Design of Disabled Standing Assistance Wheelchair Based on Ergonomics and Emotional Theory

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ABSTRACT

With the increasing attention of society to the disabled population, the design of standing assistance wheelchairs, as important rehabilitation equipment, has significant implications for improving the quality of life of people with physical disabilities through design optimization. This study aims to explore innovative design strategies based on ergonomics and emotional design theory, combined with industrial design methods, to address the limitations of current standing assistance wheelchairs in terms of appearance design, human-machine interaction, and personalized adaptation. This paper has studied and analyzed the current development status in China and foreign countries, pointing out that traditional products have problems such as high cost, single functionality, and insufficient comfort. It is proposed that comfort design should integrate ergonomics and emotional experience, using soft colors, personalized customization to relieve psychological pressure, and auxiliary function design emphasizing operational convenience and adjustability to achieve personalized adaptation and emotional recognition synergy. On this basis, a design scheme based on the core concept of "people-oriented" is proposed, which adopts a simple streamlined appearance to weaken stereotypes, integrates an intelligent control system to enhance functional experience, and enhances emotional resonance through color matching and material selection. This provides theoretical and practical references for promoting the development of the assistive device industry towards a more humane and sustainable direction.

Keywords: *Standing assistance wheelchair, Individuals with physical disabilities, Ergonomics, Appearance design, Versatility.*

1. INTRODUCTION

With the increasing attention of society to the rights and social integration of people with disabilities, the importance of assistive devices in improving the quality of life of people with disabilities is becoming increasingly prominent. Due to physiological or functional impairments, people with disabilities often rely on assistive devices to overcome obstacles in their daily lives and participate more equally in social life. As an important rehabilitation aid, the standing assistance wheelchair can not only help individuals with lower limb disabilities achieve free switching between sitting and standing positions, but also promote blood circulation, reduce complications caused by long-term sitting and lying, and significantly enhance users' social participation ability and psychological dignity. However, there are still significant limitations in the appearance design, human-machine interaction, and personalized adaptation of standing assistance wheelchairs currently available in the market. Traditional wheelchairs only provide basic mobility functions, while standing assisted wheelchairs can give users the ability to adjust their posture autonomously, but still have significant shortcomings in user experience, aesthetic expression, and environmental adaptability.

Therefore, how to combine ergonomics, emotional design, and industrial design methods to optimize the functionality, comfort, and visual appeal of standing assisted wheelchairs has become a key issue that urgently needs to be addressed in the field of rehabilitation engineering. This study aims to explore innovative design strategies and propose solutions that better meet the needs of disabled and elderly users through interdisciplinary research methods, thereby enhancing the

practicality and social value of products and helping users achieve higher quality independent living.

1.1 Research Significance

This study is based on the analysis of physiological and psychological characteristics of people with physical disabilities, combined with ergonomics and emotional design theory, to explore in depth the optimization design strategies for standing assistance wheelchairs. Standing assistance wheelchairs not only provide basic mobility functions, but also enable posture transitions between sitting and standing, effectively improving users' blood circulation, muscle function, and digestive system health, and reducing complications caused by long-term sitting and lying. Its design optimization can enhance the daily activity ability of people with disabilities, promote physiological function recovery, and thereby improve overall quality of life and happiness. Secondly, as an important means of transportation and rehabilitation for people with disabilities, the design of wheelchairs directly affects the user's social integration experience. By optimizing human-machine interaction and emotional design, it can reduce barriers to use, and help users participate more confidently in social, work, and public activities, thereby reducing social isolation and enhancing psychological dignity and independence. And in response to the special needs of people with disabilities and elderly people with limited mobility, the proposed design strategies can promote social attention to accessible facilities, promote inclusive development and innovative design, and lead the technological upgrading of the wheelchair industry, with significant economic and social benefits. Not only does it fill the research gap in the human-machine adaptation and emotional experience of standing assisted wheelchairs, but it also provides a practical and feasible path and social significance for improving the living conditions of vulnerable groups and building an inclusive society.

1.2 Development Status of Standing Assistance Wheelchairs in China and Foreign Countries

In the field of research on assistive standing devices, there are different focuses on development both domestically and internationally. Foreign research has achieved significant results in the development of mechatronics assisted standing devices with advanced theories and technologies, but the high cost makes it difficult to popularize and meet the needs of a wide range of users. There are various types of assistive standing devices in China, but each has its own limitations.

