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Contemporary Design Strategies and their Role in Enhancing the Functional and Aesthetic Values of Industrial Product

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Abstract
This study delves into the interplay between design strategies and their efficacy in harmonizing the functional and aesthetic aspects of industrial product design. It scrutinizes modern design tactics, delineating their features and benefits, and aims to forge a cohesive strategy that elevates both aesthetic appeal and functionality in industrial products. By examining literature on industrial design evolution, the merger of performance and aesthetics, and user experience, the research identifies five pivotal design strategies—Design Thinking, Agile Design, Lean Design, Six Sigma, and TRIZ theory—adopted by various industrial businesses. It utilizes qualitative methods to analyze these strategies' frameworks, pinpointing similarities and differences in their approach to design, alongside quantitative research through surveys with expert designers. The findings illuminate the distinct impacts of these strategies on industrial product development, offering insights into their potential to enhance both the utility and visual appeal of products.
Keywords: design strategies, contemporary, performance, Aesthetic, industrial product.

1. Introduction

Over the last two decades, a revolution in technology has fundamentally altered the landscape across various fields, notably in design. This shift is not just rapid but appears to be gaining momentum. The role of designers has evolved beyond the realm of creating industrial products to conceptualizing intricate product-service ecosystems or even entire systemic solutions. During this time, the designer's role has broadened from merely enhancing the economic appeal of products for businesses and public entities to embedding a diverse spectrum of values—economic, social, functional, and technological—into product design. This approach aims to align products more closely with the dynamic and changing preferences and necessities of consumers.

Moreover, technological innovation has introduced a new layer to the crafting of industrial products, necessitating the integration of novel inputs into the design process. These inputs must be calibrated to balance the users' evolving desires with swift technological advancements. Consequently, the paradigm of design development has shifted towards devising strategies that cater to user demands for performance and aesthetic appeal, which are continuously evolving. These strategies are being redefined in product design to align with advancements in design features, reflecting a transformation in how products are conceptualized to meet changing consumer expectations in an era of rapid technological growth.

1.2 Research problem

The central challenge in industrial product design has historically been to harmonize functionality and aesthetics within the product's structure and appearance. Traditionally, this equilibrium has tilted favorably towards either aspect. Entering the third decade of the 21st century, a clear trend emerged where the emphasis on products' functional attributes and their technical and technological merits significantly overshadowed aesthetic considerations. This shift has been evident across various product categories, including electronics, tools, furniture, and vehicles, where technological superiority has often

relegated aesthetic appeal to a secondary priority. Consequently, we encounter products characterized by minimalist designs and plain surfaces, lacking in aesthetic richness to meet the contemporary user's expectations.

The influence of industrial production philosophies on design priorities has left an indelible mark, driven by manufacturing demands that advocate simplicity and cost reduction at the expense of aesthetic richness. Moreover, the advent of digital technologies in design and manufacturing processes promised a paradigm shift. The potential of digital tools to enrich aesthetic values, by transcending traditional performance constraints and incorporating digital over mechanical elements in design, seemed promising. Yet, this potential remains largely untapped, with digital innovations not fully leveraged to foster a synergy between functional and aesthetic values in product design.

This prevalent dissonance has led to a noticeable imbalance in design priorities, setting the stage for the research at hand. The research aims to explore and propose design strategies that can restore balance between functional performance and aesthetic appeal in industrial product design, addressing a gap that has widened in the wake of evolving production philosophies and underutilized digital advancements.

1.3 Research questions

The research seeks to address several pivotal questions central to the evolution of industrial product design in the contemporary era:

1. What modern design strategies are applicable within the realm of industrial product design?
2. Can these strategies effectively reconcile the often competing demands of functionality and aesthetic appeal within the design of industrial products?
3. What are the shared and distinct characteristics of these methodologies?
4. Is it feasible to synthesize a coherent set of strategic principles that simultaneously elevate the functional performance and aesthetic appeal of industrial products, thereby establishing equilibrium between these two critical values?

1.4 Research Significance

The significance of this research lies in several key areas that collectively aim to advance the field of industrial design:

1. By investigating current design strategies employed in the creation of industrial products, this study aims to expand the knowledge base within the domain of industrial design. This exploration is crucial for understanding the evolving landscape of design strategies and their implications for product development.
2. The examination of how these design strategies can mediate and balance the functional and aesthetic aspects of industrial products is vital. Such an analysis contributes to the development of standardized practices that could significantly enhance the effectiveness of industrial designers. Additionally, it offers practical insights for manufacturing companies, facilitating the integration of design excellence into the production process.

1.5 Research objectives

1. To pinpoint modern design strategies capable of elevating both the performance and aesthetic qualities in industrial product design, thereby fostering equilibrium between these elements. This involves a detailed investigation into the myriad approaches currently in practice, assessing their efficacy in achieving a harmonious balance between functional utility and visual appeal.
2. To formulate an overarching, cohesive strategy that draws upon the shared traits of contemporary design strategies. This strategy seeks to simultaneously boost the aesthetic and functional attributes of industrial products. The development of such a unified approach involves synthesizing the core principles that underpin successful

design strategies, tailoring them to support and enhance the dual objectives of performance excellence and aesthetic value in industrial product design.

