008)								✓	
35	(Mahmoudi Fataneh, 2008)								✓	
36	(Majidi S, 2011)								✓	
37	(Barani, 2014)								✓	

No.	Specifications of the articles	Testing Tools	Statistical population	Sample under Study			Type and Research Method		
				non-physical	Small-scale	Large-scale	Analytical		Descriptive
							Interventional study	Cross-sectional (particular topic at a particular time)	Cross-sectional (particular topic at a particular time) correlation method
38	(Abdullahi, Parveen, 2015)	✓	✓			✓		✓	
39	(Maleki S, 2018)		✓					✓	
40	(Moghadam, Nasrin, Rahaei, 2019)	✓	✓		✓				✓
41	(Sadeghi Naeini, 2020a)								✓
42	(Ahmadi E, Bahrainizad M, 2020)	✓						✓	
43	(Zare, Sadeghi Naeini, Azdari, 2021)	✓	✓						✓
44	(Ghasemi, Yalda, 2023)	✓	✓						✓

CONCLUSIONS AND SUGGESTIONS

This review article looks at how product performance and user experience are affected by ergonomic and beautiful design. Effective design can enhance user interaction with products and boost customer satisfaction, according to earlier research. However, there appear to be gaps in the research, particularly with regard to the need for more investigation into the connection between ergonomics and aesthetics. Furthermore, a thorough examination of ergonomic aspects of product usability is required, as is more research on the effects of each aesthetic variable on user experience. Future research and the creation of novel approaches to product design may be made possible by these gaps. The findings emphasize the obligation for designers to apply a multidisciplinary approach that encompasses the use of products that have a number of needs in order to directly improve the design and use of products. In order to create

products that promote the use of products that enhance the experiences and well-being of users, designers can use ergonomic principles that address comfort, safety, and efficiency, with an aesthetic element that considers people's psychological and sensory pleasure combined. By enhancing the relationship between users and products, designers will improve delight in usability, emotional engagement, and future satisfaction. Research and case demonstrations reveal that a positive interaction between function and form is critical to success in competitive markets and everyday life situations. A development process using a transdisciplinary approach is required due to changing expectations of consumers, which makes it even more difficult to a clearly differentiate function, ergonomics and aesthetics. This review article categorizes the findings into five groups (Table 5), highlighting the importance of this approach in modern lifestyles.

Table 5. Classification of Findings

No.	Field	sub-category	Research row No.
1	User-Centered Design	_ Design based on user expectations and satisfaction _ Attractiveness of the product according to the user group _ Product performance and cognitive ergonomics _ User Perception	4, 5, 16, 21, 30, 38, 39, 41, 43
2	Aesthetic Design and Form	_ Design based on aesthetic and hedonic criteria _ The effect of form on arousing emotions _ Visual aesthetic _ Combination of anthropometric with aesthetics _ Combining ergonomics and aesthetics _ Interaction of form and function	1, 10, 11, 15, 24, 25, 28, 31, 33, 35, 36
3	Product Semiotics and Expression	_ Paying attention to the language of the product through semiotics _ Emphasis on liveliness and expression through form _ Kansei Engineering _ Emotional Expression	2, 3, 6, 9, 12, 13, 17, 29, 34, 37, 40, 42, 44
4	Safety and Ergonomics	_ Safety _ Communication and collaboration between departments	7, 8, 14, 18, 19, 22, 26, 27
5	Production and methods	_ New Technology _ Production Methods	18, 24, 32

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