Science and Technology Empowering Elderly-oriented Design

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ABSTRACT

Against the backdrop of aging population and deep integration of digital technology, how to enhance the quality of life of the elderly population through technology empowerment in elderly-oriented design has become a key issue. This study is based on the framework of the "Healthy China 2030" plan, using case analysis and interdisciplinary research methods to systematically explore the application path and ethical challenges of the synergy mechanism between technology and design in the field of elderly-oriented adaptation. Research has found that technologies such as artificial intelligence and sensors have reconstructed the usability paradigm of elderly products through functional integration (such as adaptive shoelace systems) and interface simplification (such as minimalist interaction logic); The imbalance between the rationality of technological tools and the rationality of design values leads to problems such as digital divide, emotional disconnection, and algorithm bias, manifested as technological exclusion of elderly users, lack of emotional interaction in smart devices, and data privacy risks. Based on this, a three-dimensional optimization framework of "user needs - technology adaptation - ethical norms" is proposed, covering inclusive user experience design (such as emotional companionship function), algorithm transparency governance (such as medical data encryption), and modular customization technology (such as personalized 3D printing). Future elderly-oriented design needs to focus on the transformation of "sensory free interaction" under human-machine symbiosis (such as automated smart homes), sustainable material innovation (such as the application of recycled composite panels), and the expansion of virtual real integration scenarios (such as VR remote social networking), promoting the coordinated evolution of functionality, emotion, and ecology. This study provides theoretical reference and practical path for the inclusive development of technology in an aging society.

Keywords: *Elderly-oriented design, Artificial intelligence, Human-machine symbiosis, Sustainable innovation, Aging population, User experience.*

1. INTRODUCTION

The core goal of the "Healthy China 2030" plan is to promote the realization of "joint construction and sharing, and universal health". With the increasing trend of population aging, the demands of the elderly population are showing a diversified growth trend. However, existing traditional facilities are no longer able to adapt to the challenges brought about by this change. Thanks to the advancement of digital technology and related equipment, scientific and personalized elements have been injected into the development of elderly products. Therefore, it is particularly important to improve the quality of life for the elderly by closely integrating design with technological innovation. Technology, as an important force driving the development of design, not only promotes the innovation of expression forms, but also endows design works with a spirit of keeping up with the times and innovative value. On the contrary, design also adds unique aesthetic value to technological progress and enhances users' emotional experience. Artificial intelligence technology integrates machine learning and algorithmic computation to simulate human behavior, effectively breaking down the boundaries between hardware, software, and various technological products. The elderly-oriented design concept centered on elderly users fully considers factors such as the physical

condition, psychological characteristics, and behavioral habits of the elderly in the design process of products and services, aiming to improve their quality of life, ensure their health, and enhance their social communication skills. This article aims to explore the relationship between elderly-oriented design and science and technology, especially the application examples of artificial intelligence in this field, hoping to provide valuable insights and references for improving the quality of life, health level, and social participation of the elderly.

2. THE RELATIONSHIP BETWEEN SCIENCE AND TECHNOLOGY AND DESIGN

Throughout history, technological progress has always been an indispensable driving force in the field of design. It not only promotes social development, but also greatly enriches the possibilities of design. There is a mutually beneficial relationship between technology and design, where they interact and progress together, especially in improving the quality of products for the elderly.

2.1 The Promoting Role of Science and Technology in Design

Science and technology have always been the core factors driving the progress of art and design. From ancient times to the present, whether in the East or the West, every important innovation in the field of design has been closely linked to technological progress. The technological progress in history has promoted the application of new materials, prompting designers to constantly seek innovation in material selection, style shaping, and design concepts. Nowadays, with the increasingly diverse demands of digitization and virtualization, traditional design knowledge and technology seem inadequate. Taking Nike's Adapt smart shoes as an example, it achieves real-time monitoring of the user's movement status through integrated sensors and micro motors, and can automatically adjust the elasticity of the shoelaces; By analyzing the activity patterns of the elderly, the shoelace adjustment function is optimized, making this product more in line with their needs and greatly enhancing the wearing experience. This example not only breaks the conventional design framework, but also crosses multiple disciplinary boundaries, demonstrating the enormous potential of artificial intelligence technology in sports shoe development and pointing out new trends in the future development of smart shoes. This fully reflects the importance of technological progress in promoting deep integration and innovative development in the field of design.

