

Concept Design of Home Care Wheelchair Bed for Severely Disabled Elderly

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Abstract—With the development of society, the aggravation of aging and the change of population structure, the proportion of the disabled elderly in the social population is rising rapidly, which leads to some social problems. Under this social background, this paper will analyze the wheelchair beds at home and abroad, and take the actual demand as the guide, so as to draw a valid, qualitative or quantitative conclusion that can be used in the design of wheel bed chairs for home care of the severely disabled elderly. The conceptual design of wheelchair bed for home care of severely disabled elderly was completed.

Keywords-multifunctional nursing bed; research on the needs of the disabled elderly; product design; interaction design

1 INTRODUCTION

According to relevant materials, by the end of the 2010s, the population of people aged 60 or above in China had exceeded 170 million, nearly one eighth of the total population. Among them, disabled elderly people [1] accounted for nearly 33 million, accounting for nearly one fifth of the population. It is expected that by the end of the 12th Five Year Plan, the number of disabled elderly people will increase by over 10 million.

According to a sampling survey of the elderly population in October 2016, although the physical health of the majority of the elderly is improving, 18.3% of them are still in a state of disability, totaling approximately 40 million people [2].

Data shows that in the future, the number of disabled elderly people in China will still significantly increase. By the mid-20th century, it will climb to 91.4 million people, more than twice the total number of disabled people in 2020. The growth rate of the elderly with mild disability, moderate disability, and severe disability increased in order. This indicates that the growth rate of severely disabled elderly people in China is faster than the first two [3].

According to relevant data research, as of 2018, more than 50% of the disabled population has not received corresponding care, the proportion of partial unmet is 53%, and the proportion of completely unneeded care is also 3%, of which the corresponding resources are tilted towards

the severely disabled population, and the mild population has not received care that is compatible with the body's self-care ability [4],[5]. Vigorously developing the elderly care industry has become an inevitable requirement for practicing the people-centered development thinking [6].

As the population ages, the degree of disability increases, and the needs of the elderly and the sick and disabled become more and more prominent social problems [7]. The purpose and significance of this project is to understand the research status of nursing wheelchair beds at home and abroad, analyze the mechanical structure and working principle of wheelchair beds, design the functions and human-machine interface, combination forms, implementation methods, materials and value analysis of wheelchair beds, and complete the key mechanism design, appearance design, interaction design, and human-machine size design of home nursing wheelchair beds for severely disabled elderly people. And achieve simulation and display of the design scheme with a high degree of completion, thereby completing the task of caring for severely disabled elderly people.

2 DESIGN REQUIREMENTS AND AESTHETIC THEORY ANALYSIS

2.1 Product demand exploration

The author used the likes and dislikes method to collect user needs. After summarizing and organizing the interviews, Kano data analysis was conducted on the satisfaction of each function. It was found that the charm attribute accounted for the highest proportion in the total number of functions, including "assisted bathing and assisted eating". Furthermore, in the home care wheelchair bed for severely disabled elderly people, the "assisted bathing and assisted feeding" function belongs to the charm attribute. That is to say, without this feature, users will not have strong negative emotions, but with this feature, users will feel satisfied and surprised.

From the Kano chart [8], it can be seen that assisting with toileting and assisted dressing falls in the first quadrant, which is the expected factor. This indicates that user satisfaction will increase when the wheelchair bed for home care for severely disabled elderly has these two functions, but if not provided, user satisfaction will decrease; Assisted bathing and assisted eating are attractive factors, indicating that if not provided, user satisfaction will not decrease. However, if assisted bathing and assisted eating are provided, user satisfaction will greatly improve; The assistance of home care wheelchair beds for severely disabled elderly people in transportation is an undifferentiated factor, and customer satisfaction will not be affected regardless of whether the manufacturer provides this function.

By analyzing the Kano diagram, as shown in Figure 1, it can be clearly seen that it is the most charming [9]. Assisting in dressing is an expected function, but it can be seen that helping with travel is not a function that everyone needs.