For example, although crutches are portable and suitable for elderly people with good hand strength and balance, their stability is poor and they are not suitable for groups with weak lower limb strength and poor balance ability, limiting their usage scenarios; The vertical lifting auxiliary standing mechanism has a simple structure, easy operation, and can operate purely mechanically. However, its vertical standing trajectory does not conform to the natural laws of the human body and needs to be adjusted according to height. It has high requirements for upper limb strength and is large in size and heavy in weight, making it difficult to meet the convenience needs of home use. Its market acceptance is low; In terms of assistive standing robots, the standing rehabilitation training system developed by Kochi University of Technology in Japan uses dual rope control to assist patients in standing up. However, it is difficult to adapt to complex real-world scenarios due to factors such as height and joint spacing;

Chinese auxiliary standing devices also need improvement. The auxiliary standing armrest has a single function and can only meet basic support needs, which cannot meet the diverse needs of the elderly and affects market sales. Although there are some innovations in the design of auxiliary standing seats, some of which incorporate cellular mechanisms or optimized control devices, there are problems such as complex structure, high cost, and poor comfort. The assistive standing wheelchair is easy to operate and has strong stability, but it still needs to be strengthened in the application of ergonomics and color theory; Although the auxiliary standing platform is easy to move, it lacks integration with the user and has a high cost of use, requiring optimization based on ergonomics. Although the healthcare robot assistive standing device has multiple nursing functions, its standing trajectory is single and does not fully consider individual differences. It also has high costs and complex maintenance, which increases the burden on families. In the future, research on assistive standing design needs to draw on Chinese and international experience, while reducing costs, improving product adaptability, comfort, and multifunctionality. By deeply applying ergonomics, emotional design, introducing intelligent technology, and adopting new materials and

structures, product design is optimized to meet different user needs and promote industry development.

2. PRINCIPLES AND REQUIREMENTS FOR APPEARANCE DESIGN

2.1 Comfort Design: Integrated Optimization Based on Ergonomics and Emotional Experience

In the design of standing assistance wheelchairs, comfort design is the core element to enhance user experience, which requires a deep integration of ergonomics and emotional theory to achieve dual optimization of functionality and emotion. Based on ergonomics, wheelchair design adapts to users' physiological characteristics from multiple dimensions: Firstly, by accurately adjusting the seat height, tilt angle, and foot pedal position, it provides users with stable support and comfortable sitting posture, designs comfortable back support that conforms to the human body curve, and provides stable and comfortable back support; Secondly, it is necessary to layout the operation controls in easily accessible areas, optimize the design of buttons, switches, and joysticks based on user hand abilities to ensure ease of operation, such as integrating the operation display screen into the armrest and adding a phone holder; Thirdly, the foot pedal should be made of anti-slip material, which can not only ensure comfortable and relaxed foot movement but also enhance safety; In terms of material selection, priority is given to using breathable, soft, and well supported materials to create a comfortable riding surface and enhance physical comfort.

The integration of emotional theory endows comfort design with deeper connotations. Considering the psychological issues such as inferiority and anxiety that individuals with physical disabilities may face, the design focuses on creating a warm and friendly emotional atmosphere. The soft color matching and smooth appearance lines convey a sense of affinity and security. The designers can add personalized customization elements, allowing users to choose the color, decoration, etc. of the wheelchair according to their preferences, enhancing their sense of belonging and emotional identification with the product. In addition, on the basis of meeting basic functions, the emotional temperature of the product is enhanced through detailed design, such as comfortable armrest design, thoughtful storage space, etc., allowing users to feel cared for and respected during use, so as to achieve a sublimation from physical comfort to psychological comfort, and ultimately comprehensively improve users' quality of life and happiness.

2.2 Auxiliary Function Design: Operational Convenience and User Experience Optimization

In the design of the appearance of the assistance wheelchair for people with physical disabilities, the consideration of assistive functions and operational convenience is crucial to ensure that users can easily and safely use the wheelchair. The standing assistance function takes into account the standing needs of physically disabled individuals when designing wheelchairs. By adopting an electric system, the wheelchair can be lifted and lowered smoothly and safely to assist users in achieving a standing posture. This function should be easy to control and operate, and users can control the lifting and lowering of the wheelchair through simple buttons or switches. At the same time, in order to increase flexibility and multifunctionality, the wheelchair is considered to be designed in a convertible form in the design. Through adjustable seats and backrests, users can switch the wheelchair to a sitting or standing position when needed, providing different comfort and usage options. Designers can design a user-friendly control panel and buttons, placed on the armrest for easy access and operation, so that users can easily control the various functions of the wheelchair. The design also adds an operation feedback function, allowing users to clearly understand the status and operation results of the wheelchair, providing information such as lifting status and battery level to enhance the controllability and safety of use. By considering the design of assistive functions and operational convenience, the appearance design of the standing assistance wheelchair for people with physical disabilities can provide a better user experience, enabling users to easily control and operate the wheelchair, improving their quality of life and independence.