2.2 The Guiding Role of Art and Design in Science and Technology

In the context of rapid technological progress, art and design have become an indispensable force in promoting technological innovation. Artists, with their keen insight and rich creativity, are able to provide unique insights into diverse design challenges and cross disciplinary innovations. When traditional design concepts are struggling to meet the increasingly complex demands of digital life, art and design can guide the evolution direction of technological products by deeply exploring users' potential preferences. Taking the smart temperature control device Nest as an example, in its development process, the design team used an artistic way of thinking to transform the originally complex and difficult to understand temperature control technology into an intuitive and easy-to-use operating interface. This not only makes it easy for the elderly to get started, but also allows temperature adjustment to be completed solely through voice commands through the voice assistant function. In this way, it not only enhances the modern atmosphere and user comfort of the product, but also enhances its market competitiveness, perfectly interpreting the key role of art and design in improving the functionality and user experience of technology products.

Therefore, science and technology and design innovation promote each other, jointly driving the development of elderly-oriented products towards higher quality and providing solid guarantees for them.

3. ANALYSIS OF CURRENT DIFFICULTIES

Although the application of artificial intelligence technology in elderly care services has shown initial results, its development is still in the exploratory stage. To make this type of technology more widely serve the elderly population, a series of challenges and problems need to be overcome. These issues not only limit the opportunities for elderly people to enjoy the convenient life brought by technological progress, but also pose new challenges to design work aimed at improving the

quality of life for the elderly. This chapter will explore in detail the digital divide, lack of emotional connection, and ethical considerations faced by current elderly-oriented design, and delve into the fundamental reasons behind these issues, providing theoretical support for the development of effective solutions in the future.

3.1 The Digital Divide Hindering the Elderly-oriented Process

3.1.1 Physiological Needs

Due to the unique physiological characteristics of the elderly, such as weakened vision, memory decline, hearing loss, and slower reaction times, elderly users face significant challenges when learning and using smart electronic products. This often makes them feel overwhelmed and fearful of information technology, which in turn affects their adaptability and overall experience of smart products. In addition, due to the natural decline of bodily functions and insufficient understanding of product information and operating procedures, elderly people exhibit a high level of resistance towards medical and health equipment; The degradation of perceptual functions also increases the complexity of using such products, posing a risk of causing additional harm.

3.1.2 Psychological Needs

Like non-elderly groups, elderly people have a strong interest in learning, leisure activities, and social interaction. However, in urban environments, the widespread use of digital entertainment methods has led to a high concentration of cultural and entertainment resources, making it difficult for many elderly people to access entertainment forms that meet their interests. With the acceleration of urbanization, the number of social interaction and cultural activity venues suitable for the elderly to participate in is gradually decreasing, which exacerbates the loneliness felt by many elderly people.

3.2 The Disconnect Between Technology Products and User Emotions

In the pursuit of technological performance, certain technological products often overlook the importance of user experience and emotional connection, resulting in an emotional distance between users and products. Especially in product development dominated by technological innovation, developers may focus too much on improving technical indicators while neglecting the usability and user-friendly design of the product. This not only reduces the market appeal of the product, but also hinders a closer integration between technology and design. This issue is particularly prominent in product design targeting the elderly population. Some elderly products, due to their complex interfaces and cumbersome operations, pose significant challenges for elderly users, making it difficult for them to effectively control smart devices.

The user interface design of iPhone is known for its minimalist style, which removes cumbersome operation buttons and redundant functions, and instead adopts intuitive and simple icons and gesture control methods, greatly facilitating the use of elderly users. This design concept not only significantly enhances the user experience, but also becomes a benchmark in the field of smartphone interface design, perfectly interpreting the principle of “less is more”. By minimizing visual interference elements, iPhone allows users to focus more on the screen content itself and enjoy a smoother and more natural operating experience, making technology products more in line with the living needs of the elderly.

3.3 Ethical Issues in Design Caused by Technological Development

With the increasing popularity of artificial intelligence technology, its inherent opacity, difficult to explain behavioral patterns, and potential biases have gradually become the focus of attention for both academia and industry. This opacity increases the difficulty of predicting AI behavior and its outcomes; At the same time, ensuring algorithmic fairness, protecting personal data privacy, and the impact of automation processes on the labor market pose a series of ethical challenges that urgently need to be overcome. Especially for the elderly, due to their lack of sufficient risk prevention awareness, issues related to data security and personal information protection are particularly important. Looking ahead, there will be significant challenges in enhancing model transparency, addressing the scarcity of training data, and developing both intelligent and trustworthy technological systems.

