Research on Interaction Design of Aging Smart Home Products Based on Qfdtriz

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Abstract: Objective to Provide a Good Experience for the Elderly in the Interaction of Smart Home Products Methods from the Perspective of Ergonomics, the Qfd / Triz Integrated Model Was Constructed and the Specific Implementation Process Was Given. First of All, According to the Research Content of Ergonomics, We Get the Needs of the Elderly, and Classify Them According to Their Physiological, Psychological and Interactive Needs. Then, on the Basis of the Needs, We Build the House of Quality (Hoq) of Smart Home Products, Which is Suitable for the Elderly, and Further Analyze the Relationship Matrix within the House of Quality, and Analyze the Characteristics of Redundant Products the Product Importance Characteristics Based on the Real Needs of the Elderly Are Obtained. At Last, the Negative Correlation Problem in the Autocorrelation Matrix of the Quality Roof is Extracted, and after the Transformation of Triz Problem, the Conflict of Product Characteristics in the Design Stage is Eliminated by Using Triz Theory Results the Combination of Qfd and Triz Not Only Avoids the Subjective and Unreasonable Factors of Demand Acquisition in the Early Stage of Product Design, But Also Can Modify the Applicability Requirements of Product Function and Structure, Which Provides a Clear Goal for the Design of Aging Products Conclusion Based on the Analysis and Design of the Interaction of Aging Smart Refrigerator, the Feasibility of Qfd / Triz Integrated Model Applied to the Design of Smart Home Products for the Elderly is Proposed.

1. Introduction

With the Increasing Trend of Aging in China and the Rapid Update of Modern Technology, Whether the Design and Development of Intelligent Products Have Met the Real Needs of Users Determines Whether the Products Can Survive in the Market for a Long Time. the Action Plan for the Development of Smart Health Pension Industry (2017-2020) Points out That More Than 100 Smart Pension Service Brands Should Be Built in the Period, So That the Elderly Can Also Enjoy the Great Convenience Brought by New Technology to Their Lives [1]. as a Result, the “Silver Market” under the Future Trend is Gradually Valued by Enterprises. the Development of Product Design in China Started Late, But There Are Few Smart Home Products for the Elderly, and the Design Quality of Aging Products Still Needs to Be Improved . Most Smart Home Products in the Current Market Are Mainly Designed for Young People, Ignoring the Use of the Elderly in the Family. Therefore, It is an Urgent Problem to Fully Tap the Real Internal Needs of the Elderly and Design and Develop Smart Home Products Centered on the Elderly Users [2].

2. Application Status of Related Theories and Methods

In the field of industrial design, the design of any product is based on the needs of users. The traditional product design integrates too many subjective views of designers, which makes it difficult for the product to go to the market. Quality Function Deployment (QFD) is a guiding method that runs the real needs of users through the whole product life cycle. Its core house of quality (HoQ) combines the needs of users with the characteristics of products, obtains the priority of user needs through integration, analysis and calculation, and sorts the importance of product

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characteristics, so as to achieve the real needs of users and the actual product characteristics As the key point of product design. The single method of quality function configuration has some limitations in the process of product design. Most scholars combine it with ergonomics (E), axiomatic design (AD), invention problem solving theory (TRIZ) and human computer interaction design (HCI), which not only make up the limitations of this method, but also fundamentally improve the user's satisfaction of the final product Meaning. For example, progiwati pusporini et al. [3] combined the fuzzy theory with QFD method, and applied it to the design of environmental protection products, realizing the characteristics of products meeting the needs of users and environmental protection; chatree homkhiew and thanate ratanawlai et al. Used QFD method to obtain the needs of users, and applied it to a new type of glued wardrobe, achieving a substantial increase in user satisfaction; Chen Yuan, song duanshu, Gu Junli and others integrated QFD / TRIZ / AHP, made a detailed planning for the design of bathroom products, and verified the feasibility and effectiveness of the method; Li Jun, Zhang Yong and Liu Yuchuan combined QFD / TRIZ / ad to complete the conceptual design of corresponding emergency rescue vehicles; Liu Muyi, Wu Tong and Chen dengkai combined QFD / TRIZ to verify and meet the museum requirements. The design requirements of tourist souvenirs improve the design efficiency and innovative design quality; Peng Jieyu uses the basic method of QFD to put forward the method of combination of Kano and GMA, and constructs the practical system framework of game interaction design, which is conducive to the integration of quality function configuration method and interaction design; Li Jiangbo integrates TRIZ / QFD, and puts forward the information of improving domestic Internet products The validity of the method is verified [4].

