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Industrial Design Innovation Management Based on User Demand-Driven

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ABSTRACT
In the market environment where consumption upgrading and personalized demand are increasingly prominent, industrial design is turning from technology-oriented to user value creation. With the continuous improvement of consumers' refined requirements for product experience, the compound characteristics of functional needs and emotional appeals are becoming increasingly significant, which requires enterprises to establish a systematic demand response mechanism. The traditional design process faces challenges in accurately capturing demand and efficiently transforming innovation, making it urgent to develop a design management system that incorporates deep user participation. Therefore, this study examines the management mechanism of industrial design innovation driven by user needs to establish a closed-loop framework that integrates demand insight, design transformation, and decision optimization. It provides methodological support for manufacturing enterprises to enhance product competitiveness.

KEYWORDS
User needs; Industrial design; Innovation management; Design-driven; User experience

1 Introduction

As a key link between technology and the market, the innovation management mode of industrial design directly affects the market acceptance of products. Currently, there are three structural changes in user needs: the functional dimension pursues the unity of extreme convenience and reliability; the emotional dimension focuses on the identity created by product narrative; and the social dimension emphasizes the value of responsibility embodied in sustainable design. This kind of compound requirement characteristic requires enterprises to break through the one-way investigation mode and establish a dynamic requirement perception system. At the same time, the design innovation process faces systematic challenges, including the contradiction between demand fragmentation and production standardization, insufficient user participation, and faults in cross-departmental collaboration. This study focuses on the transformation path from user needs to design results and constructs an operational innovation management framework by analyzing the demand classification method, design transformation mechanism, and management decision-making model. It aims to improve the response accuracy and implementation efficiency of design innovation in meeting market demand.

2 User demand-driven design innovation

2.1 Definition and classification of user needs

User needs are the set of expectations that target consumers have about a product's functionality or service experience. These requirements include three levels: the basic functional requirements focus on the basic use and reliability of the product, such as the call quality of the mobile phone; the experience enhancement requirements involve ease of operation and efficiency optimization, such as household electric appliances in the design of the one-button start function; emotional belonging needs to emphasize the psychological satisfaction of products, limited edition design triggered by the collection of enthusiasm is such a category. With the change in the consumption environment, the demand presents compound characteristics: the functional dimension requires the upgrading of multi-tasking ability, and entertainment equipment needs to take into account the work scene [1]; the social dimension has increased influence, consumers tend to choose product packaging that reflects the concept of environmental protection. Demand collection methods continue to evolve, and traditional questionnaires are still in use. Emerging technologies have brought richer means, such as social media public opinion analysis, which captures the emotional expression of potential pain points, and user log observations, which record the details of friction in real usage scenarios. In particular, attention should be paid to the difference between explicit and implicit needs: consumers can clearly describe their requirements for battery life, but it is not easy to express specific standards for product grip comfort, which must be determined indirectly through behavioral tests. Understanding these layered and complex demand structures is the starting point for design innovation.

2.2 The importance of user demand-driven innovation

Taking the real needs of users as the source of innovation has significant strategic value. The primary value is reflected in the market risk control level. Products designed based on actual use scenarios can effectively reduce the probability of unsalable products. The case of consumer participation in design shows that the early integration of user suggestions can reduce the product's adjustment cost by more than 30%. The construction of core competitive advantage depends on demand insight. Under conditions of limited resources, small enterprises can break through the encirclement of big brands by accurately targeting the pain points of specific groups. The cultivation of sustainable innovation also benefits from user orientation: medical device manufacturers upgrade their product designs based on feedback from medical staff and double their market share in three years. The deeper value lies in driving the evolution of industry standards. As smartphone companies continue to optimize the touch experience, they are driving the industry to enhance user interface design specifications [2]. Especially in the fast-changing field, user demand forecasting has become a key capability. Fitness equipment brands that adapt to the increase in home fitness, such as the timely introduction of quiet design and folding storage features, can seize the new market. The essence of enterprises' continuous tracking of demand evolution is to establish a breakwater mechanism—to transform the impact of market changes into an innovation-driving force. This innovative mode of deep connection with the market's source fundamentally avoids the strategic deviation caused by the misallocation of R&D resources.

