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## THE PRACTICE OF SUSTAINABLE HOUSEHOLD APPLIANCE DESIGN IN RESPONSE TO CONSUMER NEEDS

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**Abstract.** **Purpose** of the article is to discuss the strategy and practice of sustainable design of home appliances based on design demands, analyze the relationship between demands and sustainability of home appliance design through researching user preferences and market trends, propose specific design strategies and practice paths, and verify the feasibility of strategies in actual design with specific design projects.

**Methodology.** The study used the methods of observation, analysis, synthesis and generalisation of information on the practical experience of applying sustainable design principles in the design of household appliances

**Results.** The primary task of home appliance sustainable design is to grasp the core design requirements. The demand-driven sustainable design strategy of home appliance products aims to constitute a research path through three key steps: demand acquisition, opportunity point transformation and design solution output, and to convey the sustainable concepts through key elements such as product function, shape, experience and semantics, so as to finally form home appliance products with practicality and aesthetics.

The study identifies the requirements for sustainable design from both the market and users through the analysis of product samples and methods of building user profiles, integrates hierarchies of requirements and transforms them into executable design capability points that can be applied to design solutions. Through in-depth analysis of user needs and market needs, a demand-oriented sustainable design strategy for home appliances is proposed. A sustainable design framework for home appliances based on demand analysis is constructed to guide designers to incorporate sustainable concepts into product design, and to provide theoretical basis and practical guidance for the green and low-carbon transformation of the home appliance industry.

**Scientific novelty.** The role of design needs in the sustainable design of home appliances is theorized and deepened, with particular insights into the synergy between user needs and market demands to guide design innovation.

**Practical relevance.** The demand-driven sustainable design practice of home appliances is of great significance to promoting the green transformation of the home appliance industry, enhance the market competitiveness of products and promote the realization of sustainable development goals. By deeply exploring user needs and accurately grasping market demands, it helps to enhance the brand image and market position of home appliance enterprises, and also helps to promote the sustainable development of the entire home appliance industry.

**Keywords:** product design, sustainable development, design innovation, Home appliances, user demand, market demand, mini washing machine.

## INTRODUCTION

Sustainable design is the theme of today's times, and the design concept of harmonious coexistence between man and nature is the trend and direction of household appliance design. Sustainable design of home appliances is not only the inevitable choice of industry transformation and upgrading, but also a key part of achieving sustainable development. Sustainable home appliance design is not only reflected in energy efficiency, more importantly, in daily use to promote people to take the right behavior to reduce the impact on the environment. Two key features of the concept of sustainable design are the shift from single products to systems, and the shift from technologization to human-centeredness. In this context, demand orientation has become an important principle of sustainable home appliance design, which emphasizes that the design should be centered on meeting the real and long-term needs of users, based on matching the actual market demand and dynamic trends, avoiding overconsumption and waste of resources, and thus promoting the harmonious symbiosis between home appliances, the environment and society.

## ANALYSIS OF PREVIOUS STUDIES

Many scientists pay attention to the issue of sustainable development in design. Thus, Liu Xin [5; 9; 12], Zhong Fang [15], Zhang Jun [16] and other scholars discussed the sustainability perspectives and logical methods of system design, service design and biodiversity design in the context of ecological civilization construction, provided strategies and case study support for the research of sustainable design in social and environmental dimensions, and conducted in-depth research on the key elements of sustainable product design, which broadens the sustainable design potential and many possibilities. Gong Miaosen [10; 17] et al. combined the method of product service design and took degradable materials as the entry point to expand demand scenarios, shape product brands and optimize service touchpoints in the whole process, revealing the importance of environmental friendliness of sustainable design elements such as material selection, energy efficiency and recycling.

Zhang Gongbin [18], Zheng Zhenhua [19], Li Saisai [6], Wang Hui [13], Tian Xinru [11] and other scholars have discussed the importance of design needs in the fields of vehicle design, furniture products, and clinical rehabilitation. In view of the diversified and dynamic needs of different product design, we use multiple channels

to mine product design needs, collect real data, and integrate the needs, and apply them to product design and development. In the study of home appliance product design, Chu Tao [1] et al. believe that it is necessary to consider the supply-demand coordination in the home appliance industry, especially to guide the supply-side green transformation from the demand side. Yu Suihuai [2], Wang Chunpeng [14], Zhang Linghao [3; 4] and other scholars emphasized the importance of design requirements analysis in realizing sustainable design of home appliances. Only by fully understanding design requirements can home appliances that meet functional requirements and are environmentally friendly be designed.