1.6 Research limitations

Objective Limitation: The study is specifically concentrated on exploring contemporary design strategies that can harmonize the performance and aesthetic values in industrial product design. This delineation ensures a focused investigation into strategies capable of achieving a balanced integration of functional utility and visual appeal within the realm of industrial products.

Spatial Limitation: The empirical data for this study is gathered through a questionnaire disseminated among faculty members of the Design Department at the College of Fine Arts, University of Baghdad, across various design disciplines. At the time the research is conducted, the participant pool consists of 56 educators. This geographic and demographic focus provides a specific context for the investigation, reflecting the perspectives and expertise of professionals within a defined academic environment.

Time Limitation: The research is contextualized within a specific temporal frame, with all activities, data collection, and analysis confined to the year 2024. This time constraint ensures that the study is relevant to the current design paradigms and technological advancements.

1.7 Terms Defined

Design strategies: Design strategies represent an array of methodologies and frameworks utilized by designers and teams to solve complex problems, leading to innovative and effective solutions. They provide guidance throughout the design process, ensuring that the final products align with set goals and user needs (Buchanan, R. 1992, p8).

Contemporary: refers to works produced in recent times, particularly those that embody current perspectives and experiences (Eagleton, T. 2008, p20).

Performance: Performance in design is assessed both quantitatively and qualitatively, focusing on the product's effectiveness in fulfilling its intended functions and the users' valuation of its utility (Norman, D. 2013, p72).

Aesthetics: Aesthetics encompasses the comprehensive sensory experience that transcends mere visual attractiveness in products or environments, shaped by the collective impact of form, color, texture, proportion, and composition on how they are perceived and appreciated (Postrel, V. 2003, p105).

Industrial product: An industrial product combines utility and appeal for its users, necessitating an in-depth comprehension of the users' requirements, the context of the product's application, and the technological possibilities and constraints (Ulrich, K. T., & Eppinger, S. D. 2011, p85).

2. Literature review

2.1 The evolution of industrial design

Transitioning from the late Middle Ages through the Renaissance, the production of industrial goods was predominantly artisanal, with a strong emphasis on classical design trends that favored high aesthetic value, often demonstrated through elaborate and repetitive surface decorations. During these periods, design was distinctly inclined towards aesthetic appeal, with performance attributes playing a secondary, albeit essential, role in the backdrop of product design.

In the seventeenth century, efforts emerged to standardize design production within specific, codified frameworks. However, these efforts led to a noticeable dip in production quality as aesthetic considerations continued to dominate. The industrial revolution of the eighteenth century marked a pivotal shift. The advent of machinery and the rise of automated production processes saw a decline in aesthetic values, which were superseded by priorities such as quality, functionality, efficiency, and durability.

The dawn of the nineteenth century, inspired by Christopher Dresser's initiatives to institutionalize design education, saw the emergence of efforts to strike a balance between functional performance and aesthetic values in design. These endeavors sought to reconcile the increasing divergence between the aesthetic and practical aspects of industrial products, laying the groundwork for integrating design excellence with manufacturing efficiency (Goldense, 2019).

As the nineteenth century drew to a close, the Arts and Crafts movement, spearheaded by William Morris, marked a pivotal effort to reconcile aesthetic values with craft and industrial production. This movement sought to restore the dignity and beauty of handmade crafts in the face of the rapidly industrializing world, advocating for a harmonious balance between the craftsmanship of traditional production methods and the emerging mechanized manufacturing processes. However, the influence of the Arts and Crafts movement began to wane with the advent of Modernism in the 1930s, a movement that prioritized functionality, simplicity, and the utilization of modern materials, thus shifting the focus once again from artisanal aesthetics to industrial efficiency and product functionality (MacCarthy, 2014).

Entering the twentieth century, the establishment of the Bauhaus school and the adoption of the principle "form follows function" marked a significant shift in design philosophy. Aesthetic values began to be seen not as an end in themselves but as integral to the performance, durability, and efficiency of a product. The aesthetic appeal of a product's form became intrinsically linked to its functional performance, with a strong emphasis on the material's nature and the clarity of the product's functional structure.

Midway through the twentieth century, the advent of postmodernism, repositioned aesthetic values to the forefront, striving for a balance between aesthetic appeal and functional characteristics in industrial products. This movement reintroduced ornamentation to product surfaces and leveraged historical symbols and cultural references in industrial design, challenging the minimalist ethos of modernism. Postmodernism's eclectic approach celebrated diversity, complexity, and contradiction, enriching industrial design with a renewed emphasis on visual and cultural richness alongside functional integrity (Seah, 2015).