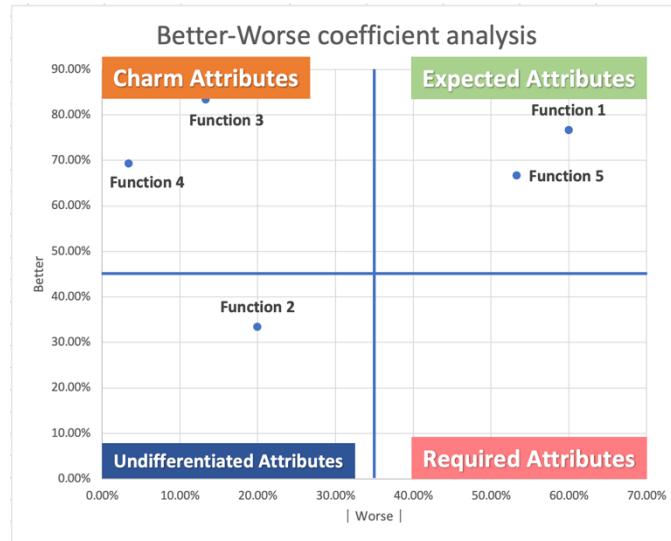


Figure 1. Kano diagram of five functions

2.2 Essential attributes of the product

This product design should have these purpose functions: to help with toilet use; Can help with travel; Able to assist in bathing; Able to assist in eating; Able to assist in dressing; Strong interaction design; The appearance is novel.

Based on the organizational form and specific functional modules of the wheelchair bed for home care of severely disabled elderly determined in the overall product design, a balance matrix analysis [10] was conducted to obtain the following data in Table 1:

TABLE I. TRADE-OFF MATRIX

Evaluation criteria and weights Head	Scheme		
	Manual variation	Motorized variation	Split variation
Ease of use 0.1	1	-1	1
Cost 0.3	0	-1	1
Practicality 0.05	0	0	1
Interactivity 0.1	1	0	1
Ergonomics 0.08	0	0	1
Aesthetics 0.05	-1	0	1
Technical 0.03	0	-1	1
Mass 0.05	0	1	1
Security 0.15	1	0	1
Reliability 0.09	1	0	1

Evaluation criteria and weights Head	Scheme		
	<i>Manual variation</i>	<i>Motorized variation</i>	<i>Split variation</i>
Sum Of +	7	4	5
Sum Of -	1	3	2
Sum Of S	2	3	3
Weight Of +	0.57	0.23	0.69
Weight Of -	0.1	0.45	0.08
Total0.3	0.47	-0.22	0.61

Based on the analysis during the product opportunity stage, as well as the overall product design analysis and personal preferences, the third option in the product concept plan was ultimately selected for refinement. Therefore, it was decided to design a split type home care wheelchair bed for severely disabled elderly people. Simulate its usage scenario: After the user wakes up, they issue commands to the operation mode module selected based on the actual situation, and the bed is separated from the electric wheelchair. Conduct daily activities such as mobility. When wearing clothing, the product assists the patient in completing the dressing movement. When eating, the caregiver places the dishes in a specific area, and the equipment assists in feeding according to the operating situation. When taking a shower in the toilet, the user can move the wheelchair to a designated position, operate the wheelchair to open the toilet valve, or start bathing. After bathing, a uniform hot air flow is sent out to blow dry.

When designing the home care wheelchair bed for severely disabled elderly people, attention should be paid to the appearance design style of other medical and elderly care products, and the psychological feelings of users should be emphasized to ultimately generate the conceptual sketch of the author's home care wheelchair bed for severely disabled elderly people.

Search for keywords such as medical products, medical equipment, and elderly care facilities on the internet, and search for style images suitable for home care wheelchair bed design for severely disabled elderly people. In terms of styling, it can be concluded that the product design of medical devices needs to have a strong sense of unity. At the same time, considering the psychological feelings of patients, the color matching should be designed reasonably. Mainly in soft colors or cool and simple colors.

Among many designs, the cool color scheme of black, white, and gray can relax users' tense nerves. The color scheme of blue, green, and white can soothe users' mood; The contrast between black and yellow can also alleviate users' anxiety. The final color scheme is based on black and white gray, strong contrast between black and yellow, and a soft blue green white design. In terms of form, referring to the design language of multiple medical devices and mechanical equipment, the overall design style is soft with rigidity, combining rigidity and softness. On the basis of squareness, rounded designs can be added in some positions to create sharp contrasts and strengthen the design structure.