3 The management framework of industrial design innovation driven by user demand

3.1 Methods of user requirements analysis and identification

Enterprises need to establish a complete user demand collection system to obtain real market information. The traditional face-to-face interview is still effective, as it can provide a deeper understanding of the specific scenarios and operating habits of users. Modern technology enables efficiency improvements. Through the analysis of e-commerce platform reviews, frequently mentioned product problems can be identified, while social media monitoring tools capture consumer expectations for new features. Behavioral observation methods offer a unique value by recording the daily usage process in users' homes, often revealing operational difficulties that designers overlook. An important method is to establish a dynamic tracking system for existing customers, create a personal demand file, regularly update usage feedback, and form a long-term database. Special attention is given to the needs of different user groups. Professional users prioritize functional scalability, while ordinary consumers focus on ease of use. During the requirement verification process, a group test prototype is used to observe users' direct reactions to the design scheme[3]. These methods work together to form a comprehensive cognitive network, ensuring that demand information accurately reflects the actual market situation.

3.2 Transformation of user requirements into design concepts and innovations

Structural Thinking Tools are needed to transform abstract requirements into concrete design schemes. The function decomposition method is used to transform the functional requirements, and the complex product is disassembled into several basic functional modules. For example, a smart home system is decomposed into security control, environmental regulation, and other units, which are optimized separately. The transformation of emotional needs utilizes storyboard technology, where the designer draws the user's complete scene story from purchase to use and implants emotional resonance design at key touchpoints. Cross-functional collaboration is key to successful transformation, with the marketing department providing requirements analysis reports, the engineering team evaluating technical feasibility, and the design team leading the solution visualization. The iterative process of prototyping establishes a mechanism for rapid verification, and 3D printing can create a physical model in two days, inviting the user to test and manipulate it. The design decision matrix was used to assist in the selection of schemes, and each scheme was quantitatively evaluated from three dimensions: implementation difficulty, cost increment, and experience improvement. With a particular focus on retaining design flexibility, the modular rocket allows for later tweaking of local functions based on user feedback. This transformation mechanism ensures that the innovation solution not only meets the core requirements but also has technical feasibility, thereby preventing the design from being hindered by the actual production dilemma.

3.3 Innovation management process and decision-making mechanism

The construction of an end-to-end innovation management process requires identifying the key control nodes. An Innovation Committee is established at the beginning of the process, and project priorities are approved by the heads of design, marketing, and production [4]. The quality gate is established during the requirement analysis stage, and any

requirement data that the user has not verified shall not proceed to the design stage. The concurrent engineering mode is adopted in the concept development phase, where the structural engineer and the exterior designer work in tandem to shorten the development period. The decision-making mechanism implements a hierarchical authorization system. The design director approves routine improvement plans, and high-level strategic meetings evaluate major innovation projects. The resource allocation is dynamically adjusted, and project progress is reviewed monthly. Additional resources are invested in programs that receive positive feedback from user testing. Risk management is embedded throughout the entire process, with preset exit criteria at each stage. When the technical bottleneck cannot be broken, or the user evaluation falls below the threshold, the project is terminated promptly. Knowledge management forms a closed loop. After the project is completed, the system archives the design decision-making basis and establishes a typical scheme library for subsequent reference. A special set of intertemporal feedback mechanisms, produced three months after the market, allows for the collection of user complaint data and the reverse optimization of design standards. This structured process not only guarantees the efficiency of innovation but also controls the cost of trial and error through system design, enabling the stable transformation of user needs into market products.

4 Industrial design innovation management strategy based on user demand-driven

4.1 Strengthen the collection and analysis of user needs

Enterprises need to establish a three-dimensional demand collection network to cover different scenarios. The brick-and-mortar stores set up interactive feedback terminals for customers to submit suggestions for improvement as they experience new products. Online channels provide convenient feedback programs, enabling users to scan QR codes and contribute to the design of questionnaires. The depth tracking strategy is implemented for special user groups, and typical users are invited to wear recording devices to collect real usage data for two weeks. The data analysis adopts the progressive processing mechanism. The basic layer sorts out high-frequency keywords to form a demand heat map. The middle layer identifies emotional tendencies through semantic analysis and establishes a demand evolution prediction model. Regularly organize requirement validation workshops inviting user representatives to operate on-site while prototype designers simultaneously record operational checkpoints. The analysis should clearly distinguish between urgent improvements and long-term innovations. For instance, the current product's loose interface needs to be addressed immediately, whereas the user's desired voice controls should be included in the next-generation development plan. Set up a Dynamic Kanban system to update all channels and collect information, ensuring that the enterprise decision-making layer always stays current with the latest market trends. This all-around requirement management mechanism can effectively prevent the problem of the design direction from deviating from the actual usage scenario.