In summary, existing research has provided important theoretical support for the construction of sustainable design strategies for home appliances, and maintaining the functionality and aesthetics of home appliances while ensuring sustainability remains a challenge that has not yet been adequately addressed. Therefore, the construction of a systematic and comprehensive sustainable design strategy for home appliances based on needs analysis is crucial for the green transformation of the home appliance industry.

## PURPOSE

Purpose of the study is to explore the application and practice of design requirements in sustainable design of home appliances.

## RESULTS AND DISCUSSION

As a driving factor, design needs have a decisive impact on product innovation and sustainability. Design requirements are not only an intuitive reflection of market preferences or user habits, but also the core driving force for shaping the overall value of products, environmental impact and user experience. Data shows that 85% of the carbon footprint of home appliances is generated after the products are sold, that is, during the use of the products by consumers. Therefore, in the sustainable design of home appliances, collecting and obtaining design requirements can not only understand the true value of the product from the user's perspective and market dynamics, but also effectively control the sustainability of home appliances at the forefront of their life cycle.

1. Two dimensions of demand-driven demand

Demand is a series of conditions or requirements that need to be considered and met when designing products or services. It is widely derived from different stages of the product life

cycle or the stakeholders involved. The core of design demand is to ensure that the product not only meets the direct needs of users, but also has competitiveness in the market. Therefore, in the design of home appliances, design demand mainly focuses on two key dimensions: market needs and user needs. The needs of these two dimensions jointly drive the sustainable design practice of home appliances.

Market demand mainly reflects the adaptability and competitiveness of home appliances in the commercial environment [7]. With increasingly stringent environmental regulations and consumers' increasing attention to sustainable development, the demand for sustainable design in the home appliance market has grown rapidly. Market demand analysis helps designers better understand the market trends, policy orientations and commercial competitiveness of home appliances. By analyzing market demand, home appliance design can achieve a high degree of fit with market demand, while reducing production costs and improving product market acceptance and brand competitiveness.

User demand emphasizes people-oriented, not only focusing on users' current needs, but also digging deeper into their potential needs. In an era of endless new products, users are the most valuable "design team". Only by grasping the key information on the product demand side can we achieve innovation and upgrading on the supply side with the support of technology. The whole process is a dynamic cycle, and users, as the core link, drive product design iteration to move forward. Through the investigation and research of user behavior experience, collect user feedback or comments and other user

opinions, understand their lifestyle and usage habits, upgrade user experience, and finally integrate resources to jointly meet user needs.

The comprehensiveness and accuracy of the design demand analysis can provide theoretical support for the sustainability of home appliances, so as to construct a more persuasive and feasible sustainable design strategy for home appliances, which can help to comprehensively understand the specific needs of home appliances in different usage scenarios and provide a clear direction for the formulation of design strategies.

2. Demand-oriented sustainable design path for home appliances

Design demand, as a medium connecting user expectation, market dynamics and environmental protection, determines the design positioning of home appliance products. The demand-oriented sustainable design path for home appliances is divided into three key steps, as shown in Fig. 1.

(1) Dual-dimensional demand acquisition. Demand acquisition aims to comprehensively collect information from two dimensions: market demand and user demand. Market demand acquisition mainly focuses on the current status of the industry through competitive product analysis, clarifies the aspects and concepts of sustainable design of existing home appliances, and captures relevant data and information on sustainable design of home appliances from the aspects of industry trends, policies and regulations, which together constitute the data source of market demand. User demand acquisition refers to grasping the basic characteristics of consumers through user surveys, determining the primary and secondary user groups, and building



Fig. 1. Sustainable Design Pathways for Home Appliances Driven by Demand Orientation (Drawn by the author)

user portraits, and obtaining user perceptions through group interviews and other methods. Ultimately, the design needs are fully grasped, and the needs and expectations for sustainable design of home appliances are summarized.

(2) Demand analysis and opportunity point conversion. Demand analysis is to cluster and integrate the acquired user and market demands and convert them into clear design points and technical requirements, so as to provide specific guidance for subsequent design practice. In the process of demand conversion, the design requirements are sorted and prioritized, basic requirements, expected requirements and exciting requirements are identified, and comprehensive consideration is given to factors such as technical feasibility, economic cost, and environmental impact to ensure that the results of demand analysis are converted into executable design opportunities.