2.3 Adjustable Design: Collaborative Implementation of Personalized Adaptation and Emotional Identity

The height and standing needs of physically disabled individuals vary, therefore the seat height of wheelchairs should be adjustable. Adopting a

retractable seat and support structure, users can raise or lower their seats according to their personal needs for standing or sitting. In order to provide better comfort and support, the sitting angle of the wheelchair can also be adjusted. Users can adjust the angle of their seat and back to suit their standing posture needs, obtaining better support and comfort. The height of the armrest and footrest of the wheelchair can also be adjusted. Users can adjust the height of the armrest and footrest according to their own needs to obtain appropriate support and standing posture. The width of the wheelchair armrests is adjustable to accommodate individual differences in body size and standing needs of different users. In addition, when designing products for people with disabilities, if it is based on emotional needs, it is necessary to start from the spiritual level and place meeting the emotional needs of people with disabilities and maintaining their dignity at the core. For example, when designing a wheelchair for standing assistance for people with disabilities, by optimizing the appearance design, using warm colors and comfortable materials, providing visual and tactile pleasure to people with disabilities from an instinctive level, allowing them to feel the beauty and security of the product; In terms of functional design, full consideration should be given to the convenience of operation and the improvement of usability, so that people with disabilities can easily grasp it during use. This satisfies their emotional and respect needs from a behavioral level, thereby helping people with disabilities gain a sense of confidence and psychological security while using the product. In addition to basic adjustability functions, the exterior design of the wheelchair also offers personalized customization options. Users can choose different colors, patterns, or decorations to make the wheelchair more in line with their personal preferences and style. The design should achieve improving product comfort and safety, optimizing the design of wheelchair components from an ergonomic perspective, enhancing the comfort of the wheelchair, and ensuring the safety of residual heat travel and use through the design of safety devices.

3. APPEARANCE DESIGN SCHEME FOR STANDING ASSISTANCE WHEELCHAIRS FOR INDIVIDUALS WITH PHYSICAL DISABILITIES

3.1 Design Concept and Innovative Features

This design is based on the core design concept of "people-oriented", committed to deeply integrating ergonomics and emotional design to comprehensively enhance the functionality, comfort, and emotional value of the assistance wheelchair for people with physical disabilities, and effectively enhance the user's quality of life and self-esteem.

In terms of design innovation, the wheelchair adopts a simple and stylish streamlined appearance, breaking the stereotype of traditional assistive devices through smooth lines and modern geometric shapes. It not only conveys a positive visual image, but also effectively reduces the psychological burden on users. At the same time, the principles of ergonomics are integrated throughout the entire exterior design process to ensure precise adaptation of seat height, backrest angle, and other body shapes, providing optimal support for standing and moving. Breaking through traditional limitations in functional design, and integrating electronic display screens and intelligent control systems, can not only achieve basic standing assistance functions, but also expand through intelligent operation and entertainment functions, significantly improving user convenience and experience.

In terms of optimizing emotional experience, appearance and color matching play an important role. Adopting a modern appearance design can weaken the disability identification attribute of wheelchairs and enhance users' confidence. Creating a technological framework through smooth lines and innovative geometric structures, paired with soft and warm main colors such as light blue, off white, orange, etc., it can create a warm and comfortable visual atmosphere. The material selection has a direct impact on emotional experience. Therefore, the seats and armrests are made of high-quality leather or fabric that is skin friendly and breathable, and the external frame is made of high-quality metal and engineering plastic, conveying respect and care from both tactile and visual dimensions.

In terms of technological innovation, intelligent regulation systems have become the core highlight. Adding an operating system to the display screen allows users to better experience the convenience brought by technological innovation and improve the adaptability of wheelchairs in different scenarios, constructing a humanized and intelligent user experience from multiple dimensions.

3.2 Appearance Design Elements and Shapes

3.2.1 Proportional Relationship

The size and position of components such as seats, back support, and armrests are adjusted according to the user's body size to ensure a balanced and harmonious overall appearance. In addition to the overall proportion, there is also a proportional relationship between the details of the wheelchair, such as the ratio between the seat and armrest, and the ratio between the seat and back support. The proportion relationship of these details is coordinated with each other, and there will be no sense of inconsistency that is too large or too small. In wheelchair design, appropriate proportion contrast can increase visual appeal and layering. By introducing elements of different sizes in the design, and highlighting handrails and decorative details, dynamic and rich exterior effects can be created. The material selection of wheelchairs can also have an impact on the proportion. Choosing to use soft materials can visually reduce the volume of certain parts, while using hard materials may increase the volume of certain parts. The design of the wheelchair makes reasonable use of space and avoids the feeling of being too crowded or too spacious. The size is shown in “Figure 1”.