4. SOLUTION PATH AND STRATEGIES

Exploring effective solutions is particularly urgent in addressing the many challenges faced by elderly-oriented design. This section will start from multiple aspects such as enhancing user experience, standardizing technical ethics, and developing product strategies specifically for the elderly, proposing a series of innovative measures that are both targeted and easy to implement. The purpose of these measures is to break through current limitations, fully utilize the power of science and technology, and enable elderly-oriented design to better meet the needs of the elderly, thereby improving their quality of life and happiness.

4.1 Strengthening User Experience Design

Sci-tech type enterprises should establish a user experience research team that covers multiple disciplines, using various methods such as interviews and testing to deeply explore users' specific needs. In addition, user experience related training courses should be conducted for R&D personnel to integrate intelligent design concepts. For example, when developing a robotic pet project, the team conducted extensive market research and ultimately designed a robotic dog that not only has a pleasing appearance but is also highly approachable, providing personalized companionship services for the elderly. By introducing relevant indicators of user experience into the product evaluation system and based on the principle of "materialization of numbers", it is necessary to evaluate whether the product can present data information to users in an intuitive way, and continuously improve product design based on these evaluation feedback, thereby comprehensively enhancing the overall user experience.

4.2 Standardizing the Ethics of Technological Design

Researchers should focus on creating highly transparent artificial intelligence algorithms to achieve clear presentation of decision-making processes in important areas such as elderly healthcare and home care.

In addition, China should establish a rigorous set of algorithm fairness standards and data privacy protection regulations to incentivize enterprises to identify and reduce potential biases during algorithm development, while using encryption and other means to ensure information security. This also helps to reduce the safety risks faced by the elderly when using artificial intelligence products. It is also necessary to actively promote the participation of all sectors of society in the discussion of ethical issues, ensure that the application of "digitalization of things" and "digitalization of numbers" technology in the field of intelligent design complies with laws, regulations, and ethical norms, in order to safeguard the interests of all stakeholders and promote the healthy and sustainable development of human-computer interaction technology.

4.3 Strategies for Customizing Elderly-oriented Products

Products designed for the elderly population cover a wide range of fields, and different types of products have their own focuses in meeting the needs of elderly users, facing different design challenges and key points. Among them, health care, daily life assistance, and leisure and entertainment products are closely related to the daily activities of the elderly and play an important role in improving their quality of life. This article will conduct a detailed exploration of these three representative elderly-oriented products, aiming to explore how to better meet the real needs of the elderly and develop more personalized and practical products through multiple dimensions such as functional improvement, emotional support, and user convenience, thereby effectively improving their quality of life.

4.3.1 Design Strategies for Healthcare and Nursing Services

In the design process of such products, a more detailed exploration of the health challenges and obstacles faced by the elderly should be conducted, and the functions should be customized and adjusted according to the specific needs of different users. It is worth noting that the users of nursing products are not limited to the elderly population, but also include their children and spouses. Therefore, in product design, it is necessary to take into account the experience and feelings of these two types of users. To this end, an inclusive design concept can be adopted to ensure that elderly users can accept and recognize the product, while also ensuring that caregivers can operate and use it conveniently and quickly. In addition, when developing such products, the changes in users'

psychological states should be fully considered, and the resistance emotions that elderly people may experience should be alleviated through optimized design.

4.3.2 Home and Lifestyle Design Strategies

In the current market, there is a significant demand for home and lifestyle products targeting the elderly. Due to the frequent daily interaction between elderly people and such products, the rationality of their design directly affects their quality of life. Therefore, when developing elderly-oriented products, emphasis should be placed on personalized design to better meet the emotional needs of elderly users. For example, traditional rice cookers often have multiple functions, dense button layouts, small fonts, and complex operating logic. Although suitable for ordinary adults, for the elderly, their basic requirements for rice cookers mainly focus on how to safely and healthily complete the cooking process to meet basic physiological needs. In view of this, when rice cookers for the elderly are retrofit, attention should be paid to the accuracy of information reading and reducing the possibility of misoperation. By increasing fault tolerance and introducing reversible modes to optimize user experience, it is ensured that food that meets the health standards of the elderly can be produced.