2.3 Detailed design and analysis

Based on the previous explanation and design ideas, we will deepen the design of Scheme 3, emphasizing the expression of product tension while also incorporating a rounded design. The overall appearance is not abrupt, and multiple color schemes are used, but all of them are relaxing, calm, and safe color schemes. The final product rendering is shown in Figures 2:

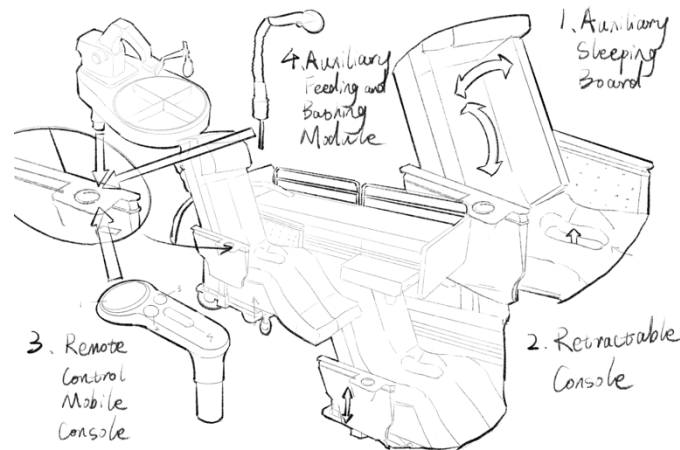


Figure 2. Refinement of wheelchair bed exterior design scheme

Assisted sleeping board with two degrees of freedom mechanisms allows users to adjust various postures, facilitating activities such as sleeping, dressing, eating, and toileting; Retractable console, retracted in bed form to keep the bed in a flat state; Used as a protective board or armrest when ascending in wheelchair form. And it can connect to the customized modules below; Remote control mobile handheld device, users with mild disability can freely control movement through this accessory. Accessory package defect: touchpad, controlling the direction of movement through touch; Open key; Close the building; Illuminate the display window; Assisted feeding and bathing module, with multiple degrees of freedom for feeding operations in the feeding module; The shower module contains a high-speed water pump that circulates water on the surface of the nozzle and inside the water pipe.

3 PRODUCT IMPLEMENTATION



Figure 3. Default black, white and gray simple color rendering

On the overall sensory aspect of the product, solid wood gives a natural and friendly feeling. The cool color scheme of black, white, and gray can further soothe users' mood, as shown in Figure 3.

Usage process: The product can be assembled together with the wheelchair and bed parts through a joystick or program automation, as shown in Figure 4.



Figure 4. Wheelchair bed combination status

The product is equipped with two movable auxiliary dressing boards, which can be used to complete various dressing positions with the forward and backward swing of the wheelchair. Save time and effort, greatly reducing the cost of nursing staff. The bowl can hold food, and by controlling the movement of the robotic arm, the spoon can scoop up the food inside the bowl, achieving auxiliary feeding. At the same time, the bowl can be individually heated as needed, making it easy to use, as shown in Figure 5.

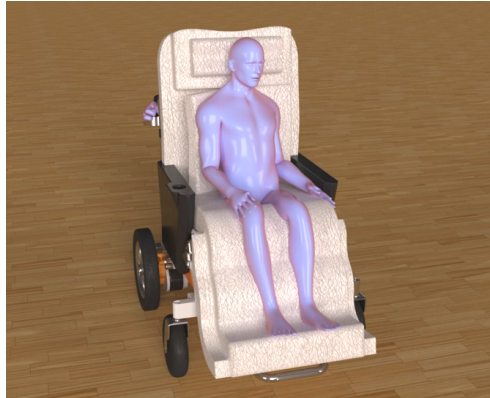


Figure 5. Wheelchair bed auxiliary changing and auxiliary feeding function

The wheelchair bed is equipped with toilet holes, and can be manually or automatically moved to the toilet position using a free movement device, as shown in Figure 6.



Figure 6. Wheelchair bed assisted movement and toilet function

Using the principle of a vacuum cleaner, the powerful suction force will suck back the sprayed water, ensuring that the shower water will not be scattered everywhere on the wheelchair bed. Latex mattresses can absorb and dry the water accidentally spilled from the bathing function in a timely manner, as shown in Figure 7.



Figure 7. Wheelchair bed auxiliary bathing function

4 CONCLUSIONS

The conceptual design of the home care wheelchair bed for severely disabled elderly people is a self selected topic. By implementing the key mechanism design, appearance design, interaction design, and human-machine size design of the home care wheel bed chair for severely disabled elderly people, it meets the requirements of the elderly for the use of nursing products. Further exploration is needed to determine whether it is practical to improve the current situation of disabled elderly people in practical problems, and whether the initial design ideas can be utilized. Further reasonable analysis of user experience is also needed. Similarly, the issue of the rapid increase in the number of disabled elderly people in China is becoming increasingly urgent. I hope to have the opportunity to improve the shortcomings in this design in the future.

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