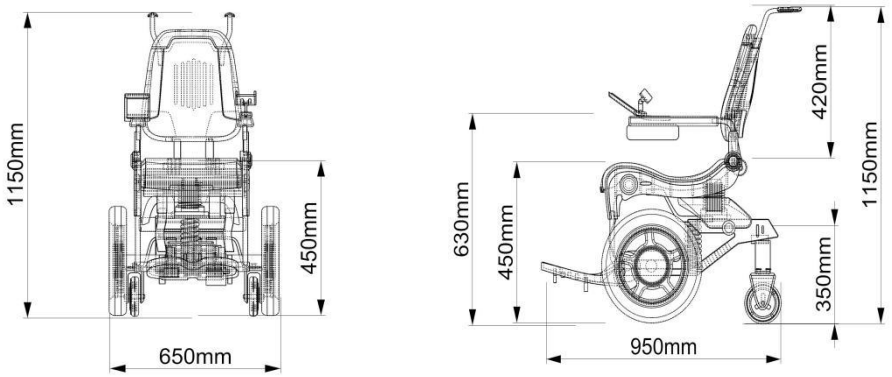

Figure 1 Product dimension drawing.

3.2.2 Line and Curve Design

Lines and curves have the characteristics of smoothness and coherence, without any abrupt or broken feeling. Through the curvature and connection of lines, it can create a visually smooth transition and smoothness. The use of smooth lines and curves can give products a sense of dynamism and vitality. These lines can present a light and flexible image, conveying a positive, sporty, and modern visual effect to people. The design of curves follows ergonomic principles and corresponds to the curves and contours of the human body. By using moderate curvature and curves, the product can better integrate and fit with the human body, providing a more comfortable user experience. The design of the lines is simple and clear, avoiding excessive complexity or excessive decoration. It is necessary to maintain the balance and harmony of lines, avoiding overly deliberate or uncoordinated combinations of lines. Smooth lines and curved designs can enhance the visual aesthetics and quality of products. This design style can give people a refined and high-end impression, enhancing the overall value and attractiveness of the product, as shown in “Figure 2” and “Figure 3”.

Figure 2 Product standing effect drawing.

Figure 3 Product sitting position effect diagram.

4. DESIGN RENDERINGS

Wheelchairs can be classified into two types: standing and sitting, depending on the user's usage status. As shown in “Figure 4” and “Figure 5”,

the soft frame curve and warm color matching break the rigid and rigid shape of the original product, and the curved seat surface is more in line with the human-machine scale, providing users with a more comfortable experience. Bright and vibrant colors can increase the vitality and positivity of wheelchairs. Bright colors such as blue and orange can attract attention and enhance the overall appearance appeal. Neutral tones such as gray can give people a warm and comfortable feeling, and are more harmonious with the natural environment. Choosing contrasting colors between different parts of the wheelchair can increase visual depth and aesthetics. This not only breaks the inherent impression of wheelchair colors, but also boldly carries out innovation. Considering the portability and operability of wheelchairs, choosing lightweight materials can reduce the overall weight. The main structural components of the wheelchair are made of materials such as aluminum alloy and carbon fiber to ensure strength and durability while

reducing overall weight. The appearance components are made of durable and easy to clean materials for daily use and maintenance, as shown in “Figure 4” and “Figure 5”.

Figure 4 Instruction with usage diagrams.

Figure 5 Instruction with usage diagrams.

5. CONCLUSION

The appearance design of the assistance wheelchair for people with physical disabilities is a comprehensive design, which is a systematic exploration of the design of assistance wheelchairs for people with physical disabilities based on ergonomics and emotional theory. The appearance design of wheelchairs is not only an aesthetic expression, but also a comprehensive solution that concerns the safety, comfort, and dignity of users. By integrating principles of ergonomics and emotional design, innovative practices have been carried out from the dimensions of structural stability optimization, dynamic center of gravity adjustment, multi-dimensional safety protection system construction, and user-friendly interface development, effectively improving the safety and reliability of wheelchairs during standing and movement, providing users with a stable and comfortable user experience. In terms of practicality, the appearance design of wheelchairs should pay attention to factors such as the body structure and daily needs of people with physical disabilities, in order to improve their user experience. In terms of aesthetics, the appearance design of wheelchairs should focus on color matching, smooth lines, and simple appearance to enhance the confidence and quality of life of people with physical disabilities. In future designs, new technologies and innovations can continue to be explored to further enhance the safety and stability of the appearance design of standing assistance wheelchairs for people with physical disabilities. At the same time, it is necessary to incorporate the concepts of environmental friendliness and sustainability into the design process, and emphasize green energy supply and resource recycling, to promote the realization of sustainable travel.

In summary, the design practice of standing assistance wheelchairs for physically disabled individuals provides theoretical basis and innovative paths. It is hoped that there will be continuous technological breakthroughs and design innovations in the future, so as to promote the development of the assistive device industry towards higher quality and more humane care, effectively improve the quality of life and social participation of disabled groups, and help to build a more inclusive and sustainable social environment.

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