In the 1980s, the Deconstructionist movement emerged, introducing design philosophies that embraced disassembly and fragmentation, eschewing conventional harmony and coherence. This movement redirected attention towards aesthetic values, emphasizing unconventional structures devoid of uniform systems and highlighting asymmetry in composition. By doing so, Deconstructionism challenged traditional notions of beauty and functionality, proposing a radical reconsideration of how aesthetic and performative attributes could coexist within design. This era of design thought provocatively questioned the established paradigms, encouraging a deeper exploration into the relationship between form, function, and meaning in industrial products (Taschen, 2016, p. 148).

As we navigate the third decade of the twenty-first century, the advent of parametric and fractal design, alongside biophilic and biomimetic design principles, signals a shift towards a more naturalistic and mathematical design ethos. This shift reflects the current era's dynamism and the evolving instability in design orientations. The incorporation of three-dimensional modeling and the advancements in 3D printing technology introduce an

additional layer to the design process, emphasizing innovation and uniqueness over the traditional, standardized balance between design elements and the dual imperatives of aesthetics and functionality.

In this context, our research aims to identify and formulate design strategies that can serve as a foundational framework for the design process and achievement. This framework seeks to establish a codified approach upon which industrial designers can rely to create products that harmonize functionality and aesthetic, meeting the user's needs. The goal is to navigate the complexities of contemporary design trends and technological innovations to achieve a balanced integration of user requirements in terms of both function and aesthetic appeal.

2.2 Aesthetic and performance values in industrial product design

In the realm of industrial product design, the harmonization of aesthetic appeal with performance attributes is paramount for crafting products that resonate with users, fulfilling both their practical requirements and emotional aspirations. Performance is characterized by functional attributes like ease of use, efficiency, longevity, dependability, and the capacity to function effectively over its intended lifespan. On the other hand, aesthetic values encompass the tangible and nuanced sensory elements of product design, such as form, color, texture, style, and the emotional dimensions that emerge from the user's interaction with the product. This balance ensures that products not only meet the practical demands of daily use but also connect with users on a deeper, more personal level, enhancing their overall experience and satisfaction.

2.2.1 Performance considerations in industrial product design

In industrial product design, the emphasis on performance considerations highlights the necessity of crafting products that align with users' demands and live up to their expectations. This necessitates a meticulous approach by designers to integrate specific performance features and specifications into the product. These specifications encompass attributes like the product's operational speed, its effectiveness in executing its intended function, and its reliability in consistently delivering on these aspects (Ulrich, 2011). By prioritizing these considerations, designers ensure that the product not only serves its functional purpose efficiently but also enhances user satisfaction by meeting and potentially exceeding their anticipated performance criteria. Achieving this necessitates a thorough grasp of the user's requirements, coupled with rigorous testing of the product's design, functionality, and its capacity to fulfill the tasks it's designated for, without fail. Moreover, performance-related factors such as the product's ergonomic design, safety features, ease of access to operational interfaces, and user interaction mechanisms play a crucial role. These elements are indeed fundamental in assessing the overall quality of the product's performance. By giving due attention to these aspects, designers can ensure that the product not only meets the functional expectations of users but also provides a seamless and satisfying user experience.

Performance stands as a cornerstone of design, given its profound impact on the product's functional facets and its intended utility. A product that is designed effectively incorporates fundamental performance attributes at its core, ensuring that its overall configuration is intricately and integrally woven to bolster its functional efficacy. Every aspect of the product's design, from its aesthetics and dimensions to its structural properties, is meticulously tailored to facilitate the user's access to and engagement with the product's functional capabilities.

2.2.2 Aesthetic values in industrial product design

The aesthetic element's role and significance in a product's lifecycle can be regarded as the essence, content, and soul of the product. Its success in the market is often contingent upon its shape, form, morphological and physical attributes, among other characteristics that resonate with consumers. The term 'aesthetic component' encompasses the visual

appeal of the product, including its color, shape, form, iconic symbols, and the overall aesthetic ambiance it projects. These elements are pivotal in determining the product's market appeal, profitability, and overall success, serving as critical indicators of how well it will be received by potential users. Essentially, the aesthetic quality of a product does not merely add to its visual appeal but significantly contributes to its market performance and user satisfaction (Obasuyi, 2017).

The triumph of a product in the marketplace is intricately linked to the caliber of its aesthetic features, necessitating designers to meticulously evaluate and integrate these qualities throughout the design process. This approach aims to forge products that are not only visually appealing but also provide emotional gratification to users. It compels industrial designers to delve into various design elements, engage in creative experimentation with colors, materials, and textures, refine the form and style, and stay abreast of current design and aesthetic trends. Such endeavors are geared towards eliciting the desired sensory responses and emotional connections from users. Moreover, a keen focus on details, finishes, and the craftsmanship of production significantly enhances the aesthetic value and quality of industrial product design, underscoring the vital role of aesthetics in the overall design and market success of a product.