(3) Design practice and solution output. Based on demand analysis and comprehensive evaluation, the design positioning of the product is clarified and the design solution output stage is entered. In this process, designers need to use innovative design thinking to integrate sustainable concepts into various aspects such as product form, material selection, functional configuration, and energy efficiency. And pay attention to improving user experience to ensure that the product meets sustainable requirements while enhancing user acceptance and satisfaction. In addition, the design solution needs to be continuously optimized and iterated in combination with the needs of production and manufacturing, and ultimately form a sustainable home

appliance product that meets both user needs and market requirements.

### 3. Design application - mini washing machine design practice

Based on the above demand-driven sustainable design path for home appliance products, the "mini washing machine product design" project is taken as an example for development and application. Through product sample analysis and user portrait construction, the design needs of mini washing machines are analyzed from both market and user aspects to further verify the feasibility and rationality of the design path.

Study the demand for mini washing machines from the current market situation. The development of small home appliances has not only enriched the home appliance market, but also resulted in diversified consumer choices [20]. Currently, mini washing machines in the market are popular because of their small size and suitability for washing small amounts of clothes [8]. Based on this premise, 45 single-drum mini washing machine samples with high sales in the Chinese market are selected as research objects to analyze the market demand for mini washing machines in the current market, as shown in Fig. 2.

The samples were sorted out based on color matching. The color matching of mini washing machines is mainly divided into color series, color-difference series and pure color series. In terms of product styling, the color series and color-difference series samples have rich and varied styling, clear themes, high brand recognition, and rich emotional expression; the pure



Fig. 2. Analysis of Current Market Status (Drawn by the author)



color series samples pursue a sense of technology and intelligent creation, are simple and elegant, and fashionable. Overall, the existing products have the disadvantages of outdated styling and similar designs. Their styling and semantics fail to resonate with users, resulting in a lack of warmth and appeal in the product experience, especially for specific user groups, which makes them lack functionality and design sense.

In terms of functions, most mini washing machines remain at the basic functional level. Fully automatic washing machines have more diverse functions and high efficiency, but the processing cost is also high; semi-automatic washing machines are mainly washing and drying, supplemented by blue light sterilization functions, and the function settings are relatively simple.

From the perspective of market categories, there are many brands in the mini washing machine market, the product manufacturing and processing technology is mature, the competition is fierce, but the product demand is not saturated, and the differentiation is not obvious. The problem of product homogeneity not only weakens the competitiveness of the brand, but also hinders the upgrade and iteration of the mini washing machine market towards high quality and sustainability.

It can be seen that the alienation of the design not only reduces the user's preference and frequency of use, which in turn leads to waste of resources, but also fails to effectively convey the concept of environmental protection and long-term use. Therefore, in order to break through the

design bottleneck of the mini washing machine market, by improving the appearance and design semantics of the mini washing machine, the user's emotional resonance can be enhanced, thereby improving the sustainability of the product.

Analyze the user needs of mini washing machines from typical user portraits. Interviews and surveys were conducted on four representative user groups to construct character portraits of role characteristics, thereby analyzing typical user needs, as shown in Fig. 3.

The first type of users are new mothers. Most of them are born in the 80s or 90s. They are the new mothers of the younger generation. They not only face the change of identity, but also bear the dual pressure of family work. Their most daily work is to take care of the baby and complete the task of changing clothes. Therefore, in order to free their hands and reduce labor, mothers need a dedicated mini washing machine to provide a healthy and sterile washing environment for the baby.

The second type of users are young people living in small houses. Most of them are young men and women who are wandering outside, working hard, living alone or sharing a house. They are young and passionate, have strong self-living ability, but are prone to impulse consumption. Due to work or life requirements, they need neat clothes and decent clothes. Therefore, they need a stylish smart washing machine that can occupy a small space, be dedicated to one person, and have a high cost-effectiveness.

The third type of users are empty-nesters. They are a special group with traditional and



Fig. 3. Keyword Descriptions for Four Types of User Personas (Drawn by the author)

conservative ideas. They lack interest in intelligent machines and enjoy a simple and leisurely life. Due to age and physical changes, they are not flexible enough and need help from people around them for daily activities, which makes laundry a problem to be solved. They need a laundry machine with simple functions and labor-saving.

The fourth type of users are millennials. As a young generation full of vitality and vigor, this group has independent personality, follows fashion trends, is full of curiosity and challenges, and is also unconstrained and impatient. They pay attention to the quality of life, have a wide range of interests, and have a strong independent spirit. Therefore, they need a dedicated washing machine as a symbol of independence and a personalized pursuit of life.

Through market research and user research, the design needs of mini washing machines are deeply analyzed, and three levels of basic needs, expected needs and exciting needs are summarized.