4.2 Enhancing cross-departmental collaboration and innovation

Breaking down organizational barriers requires changes in both physical space and institutions. Establishing open innovation collaboration zones to concentrate design engineering market teams, with shared office walls equipped with writable glass boards to capture creative sparks at any time. The workflow is implemented in three phases: the first phase involves engineers intervening early to assess technical feasibility during the design stage; the second phase includes market personnel participating in usability testing during the prototype mass production stage; and the third phase has designers following up on the production line to ensure precise restoration of the design[5]. Develop a visual knowledge-sharing platform to establish a comprehensive project case base, showcasing typical solutions for setting up cross-disciplinary Q&A modules that eliminate communication barriers. The design of an innovative incentive mechanism employs a dual-channel model, offering immediate rewards to employees who propose effective improvements during the annual selection of the best collaborative projects. External collaboration extends to user communities, where core user group members can experience and test in advance, and professional users of testing machines participate in discussions on technical standards. In particular, a data-driven conflict resolution mechanism is established. When the design and engineering opinions differ, the user test results serve as the basis for the final decision. Monthly innovation exchange meetings are held, where rotating departments share industry technology trends to promote the flow of knowledge. This deep collaboration model transforms dispersed professional wisdom into a continuous capacity for systemic innovation.

4.3 Optimal design decision-making and implementation process

It is necessary to build a standardized evaluation system to improve the efficiency of decision-making. In the concept screening stage, a multidimensional scorecard is used to quantify the three dimensions of user value, technical feasibility,

and cost control. External experts are invited to participate in an anonymous review to reduce subjective bias. In the design deepening phase, the implementation of a parallel approval process and the design of an appearance scheme structure will be synchronous, aiming to shorten the cycle. The prototype validation establishes a three-tier testing system: the basic level verifies the implementation of core functions, the advanced level simulates extreme usage environments, and the user level organizes real-world scenario experiences. In the production link, a clear design freezing point should be set, and the delivery standard and time node of the final scheme should be stipulated to avoid repeated revisions in the later stage. Progress control employs agile management methods, breaking the design process into two-week iterative units, with visible deliverables at each stage. The knowledge accumulation mechanism ensures that a review meeting is held after the completion of the experience inheritance project, and the design decision logic is recorded in the corporate knowledge base. A special fast response channel is established, allowing the design process to be restarted with the approval of the Innovation Committee in the event of significant market changes. The implementation of digital kanban management enables real-time monitoring of the progress of each link, providing automatic early warnings of delays and risks. This refined process management can significantly shorten the product launch cycle while ensuring design quality.

5 Conclusion

The essence of user-demand-driven industrial design innovation management is to establish a dynamic bridge between market insights and the implementation of technology. This study reveals that successful innovation requires three core supports: an accurate demand analysis system to ensure that the design direction aligns with the real market pain point, a scientific transformation mechanism to ensure the effective implementation of the idea and a standard decision-making process to control the full cycle of risk. The key is to realize the triple transformation from passive research to active demand tracking so that fragmented information is transformed into systematic design input. This involves upgrading departmental collaboration to knowledge integration and co-creation and breaking down professional barriers to form innovative synergies. Empirical decision-making has evolved into a data-driven process, and key decisions are optimized through user test data. In the future, innovation management will need to leverage the application of digital tools further. Virtual reality technology can facilitate global user collaborative design, and artificial intelligence can assist in demand forecasting to enhance the accuracy of market responses. This user-centered management system is not only the core engine for enterprises to enhance product competitiveness but also the strategic fulcrum for the manufacturing industry to shift from technology orientation to value creation. It provides sustainable power for industrial design, empowering industrial upgrading.

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