2.2.3 Integration of performance and aesthetics in product design

The harmonious melding of aesthetic values with functional properties is pivotal in the development of industrial products that not only meet but exceed the aesthetic and performance expectations of users. Attaining this equilibrium necessitates a systematic and cohesive approach throughout the design process, from the initial conception to the selection of the optimal solution (Bardzell, 2013). Evidence suggests that aesthetic values, when thoughtfully considered and aligned with the user's aesthetic preferences; wield a profound influence on product evaluations. Products imbued with appealing aesthetic qualities have the potential to enhance the user's perception and overall interaction with the product, underscoring the significant role that aesthetics play in complementing functionality, thereby contributing to the product's success (Hoegg, et al, 2010).

It's crucial to underline that the aesthetic aspect should harmonize with the product's performance attributes, its functional forms, and the practical purposes it's intended to serve, ensuring that functional qualities are not compromised for the sake of aesthetics. Consequently, designers are tasked with achieving a delicate equilibrium between aesthetic values and performance features to forge products that resonate success. This balance can be attained through the adoption of specific standards and strategies aimed at harmonizing aesthetics with performance in product design. Such approaches endeavor to establish comprehensive methods that facilitate an integrative and balanced coexistence of functionality and aesthetics in industrial product design. By striking a balance between aesthetic appeal and performance capabilities, designers can craft products that not only deliver high performance and reliability but also evoke emotional engagement and elicit admiration, thereby enhancing the overall user experience.

2.3 User experience with industrial product

User experience design is instrumental in elevating both the aesthetic appeal and performance attributes of product design. It serves as a critical component of product development processes that synergize aesthetic considerations with performance features, resulting in products that are not just functionally dependable but also visually appealing and enjoyable for users. As highlighted by Norman and Nelson, the essence of user experience design lies in its commitment to enhancing usability, accessibility, and the overall pleasure of the user's interaction with the industrial product. This focus underscores the importance of a user-centered approach in design, aiming to create products that not only meet practical needs but also resonate on an emotional level, thereby enriching the user's engagement with the product (Norman, 2010).

When designers prioritize crafting a well-considered user experience, their focus transcends mere performance outcomes; they aim to ensure the product is aesthetically pleasing to the user. This encompasses not only ease of use, effectiveness, efficiency, and reliability but also aesthetic values that evoke positive emotions in the user. Such a holistic approach to design considers the user's interaction with the product from multiple dimensions, ensuring that the product not only performs its intended function with excellence but also connects with users on an emotional and sensory level. By integrating aesthetic appeal with functional performance, designers can create products that truly resonate with users, enhancing their overall experience and satisfaction (Hassenzahl, 2008).

The endeavor to weave aesthetic values with performance considerations into the fabric of user experience design necessitates the adoption of holistic design principles that delicately balance these two facets, with a keen eye on the preferences and requirements of the intended audience. Taking the example of a van, performance attributes such as speed, fuel efficiency, durability, agility in responding to road conditions, engine robustness, reliability, safety features, and the vehicle's protective measures in accidents form the core of its functional merits. On the aesthetic front, emphasis is placed on the sleekness of the vehicle’s exterior, modern design elements, and the visual and tactile appeal of the cockpit, including considerations of color schemes, textures, styling, and the quality of materials used.

By achieving a synergistic balance between these aesthetic and performance values in vehicle design, designers not only deliver a product that excels in efficiency and functionality but also one that resonates with the user's sense of style and visual preference. This comprehensive approach to design ensures that the vehicle not only meets the practical demands of transportation but also enhances the overall user experience, fostering a sense of satisfaction and joy to the user. This integrated design philosophy underscores the importance of considering both the functional and emotional dimensions of user experience, aiming to create products that are not just tools but also objects of desire.

2.4 Contemporary design strategies

2.4.1 Design thinking

Tim Brown, CEO of design consultancy IDEO, describes design thinking as “a powerful innovative approach that anyone can use to create amazing ideas. A range of design projects have also been used to further illustrate the given description.” (Brown, 2009, p. 3). “The design process is the translation of information in the form of requirements, constraints, and experiences into potential solutions that the designer takes into account to meet the required performance characteristics.” (Luckman, 1967, p. 13). Accordingly, the design process seeks to translate aesthetic requirements and performance formulas into simultaneous standards that complement each other and are developed in the form of solutions that focus on integration and balance between aesthetic and performance in product design. “Design effectiveness is the exercise of a set of skills useful in planning, implementation and evaluation.” (Royal College of Art, 2009, p. 54). This ultimately leads to finding a kind of integration between functionality and aesthetics and evaluating the final version of the design solution in a way that allows the user’s needs and desires to be met. Design thinking focuses on the following strategic characteristics:

Empathy	Understanding the users—who they are, their needs, preferences, and the context in which they will interact with the product
Definition	Restructuring the problem into a framework centered around user needs
Demonstrate ideas	Generating a wide range of creative ideas to define the problem
Prototyping	Creating a tangible physical image in three-dimensional form of the design idea
Examination	Testing the Prototype by real users
Improvement	Refinement and re-optimization of the design idea according to an iterative process