First, basic needs focus on the basic functions and price competitiveness of mini washing machines. The market requires mini washing machines to have basic cleaning and washing capabilities, low water and power consumption, and suitable prices to meet the needs of ordinary consumers for convenient operation, efficient use and economical affordability.

Second, expected needs emphasize the differentiation and user stickiness of mini washing machines. The market hopes that products can be segmented and innovated in terms of functions, appearance design and target groups to enhance brand competitiveness and consumer loyalty. In terms of user dimensions, washing machines need to be more intelligent and humanized to enhance the user experience. For example, the size of the washing machine is easier to move and store, and the structure is easier to disassemble, clean and maintain, thereby extending the service life of the product and reducing waste generation.

Third, the excitement demand is manifested in the sustainable design and brand image enhancement of mini washing machines, taking into account the innovation of multiple dimensions such as appearance design, interactive operation and environmental performance. For example, the aesthetics of product shape are integrated into the home environment to trigger emotional resonance; environmentally friendly materials and low-carbon manufacturing processes are used in products to respond to the trend of green consumption; and brand image and product repurchase rate are enhanced

through high-quality related services such as product recycling and reuse.

Comprehensively analyze the design demand level, transform it into practical and executable design opportunities, and refine the sustainable design strategy from multiple dimensions of product design, including basic function design, differentiated appearance design, user experience design, and product semantic communication.

In terms of basic function design, optimize cleaning performance and energy saving effects. By improving the accuracy of the washing program, reducing water consumption and energy consumption, ensure that the body of the small washing machine can also meet the cleaning needs.

In terms of differentiated appearance design, exclusive shapes and colors for different groups of people are used. To meet the emotional needs of different user groups, especially mother-and-child users, single users and young families, specific theme appearance and color matching are designed. Soft styling lines and friendly colors are used, and safer corner treatments are designed on the appearance to prevent accidental collisions. In addition, a small and simple design style can be provided to adapt to the home environment of single or small-sized families. Diverse color matching and humanized appearance design make the product easier to integrate into the family scene and enhance the market recognition of the brand.

In terms of user experience design, optional model modes are provided to improve ease of use. The operation interface is simplified, and touch screen or knob control is used, with clear icons and concise instructions, which is convenient for users of different ages, especially the elderly in mother-and-child families. Provide detail optimization in user experience to increase the convenience and humanity of the product.

In terms of product semantic communication, choosing intention or carrier as a symbol of design concept can not only form a unique recognition in shape, material and color, but also imply the functional characteristics, usage and emotional value of the product through appearance, giving the product a unique visual language and emotional connotation. Clear design intention and product semantics can transform the design concept from an abstract concept into a concrete visual and tactile experience, enhance the beauty and practicality of the product, and make users feel emotionally identified, thereby strengthening the unique value of the brand. Therefore, the design of the mini washing

machine will position the design direction from four aspects: function, appearance, experience and semantics, and take the mother and baby user group as the representative user role to output the design plan of the mini washing machine, as shown in Fig. 4.

The design scheme is based on the theme of "protection". First of all, the design concept is "water", highlighting the product semantics of both softness and hardness. The semi-wrapped form embodies the feeling of protection, and the lines are softened to break the monotony of traditional washing machines. The saturated three-dimensionality of the product is displayed through layered changes, making the overall product smooth and soft, and with tough metal edging, it conveys the soft and strong maternal love. Secondly, the flap handle of the washing machine is inspired by the anthropomorphic "mouth", which is genetically recombined and integrated with the cover to form an arc curve design. Then, the full curved surface design of the body not only enhances the soft and elegant feeling of the product, but also prevents bumps and pays attention to the interactive safety between the product and the user. At the same time, the most user-recognized blue light sterilization function is added to the washing machine design, and combined with the use environment and transportation conditions, a semi-hidden storage slot is designed on the back of the product, and the details such as the washing

machine's wire collection and drain pipe are integrated to make the product no longer messy and more in line with the family atmosphere. In addition, considering the diversity of user choices and the level of product demand, semi-automatic knob washing machines and fully automatic touch-screen smart washing machines are designed. Finally, considering market demand and color trends, a variety of mainstream color schemes are provided, colorful matching, to enhance the visual appeal of the product.