From the perspective of product design, the application of quality function configuration is mainly aimed at the analysis of user needs and product characteristics. As the basis of the whole life cycle of the product, in the actual design and development, it has limitations in terms of product structure, beauty, function configuration and the comfort performance of human-computer relationship. TRIZ theory is to model the conflicts encountered in the early stage of design, find the corresponding solutions by using the relevant principle tools, and meet the design expectations to a large extent [5]. Therefore, the combination of QFD method and TRIZ theory is of great significance for product design and development.

In view of the shortage of aging smart home products in the current market, this paper takes the aging smart home refrigerator design as an example, obtains the demand characteristics of the elderly from the aspect of human-computer interaction, constructs the house of quality model between the elderly demand and the product characteristics of the smart refrigerator, and solves the relevant physical and technical contradictions in the design process with the help of the relevant principles of TRIZ theory, so as to demonstrate The integration method of QFD / TRIZ can guide the interaction of aging smart home products [6].

3. Construction of Hoq / Triz Integrated Model Based on Ergonomics

The establishment of the house of quality is mainly based on the human-machine requirements as the input. Through the establishment of the house of quality between the requirements and product characteristics, further determine the required performance of the product. Based on this, the construction of the QFD / TRIZ integration model (see Figure 1) is mainly carried out from the following three steps. 1) according to the demand description of the interaction of the elderly in the smart refrigerator, we obtain the demand, sort and classify the demand, and then use the numbers 1, 3, 5, 7 and 9 to measure the importance of each demand, and determine the relative weight of the user demand with the five characteristics of extremely unimportant, unimportant, general, important and extremely important, and unify the weight of the demand The chemical treatment is calculated according to the following formula: $W_i = r_i / \sum_{i-1}^{n} r_i$

According to the needs of users and the characteristics of products, the comprehensive house of quality (HoQ) is established. According to the demand interview data, we extract the relevant characteristics of various aspects of the product, and then construct the relationship matrix between

user demand and product characteristics, scale the correlation between user demand and product characteristics with 1, 3 and 5, respectively representing weak correlation, medium correlation and strong correlation [7]. At the top of the house of quality, a "+" is used to indicate the strong correlation between two product features, that is, the enhancement of one product feature makes another product feature stronger; a "-" is used to indicate the negative correlation between two product features, that is, the enhancement of one product feature makes another product feature lower, and the relationship between several main product features is listed.

Based on the principle contained in TRIZ theory, the conflict of product characteristics is eliminated. Firstly, the model of TRIZ problem is transformed from the technical problem and physical problem between the two corresponding negative correlation product characteristics in the upper part of the matrix (the transformation process is based on the archishure contradiction matrix of TRIZ theory), and the type of the negative correlation characteristic contradiction is judged to be technical contradiction or physical contradiction In this way, thirty-nine general engineering parameters and forty principles of invention provided by TRIZ are used to eliminate technical and physical contradictions respectively, so as to solve the problem and realize the product characteristics to meet the needs of users to the greatest extent [8].

4. Design Case of Intelligent Refrigerator for Interaction of the Elderly

4.1 The Construction of House of Comprehensive Quality

First, we need to screen and classify the needs of the elderly. The needs of the elderly in the use of refrigerators mainly include the following three aspects.