2.4.2 Agile Design

Agile design, initially conceived within the realm of software development, emphasizes adaptability in both design and redesign processes to ensure the final product resonates well with its intended users. It advocates for iterative refinements to the design concept, facilitating the design team's ability to adapt to evolving needs and deliver solutions that are both high-quality and effective, ultimately fulfilling user expectations (Schön, et al, 2019, p. 3). In the contemporary landscape, product design necessitates not only flexibility to accommodate shifting demands but also cost-effectiveness, eco-friendliness, efficiency, and high-quality output that provides significant added value (Molhanec, 2013, p. 2). Agile design support a methodology centered on flexibility, collaboration, and iterative progress within the design process. It proposes the segmentation of the design process into smaller, more manageable components, enabling precise control and facilitating ongoing development through steady feedback and adjustments. This strategic approach highlights the importance of adaptability and continuous improvement, as underscored by Highsmith & Cockburn (2001) and Cohn (2010). As follows:

cooperation	Active participation among members of the design team
Continuous adjustment	Continuous adjustment allows the design team to extrapolate renewable requirements
Feedback	Identify the requirements and desires of the target market
Adaptive planning	Decision-making processes, improvements, and product design requirements and priorities are continually improved and modified based on new requirements and feedback.

2.4.3 Lean Design

The term "lean" signifies being devoid of excess, specifically referring to unnecessary elements that do not add value. In the 1980s, Dr. James Womack and his team, during their groundwork for the seminal book "The Machine That Changed the World," elucidated the concept of lean manufacturing as practiced by the Japanese automotive industry, prominently by Toyota. This approach, which evolved as part of the Toyota Production System, was a response to the imperative of revitalizing the Japanese economy post-World War II (Hedeya, 2015, p. 127). Lean design strategy is predicated on enhancing the product's value by minimizing waste throughout the development process, thereby boosting efficiency, lowering costs, and elevating user satisfaction (Womack, et al, 1990). The foundational principles of lean design, as outlined by Hedeya and colleagues (Hedeya, et al, 1990, p. 127-128), focus on:

Value	Creating values in product design in collaboration with stakeholders
Value stream	Identify the steps that add value along the design process chain
Flow	Value Process Flow Mapping (Process Mapping)
Pull	Determine only what the customer needs (push production with the order)
Perfection	Produce exactly what the customer wants while preventing defects and rework (preventive system)

2.4.4 Six Sigma

Six Sigma is a methodology aimed at enhancing process efficiency and quality by identifying and eliminating the causes of defects and variability in manufacturing and business processes. It uses statistical methods to quantify the fluctuations that can occur in any given process. The central tenet of Six Sigma is that such variability is the root cause of most errors, leading to product defects, which in turn can diminish customer satisfaction. By rigorously focusing on reducing this variability and minimizing errors, Six Sigma seeks to lower operational costs and, more importantly, improve customer satisfaction. The approach underscores the critical relationship between process precision, product quality, and customer perception of value, advocating for continuous improvement in all areas of production and service delivery (The Council for Six Sigma, 2018, p. 8).

Six Sigma represents what is often deemed an "ideal" process by many experts, characterized by its highly ambitious goal of achieving near-perfect process performance.

Specifically, a process operating at Six Sigma efficiency is expected to produce only 3.4 defects for every million opportunities, which translates to a remarkable defect-free rate of 99.99966 percent of all products (Snee, 2010). This statistical benchmark underscores the methodology's rigorous standards and its commitment to excellence in quality management. The foundational principles of Six Sigma, as detailed by Zin and colleagues (2018), focus on:

Definition	Understanding, defining and determining the needs of the target user and converting these needs into standard values
standardization	Selecting product characteristics, mapping the processes involved, performing the necessary measurement, recording the results, and estimating the value and capabilities in the short and long term
Analysis	Root cause analysis, anticipating any problems that could prevent effective implementation, and performing regression analysis to create and conduct hypothesis testing to evaluate new processes.
Refinement	Refinement that will eliminate or reduce the impact of the root causes of the problem
control	Controlling all procedures for the design and manufacturing process of products

2.4.5 Triz theory

The TRIZ strategy synergizes the strengths of two distinct design approaches: it overcomes the psychological barriers that hinder creative thinking and employs knowledge-driven analytical techniques to foster the generation of innovative ideas. It's important to note that TRIZ doesn't seek to supplant existing methods but rather to augment them. Its utility lies in its capacity to inspire the conception of inventive solutions (Ghimisi & Nicula, 2014). The core principles of TRIZ, as outlined by Russo and Spreafico (2015), concentrate on:

Contradiction	Every innovative patent is the result of solving an inventive problem, which usually contains some inconsistencies. The contradiction is divided into material contradictions and technical contradictions
Idealism	The ideal state of the system is that all its functions are fulfilled without causing any problem
Fragmentation	Dividing the system into smaller parts to reduce Contradiction
Subtraction	Remove all parts related to the basic system of the product, and keep the basic elements of the product
Resources	Focus on available resources in product development rather than searching for new resources
Analysis of materials and performance environment	Analysis of the elements and their physical components, their ability to perform tasks, and their ability to withstand performance conditions and variables

3. Methodology

In this study, the researcher employed a mixed-methods approach, incorporating both qualitative and quantitative procedures to enrich the research context. The qualitative aspect aimed to uncover the similarities and differences among the various design strategies explored within the research framework. Conversely, the quantitative dimension involved data collection via a questionnaire distributed to professors from the Design Department at the Faculty of Fine Arts. In 2024, the questionnaire reached 56 faculty members, out of which 46 responded. The data was then validated and analyzed based on these responses, allowing for a comprehensive examination that leverages the strengths of both qualitative insights and quantitative evidence.