After completing the preliminary design of the maternal and infant mini washing machine, practical issues such as the feasibility of the plan and production technology will be considered. Based on the professional suggestions and evaluation results of the engineers, the plan will be further refined under the guidance of the technicians, as shown in Fig. 5. First, the opening method of the washing machine cover is tested in the computer-aided design tool, and the position of the cover is adjusted; secondly, considering the production cost and manufacturing process of small household appliances, the double-layer drum wall in the original plan is changed to a single layer on the basis of ensuring the normal operation strength of the washing machine; finally, in order to meet and facilitate mold demolding, the product contour lines are adjusted, the overall expansion size is converged, and only a specific demolding slope is retained. The modified plan is re-evaluated to



Fig. 4. Design concept of mini washing machine for mother and baby (Drawn by the author)



determine that the plan can be used for actual production.

At this point, the design plan is fully integrated and visualized, commercial elements are added, and the commercial product display materials are

completed with copy interpretation, scenario-based publicity and specific product parameters, so as to better convey the product selling points and sustainable guidance and enhance market appeal. The display effect is shown in Fig. 6.



Fig. 5. Mini washing machine model conforming to engineering production (Drawn by the author)



Fig. 6. Display effect diagram (Drawn by the author)



## CONCLUSIONS

This study focuses on the sustainable design strategy of home appliances driven by market demand and user demand, proposes a systematic path of demand acquisition, opportunity point conversion, and design output, clarifies the design positioning of mini washing machines driven by demand, and combines the specific needs of maternal and infant users with the emotional expression of product semantics for design practice. The sustainable design strategy not only enhances the market competitiveness of mini washing machines, but also provides a useful exploration for the sustainable development of home appliances. In the future, with the continuous advancement of the concepts of intelligence and ecology, home appliance design will pay more attention to the combination of user experience and environmental benefits, bringing consumers a higher value experience.

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## АНОТАЦІЯ

### **Інь Цзінь, Кротова Т. Практика сталого дизайну побутової техніки з урахуванням попиту споживачів**

**Мета** статті – обговорити стратегію і практику сталого дизайну побутової техніки на основі вимог до дизайну, проаналізувати зв'язок між вимогами і сталістю дизайну побутової техніки через дослідження вподобань користувачів і ринкових тенденцій, запропонувати конкретні стратегії дизайну і практичні шляхи, а також перевірити здійсненність стратегій у реальному дизайні за допомогою конкретних дизайн-проектів.

**Методологія.** У дослідженні використано методи спостереження, аналізу, синтезу та узагальнення інформації щодо практичного досвіду застосування принципів стійкого дизайну в проектуванні побутової техніки.

**Результати.** Першочерговим завданням сталого дизайну побутової техніки є розуміння основних вимог до дизайну. Стратегія сталого дизайну побутової техніки, орієнтована на попит, має на меті створити шлях дослідження, що складається з трьох ключових етапів: вивчення попиту, трансформація точок можливостей і виведення дизайнерського рішення, а також передати концепцію сталого розвитку через такі ключові елементи, як функція продукту, форма, досвід і семантика, щоб врешті-решт сформувати практичну та естетичну побутову техніку.

З'ясовано вимоги до стійкого дизайну як з боку ринку, так і з боку користувачів, за допомогою аналізу зразків продукції та методів побудови профілів користувачів, інтегровано ієрархії вимог і перетворено їх на вихідні дані проєктних можливостей, які можна застосувати у дизайн-рішеннях. На основі глибокого аналізу потреб користувачів і потреб ринку запропоновано стратегію сталого дизайну побутової техніки, орієнтовану на попит. На основі аналізу попиту розроблено концепцію сталого дизайну побутової техніки, яка допоможе дизайнерам впроваджувати сталі концепції в дизайн продукції, а також забезпечить теоретичну основу та практичні рекомендації для зеленої та низьковуглецевої трансформації індустрії побутової техніки.

**Наукова новизна.** Теоретично обґрунтовано та поглиблено роль дизайнерських потреб у сталому дизайні побутової техніки з особливим акцентом на синергію між потребами користувачів та ринковими вимогами для спрямування дизайнерських інновацій.

**Практична значущість.** Практика сталого дизайну побутової техніки, орієнтована на попит, має велике значення для сприяння зеленій трансформації галузі побутової техніки, підвищення ринкової конкурентоспроможності продукції та сприяння реалізації цілей сталого розвитку. Завдяки глибокому вивченню потреб користувачів і точному розумінню ринкових потреб, можна покращити імідж бренду та ринкові позиції підприємств побутової техніки, а також сприяти сталому розвитку всієї індустрії побутової техніки.

**Ключові слова:** дизайн продукту, сталий розвиток, інновації в дизайні, побутова техніка, попит користувачів, ринковий попит, міні-пральна машина.

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