4.3.3 Cultural and Entertainment Design Strategies

Whether cultural and entertainment products can successfully provide users with a good experience depends on whether they can fully consider the physical and psychological characteristics of the elderly, and actively attract this group to participate deeply, thereby bringing them a sense of spiritual satisfaction. Given that elderly people often have deep emotions towards the past and may have a certain aversion towards emerging things, when designing entertainment products for elderly users, innovative adjustments can be considered while retaining traditional forms of entertainment. Specifically, it is based on people's familiar usage habits, combined with modern technology to enhance and achieve effective integration of traditional models and the latest technology. This can not only increase the attractiveness of the product, but also effectively narrow the gap between elderly people and contemporary technology products. The aim of designing specialized strategies for various agingfriendly products is to meet the diverse needs of elderly people in their daily lives, thereby improving their quality of life and happiness.

5. FUTURE TRENDS

Looking ahead to the future, with the continuous advancement of science and technology and the increasing attention of society to the elderly population, the design field that adapts to aging will usher in broader development prospects and unprecedented opportunities. Emerging technologies, concepts, and design methods will continue to emerge, bringing profound changes and novel experiences to the lives of the elderly. This chapter will explore the future direction of elderly-oriented design in human-computer interaction, sustainable development, modular design and personalized customization, and the application of augmented reality and virtual reality technology based on current development trends. This chapter will also depict a hopeful blueprint for this field.

5.1 Elderly-oriented Design under Human-Machine Symbiosis

In today's era of coexistence between humans and machines, the integration of design and science and technology is becoming increasingly close. Artificial intelligence not only plays the role of a design tool, but has also become a key force leading the transformation of the design industry. Looking ahead to the future, the development trend of design will shift from relying on personal experience to focusing more on intelligent collaboration. The collaborative mode of human-computer interaction will become an important way to stimulate new design ideas.

5.1.1 Integration Design of Sensibility and Rationality Under Problem-orientation

With the increasing integration of design and technology, the collaboration between designers and computers has undergone profound changes. This evolution process has evolved from early design patterns that relied on computers as auxiliary tools to today's closer and more creative collaborative relationships between humans and machines. Designers not only provide practical cases and professional guidance for the application of computer technology, but also use artificial intelligence tools to systematically analyze a large

number of user needs and develop design solutions that meet personal preferences.

Taking Tesla's new energy vehicles as an example, the designers have contributed valuable opinions to the overall architecture and detail optimization of the vehicle based on their profound understanding of aesthetics and human-machine interaction. At the same time, the powerful computing power of computers has enabled autonomous driving technology. Another case is a smart health monitoring mattress developed by a certain enterprise, which can collect real-time health information such as the sleep status and heart rate of elderly people, and send it to their children's mobile devices in real time for remote care. This method of combining intuitive insight with rational analysis not only ensures the effective implementation of product functions, but also makes the final result more in line with users' emotional needs.

5.1.2 Quiet and Warm Collaborative Design Mode

When designing intelligent products, it is necessary to fully consider the distribution of users' attention and emotional needs, in order to prevent confusion caused by overly complicated interfaces or operation processes. The ideal product design should be able to operate autonomously, meet the needs of users to the greatest extent possible, while reducing dependence on user intervention, thus achieving a transition from traditional “five sense” interaction to a more natural and smoother “no sense” experience.

Taking Xiaomi's smart home system as an example, it not only integrates smart devices with voice assistants, but also automatically adjusts the status of lighting and air conditioning facilities based on users' daily habits. This design allows technology products to naturally integrate into the living space without disturbing users, significantly improving the comfort of elderly users and reflecting a high emphasis on user experience and humanistic care.