3.1 Analysis the structure of design strategies

Drawing from the theoretical underpinnings regarding the characteristics and essence of the design strategies under consideration, and in line with the research objective to formulate foundational design principles that encapsulate a unified strategy for steering the design process towards a balanced integration of performance and aesthetic values in industrial product design, the analysis of the proposed design strategies will be directed towards:

3.1.1 The unique contributions of each strategy to the design process

- **Design Thinking**: In the realm of Design Thinking, empathy and rapid prototyping are identified as essential components. These elements unlock a profound understanding of user needs and support the advancement of design innovation at both functional and aesthetic stages.
- **Agile Design**: characterized by its focus on continuous improvement, simplicity, and user-friendly functionality, positioning it as a vital approach for creating products that are not only efficient but also provide a satisfying user experience.
- **Lean design**: aims to improve both performance and aesthetic qualities while eliminating superfluous components to streamline design and cognitive operations. This approach boosts performance efficiency and focuses on the core aspects valued by users in terms of both performance and aesthetics.
- **Six Sigma**: approach utilizes a data-driven strategy to increase precision in design, guaranteeing high-quality performance outcomes with minimal errors and maintaining uniformity in design aesthetics.
- **TRIZ Theory**: offers a structured and inventive approach to the design process, emphasizing innovation in both performance and aesthetics. This allows designers to break away from conventional thinking patterns and develop innovative, effective solutions.

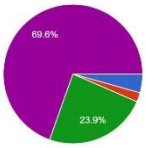
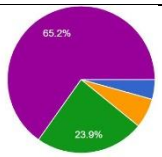
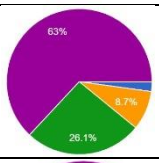
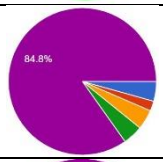
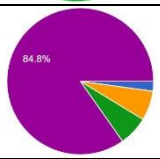
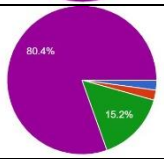
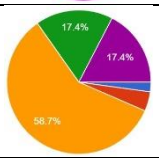
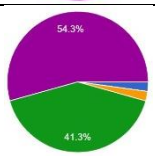
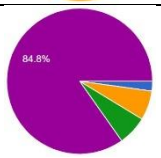
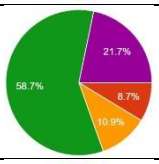
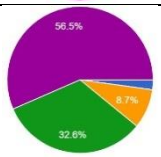
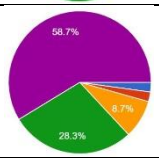
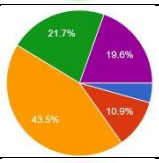
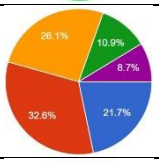
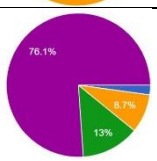
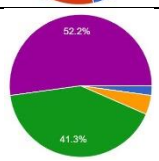
3.1.2 Convergences in technical characteristics of strategies

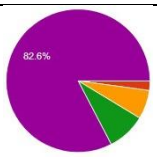
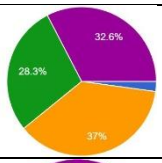
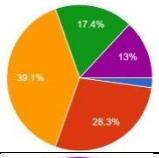
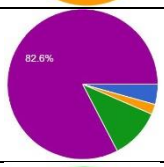
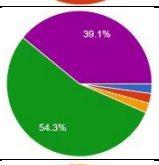
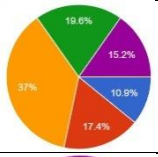
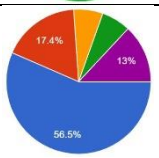
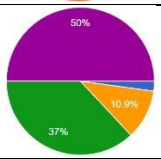
1. Design strategies like Design Thinking and Lean Design prioritize deep understanding and fulfilling user needs by empathizing with them, serving as a foundational aspect in crafting products aimed at specific audiences. This approach entails incorporating both functional and aesthetic values into the product design to resonate with users on practical and emotional dimensions. Analyzing and comprehending user needs and preferences is critical to both the Six Sigma and Lean Design approaches. Each strategy aims to convert these insights into definitive criteria, ensuring that products meet customer expectations in terms of both functionality and aesthetics.
2. The Six Sigma and Lean Design methodologies place significant emphasis on iteration and the ethos of continuous improvement. Both strategies underscore the necessity of perpetually refining design concepts and adapting the design in response to feedback from real users, as well as insights from evaluations conducted by teams like those responsible for Inspection and Improvement, with the ultimate aim of reaching excellence. This continuous focus on enhancing products and design concepts within Six Sigma and Lean Design reflects a dedication to producing high-quality products and upholding aesthetic values that align with the evolving needs and preferences of users over time.
3. Lean Design strategy prioritizes the enhancement of aesthetic appeal and performance efficiency by concentrating on steps that genuinely augment the product's value while minimizing waste throughout the design process. Similarly, the Six Sigma strategy is dedicated to boosting performance efficiency, utilitarian quality, and the aesthetic appeal of products through the reduction of variability and errors, aiming for a heightened level of precision and control at every phase of the design and production process.
4. Every strategy emphasizes the critical role of teamwork and collaboration within the design team throughout the design process. The collective effort and sharing of experiences among team members are essential for generating innovative and impactful outcomes. Such collaboration is a key element in realizing continuous enhancements and making adjustments based on feedback from the end-users of the products, significantly contributing to the creation of designs that align with user needs and expectations both functionally and aesthetically.