From the physiological point of view, first of all, the structure of the refrigerator in the past, due to the height problem, makes the elderly squat down and can not reach the internal items. The placement and cleaning of refrigerator items also brings great inconvenience to the elderly. Secondly, with the progress of technology, the intelligent degree of refrigerator is constantly improving, and the function buttons and display interface are complicated, which makes the elderly at a loss and affects their "enjoyment" of refrigerator functions. Finally, the noise generated by the frequent operation of the traditional refrigerator compressor also brings troubles to the life of the elderly to a certain extent.

From the psychological point of view, safety and health is one of the main reasons for users to use any product. The safety and health of refrigerators affect users' daily diet, which should also be paid attention to. For the elderly, intelligent products should reduce the cost of learning. The lack of cognition of the elderly can not be a factor for them to enjoy the convenience of science and technology. Reasonable aging design is It can eliminate the old people's fear of using intelligent products. In addition, the elderly's thrifty psychology is much heavier than that of the contemporary young people. The multiple mode switching of the refrigerator not only reduces energy consumption but also meets the demand [9]. The reminder of leftovers, expired food and the important agenda of the elderly also makes up for the elderly's psychology.

From the perspective of interaction, due to the limitation of physiological function, the control of refrigerator for the elderly is not more flexible than that for the young. Therefore, the combination of modern voice, touch screen and other technologies can be applied to it, which can greatly facilitate the interaction of the elderly users. In addition, due to the different needs of the elderly, the diversity of functions should also be customized to meet the coordination between product and user needs. According to the needs analysis summary, the elderly interaction needs are shown in Table 1.

Table 1 Interaction Needs Of the Elderly

Physiological needs	Simple structure	Easy operation
Psychological needs	Safety and hygiene	Energy saving reminder
Interaction needs	Diversity of control methods	Functional diversity

According to the sorting data recorded in the survey, the importance of each requirement is listed through comparison among all the listed requirements. The weight of each requirement is:

$(r_1 r_2 r_3 r_4 r_5 r_6 r_7 r_8 r_9)^T = (3,7,5,9,5,9,7,7,5)^T$

After sorting out the data, it can be seen that safety, health and easy maintenance are the most important, simple structure is not important, and other needs are of general importance. Therefore, the weight vector of user demand is obtained after normalization of demand weight:

The main purpose of building the house of comprehensive quality is to get the correlation between the needs of the elderly and the required product characteristics, so as to get the priority order of the actual product characteristics, at the same time, eliminate the unimportant or redundant product characteristics, appropriately increase the product characteristics that meet the needs of users, and solve the demand problem to the greatest extent. See Figure 2 for the comprehensive quality house.

Through the analysis of the relative relationship matrix between the product characteristics of the house of quality and the user's demand (here the positive correlation is only listed in part, mainly to get the negative correlation), three groups of main conflict problems in the correlation matrix (as shown in Figure 2 triangle area of the quality roof), and then three groups of negative correlation problems between the product characteristics and demand are transformed into TRIZ problem model, see Table 2.

4.2 Analysis and Solution of Design Problems

After transforming the conflict between product characteristics and requirements into TRIZ problems, the solutions proposed by using TRIZ theory are shown in Table 3, and the breakthrough of each problem is carried out according to the three steps listed above.

Modularity and size are physical contradictions. Nowadays, refrigerators are mainly one-piece multi room refrigerators with large size. On the one hand, it is found that the lower part is too low and the top part is too high, which causes squatting and inaccessibility for the elderly, and brings great inconvenience to the use of the elderly. On the other hand, the old people's unique practical and thrifty psychology, as well as the gradual decline of physiological functions, the integration of the traditional refrigerator makes the used storage room and the idle storage room work at the same time, resulting in a large amount of energy consumption. The invention problem solving theory (TRIZ) provides archishure contradiction matrix. According to the physical contradiction in the process of product design, the relevant principles that can solve the contradiction can be selected from 40 invention principles. Modularity and size belong to No.8 (volume of static object) with 39 general engineering parameters, and archishure contradiction matrix provides the solution group The invention principle of physical contradiction, “principle of space separation”, No.1, i.e. principle of division, i.e. change the integration of refrigerators, tend to modular design, separate the fresh-keeping room from the cold storage room, respectively control with air cooling and compression refrigeration system, and then use the Internet of things under the future trend to carry out independent or collaborative work of each module, not only to meet the demand but also to solve the idle problem The storage problem achieves the goal of structure optimization and energy saving. See Figure 3 for modular structure design.