5.2 Elderly-oriented Design Under the Concept of Sustainability

IKEA is committed to the deep development of traditional materials such as wood and bamboo, using innovative processing techniques to transform them into more environmentally friendly and renewable product materials. For example, by recycling waste wood to produce composite panels for furniture production, not only does it reduce the demand for raw wood, but it also effectively controls costs. Applying these sustainable materials to elderly home products can not only alleviate their aversion to digital products, but also reduce the level of environmental pollution. In addition, in terms of product design, IKEA focuses on optimizing the entire life cycle of products and the design concept of recycling, such as designing furniture structures that are easy to disassemble and assemble, making it convenient for users to disassemble and recycle products at the end of their service life, thereby reducing the impact on the natural environment. This series of measures has inspired designers to think from the perspective of new uses of traditional materials, explore environmentally friendly, practical, and creative design solutions, further enhance the emotional experience of the elderly, and point out new development directions for the field of home design.

5.3 Modular and Customized Design of Elderly-oriented Products

With the continuous evolution of the design field towards electronicization, integration, and miniaturization, the application of new materials has opened up broad prospects for breaking through traditional structural limitations, and may even trigger innovation in the fields of materials and technology, thereby giving birth to new design concepts. The case of BMW Group adopting 3D printing technology is a powerful proof, demonstrating extraordinary creative potential by combining 3D printing with innovative materials. This approach not only meets the high-strength requirements of automotive components, but also significantly reduces weight, thereby improving overall vehicle performance while reducing manufacturing costs. Currently, 3D printing technology has made rapid prototyping a reality, greatly enhancing designers' ability to adjust and optimize design schemes in a timely manner, and accelerating the product development cycle. In addition, 3D printing technology has also promoted the development of personalized customization services. For example, the elderly can use this technology to customize personalized accessories to meet their pursuit of uniqueness. This undoubtedly injects new vitality into the design field and promotes profound changes in the entire chain from material selection to final product form. With the rapid growth of the Chinese economy and the continuous improvement of personal living

standards, the standardized design schemes of the past have become increasingly difficult to meet the growing personalized needs of consumers, so the private customization model has gradually become popular. The advancement of science and technology and economy provides technical support for achieving more diversified personalized design, for example, elderly people can customize their own sports shoes through online platforms; Smartphone manufacturers have also begun offering customization options to better serve the needs of this particular user group.

5.4 Elderly-oriented Product Design Under the Application of Augmented Reality and Virtual Reality Technology

With the advancement of technology, augmented reality (AR) and virtual reality (VR) will play an increasingly important role in the field of design for the elderly. For example, in terms of rehabilitation therapy, the use of VR devices provides a new way for elderly people to walk and exercise in virtual spaces, which is particularly beneficial for those with limited mobility. In addition, the application of AR technology can help elderly people more accurately identify the location of key positions or facilities in their homes, thereby reducing the risk of losing direction in their living environment. Then, with the support of VR technology for remote social activities, the elderly can participate in various social occasions across geographical boundaries, achieve "face-to-face" interaction and communication with distant family and friends, and help alleviate their sense of loneliness.

In the future product design process, the design concept of human-machine collaboration should be emphasized, and the principles of sustainable development should be integrated into the design for the elderly. What’s more, by adopting modular and customized strategies, combined with the application of augmented reality and virtual reality technology, the personalized needs of the elderly population can be better met. These methods not only provide high-quality and personalized service experiences for elderly users, but also greatly enrich the functionality of products, thereby promoting the design for the elderly to a new level.

6. CONCLUSION

Under the trend of aging population, the close integration of design and science and technology has become a key driving force for promoting the transformation and upgrading of aging related products. This article explores the unique potential and possibilities of artificial intelligence as an emerging technology in the field of elderly-oriented design. Although aging products face many new challenges as a result, traditional barriers are gradually being broken down with the increasing interdisciplinary collaboration and the emergence of innovative thinking. The article proposes various response strategies, including enhancing user experience and improving measures for specific aging products. Technology provides efficient tool support for design, such as applying artificial intelligence to industrial design, which can accelerate solution generation and optimize processes, thereby reducing research and development costs; By imbuing the work with emotions and soul, designers make the product more relatable to people's hearts and full of humanistic care , intending to meet the physiological and psychological needs of the elderly population through deep integration of design and technology. Looking ahead to the future, elderly-oriented design will not only focus on functional implementation, but also emphasize emotional expression and experiential transmission. With the deep application of digital technology and the organic integration of physical products, digital solutions in the field of aging will find a new balance between innovation and practicality, better serving the diverse needs of society. This combination is not only a manifestation of the coordinated development of technology and art, but also the result of the perfect integration of sensibility and rationality, destined to become an important symbol of building a better future.

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