3.1.3 Divergences between characteristics of strategies

1. Each strategy emphasizes a distinct aspect; for instance, Design Thinking centers on empathizing with users and grasping their needs, whereas Agile Design prioritizes collaboration and the principle of continuous enhancement.
2. The techniques and approaches employed across each strategy differ, such as the emphasis on modeling within Design Thinking and the focus on analysis within Six Sigma.
3. Strategies vary in their emphasis on product quality and process management. Agile design is centered on ongoing control and adaptability, whereas Six Sigma prioritizes quality assurance and meticulous process oversight.

4. Results of statistical analysis of expert opinions

Characteristics of strategies	Total percentages	Chart	Characteristics of strategies	Total percentages	Chart
Empathy	94%		Definition	89%	
Demonstrate ideas	89%		Prototyping	87%	
Examination	91%		Refinement	96%	
cooperation	35%		Continuous adjustment	96%	
Feedback	91%		Adaptive planning	80%	
Value	89%		Value stream	87%	
Flow	41%		pull	20%	
Perfection	89%		standardization	94%	

Analysis	91%		Control	61%	
Contradiction	30%		Idealism	94%	
Fragmentation	93%		Subtraction	35%	
Resources	20%		Analysis of materials and environmental performance	87%	

5. Conclusions

1. The distinctiveness of these strategies is markedly affirmed by their alignment with understanding the user's wants and needs, alongside the design team's capability to meet these requirements and integrate them with the product's functional and aesthetic features. This alignment fundamentally satisfies the user's needs to utilize the product's functionalities and appreciate its visible formal and material attributes, as well as its underlying expressive qualities.
2. Design strategies focused on the ongoing and dynamic exploration of user desires and needs prioritize the evolving, developing nature of user preferences. This approach guarantees that both the design process and the final product possess attributes and features rooted in the genuine, evolving needs of the user, reflecting their changes over time.
3. Inspection, feedback, and the segmentation of the system into smaller components serve as preliminary steps towards understanding the user's preferences regarding the system's fundamental functional and aesthetic attributes. Feedback delivers insights into the immediate preferences of the product's actual users, aiding the design team in specifying the product design's functional and aesthetic qualities. Moreover, the repeated scrutiny of the system yields precise data on the presence of features that satisfy the user's preferences by breaking down the system into its core elements and evaluating how well these features meet the user's expectations.
4. The aspect of measurement illustrates the capability to regulate the inputs and outputs of the design process concerning both performance and aesthetic values. This regulation is achieved through the design team's capacity to define these values based on a structured selection relationship, informed by a methodical experimental approach. Furthermore, the analytical process plays a crucial role in elucidating the connection between these features and the user’s genuine desires and needs. Through the analysis of performance metrics and materials—their task performance capabilities and resilience under usage conditions—the designer is enabled to create a structured and precise catalogue of performance characteristics and aesthetic values that reflect the user’s preferences.
5. The pursuit of idealism and perfection in product design embodies the quest for a harmonious balance between performance and aesthetics. This pursuit originates from the objective to establish an optimal scenario that achieves equilibrium, mitigates errors, and steers clear of leaving the design outcomes to chance. Instead, it advocates for regulated and methodical processes aimed at reaching peak performance, in alignment with the user’s desires and aesthetic preferences. These

preferences are derived from genuine and tangible user aspirations, guided by thorough studies and analyses of user inclinations, performance standards, and aesthetic values inherent in the product.

6. Idea presentation, adaptive planning, and modeling constitute fundamental visualization methods crucial for delineating the visual concept of the design and evaluating how well the performance and aesthetic values align with user preferences. These techniques reveal the degree to which desired features are realized in the product's structural design and assess the product's capacity to maintain a balance between functionality and aesthetics over time. Furthermore, they empower the design team to examine the product's structural and apparent composition at both functional and aesthetic levels, showcasing the product's potential to cater to the user's desires and requirements.
7. Features that prioritize value and its adaptation to the evolving variables and shifts in user requirements underscore the critical importance of incorporating functional and aesthetic values that resonate with the user's preferences. Moreover, these attributes enable the design team to project and scrutinize user needs, subsequently realizing them through performance features and aesthetic values in the product design.
8. The collaborative dynamic within the design team is a trait of paramount significance for the ideation and selection of suitable attributes for product design, encompassing both functionality and aesthetics. Despite receiving a modest proportion of focus in the survey, this characteristic remains crucial as it facilitates a clear understanding among all professionals involved in product's design of their fundamental roles. It also aids in identifying any discrepancies between technical, mechanical, and material properties, thereby enhancing the efficiency of the design process. This collaboration ensures a higher level of performance and a greater balance of aesthetic values with functional characteristics, while also preventing potential conflicts among varying values.
9. Fulfilling user needs and desires on both functional and aesthetic fronts transcends mere basic requirements; it involves performance features and aesthetic values that exceed the foundational needs of the user, paving the way for cognitive growth and personal development. This approach extends the product's usability and fosters an appreciation that surpasses mere immediate visual appeal, enhancing long-term user engagement and satisfaction.
10. Selecting suitable materials for realizing both performance characteristics and aesthetic values in product design should not be confined to readily available resources. Instead, it necessitates exploring material formulations that align with the immediate needs and anticipated future advancements in the product's functionality and appearance. This involves seeking out smart materials that bolster the product's performance, aesthetic appeal, and user-friendliness, thereby ensuring the material choice enhances the overall design and utility of the product.

6. A proposed comprehensive design strategy

To attain the research's second objective, which is to develop an inclusive design strategy that harmonizes the functional design characteristics with the aesthetic values of the industrial product, the researcher proposes the following foundational principles:

1. **Understanding User Needs**: To establish equilibrium between the functional and aesthetic attributes in product design, it is imperative for the design team to be well-versed with both the immediate and evolving needs of users. This necessitates the undertaking of ongoing market research studies aimed at gathering comprehensive data that will elucidate not only the current but also future needs, desires, and aspirations of the user, along with prospects for potential growth.
2. **Collaborative Engagement**: Integrating the potential user into the design process from its inception to the completion of the prototype stage is crucial for acquiring immediate feedback on how well the product's performance and aesthetic features align with the real needs and desires of the user. This approach ensures that the

design evolves in direct response to user input, fostering a product that truly resonates with its intended audience.

3. **Ongoing Enhancement**: Leveraging feedback allows for the iterative refinement of the product's annual models by dissecting the architecture of user needs and correlating these with product features. Furthermore, the incorporation of technological advancements serves as vital inputs to the performance traits and interactive values, which can be intricately connected to the product's aesthetic appeal at an interactive level, ensuring the product remains cutting-edge and highly relevant to user preferences.
4. **Material Innovation**: Advances in material technology, particularly in the realm of smart and interactive materials, are progressing rapidly. Associating performance properties with the physical attributes of smart materials plays a pivotal role in transforming performance quality and guarantees user satisfaction with the product on an aesthetic level, making the exploration and application of these innovative materials essential for enhancing both functionality and visual appeal.
5. **Analysis, Testing, and Evaluation**: Establishing a comprehensive set of analytical processes tailored to understanding the user's requirements, needs, and desires is crucial. This involves scrutinizing the overall structures of products fashioned to meet these needs and formulating standardized criteria to assess the congruence between user needs and the product's attributes on both functional and aesthetic levels. This approach aims to encompass the fullest range of physical needs and the highest degree of expressive and aesthetic values in terms of physical composition and emotional engagement.
6. **Diversity and Customization**: Incorporating a wide array of performance values in the product's design and introducing options for customization are key. This enables users to tailor the product, its performance characteristics, and aesthetic values to their unique preferences and needs, thereby ensuring their distinction within the social contexts they engage with. This strategy not only meets the diverse requirements of users but also enhances their personal and social experience with the product.
7. **Individual and Collective Identity**: Embedding the product with performance features and aesthetic values that allow users to modify its outputs and interaction modes is crucial. By designing functional interfaces with structures that are adaptable for development, alteration, and augmentation, the product supports users in forging their individual identities. It becomes an extension of their personal essence, linked to the concept of self-image within the social context, thereby enriching their social interactions. This approach ensures the product serves not just a functional purpose but also plays a significant role in the user's personal and social expression.
8. **Sustainability from Cradle to Grave**: The product should be designed with performance features and physical characteristics capable of supporting environmental sustainability throughout its usage period. This includes considerations for energy consumption and emissions generated during product use, as well as the product's impact on ecosystems post its lifecycle. Ensuring that the product maintains ecological balance from its inception through to its disposal underscores a commitment to long-term environmental stewardship.

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