Internal structure and cleaning method. The complexity of internal structure has a direct impact on the operation and use of refrigerators for the elderly, including the cleaning of items and internal space. Traditional refrigerators use drawer box or glass plate as storage space, which is more convenient to take and place items. But for the elderly with physiological decline, cleaning becomes a problem, which is not only inconvenient to hold, but also easy to fall. According to archishure contradiction matrix, the internal structure and cleaning method correspond to No.36 (system complexity) and No.33 (convenience of operation process) of thirty-nine general engineering parameters respectively. This contradiction belongs to technical contradiction, and the invention principle number provided by the matrix is No.9 (pre reaction), No.24 (intermediary), No.26 (replication), No.27 (substitution), aiming at The contradiction is solved by No.26 and No.27, i.e. the original push-pull structure is retained, the drawer type and plate structure are replaced by the fence type carriage, and the combination of fence type and support plate is adopted to facilitate the use and cleaning of the elderly considering the placement of some foods,.

Function configuration and learning cost. The degree of diversification of function configuration determines the learning cost of the elderly, while the diversity of function and high learning cost is an important reason for the elderly to reject smart home products, while the use psychology of the elderly and young people for smart products is mainly different from the physical environment and social environment. From the point of view of physical environment, mainly in relation to the characteristics of intelligent products, according to the practical and economical psychological characteristics of the elderly, various functions and “additional” functions are not necessarily the important needs of the elderly. Therefore, the function selection should be based on the most important needs to be configured in order to reduce the exclusion of the elderly. From the social point of view, with the growth of age, the elderly are more eager to communicate with the outside world, and hope to realize their own value. In order to eliminate the negative psychology that the elderly are considered “old but useless”, in the design process of smart home products, the elderly should be provided with channels for communication with their families and society, and build their confidence with simple operation process. From the above two aspects, in order to reduce the learning cost caused by the diversity of functions, according to the parameters No.35 (adaptability, universality) and No.19 (energy consumption of moving objects) corresponding to the characteristics of the group of products, the number of invention principles provided by the contradiction matrix is No.13 (reverse method), No.19 (discrete method), No.29 (pressure method), No.35 (Performance conversion method), and N is selected O.19 (discrete method) and No.35 (Performance conversion method). The discrete method “from continuous function to periodic function or pulse function” is used to control the continuous operation of the intelligent refrigerator with one key to reduce energy consumption and meet the elderly's psychology of saving; the performance transformation method “changes the physical state of the system” is used to replace the written description of the traditional recipe with the cooking course, and the aging's eyesight decline is taken into account to use the cooking education Due to the influence of program, video, audio and other functions, the convex lens principle is properly used outside the display screen to make up for the lack of vision of the elderly. Interface layout and function setting of refrigerator.

Table 2 Triz Problem Transformation of Conflict Problem

Serial number	Negative correlation property	39 general engineering parameters	Contradictory types
1	Modularization	Volume of a still object	Physical contradiction
	Size	Volume of a still object	
2	internal structure	Complexity of the system	Technical contradiction
	Cleaning method	Convenience of operation process	
3	Functionconfiguration	Applicability and generality	Technical contradiction
	Learning cost	Energy consumption of moving objects	

For aging products, experiential design has a huge impact on the emotional output of the elderly, sensory experience as the basis of all experiences, and the decline of cognition, hearing and vision of the elderly is the most critical to their interaction experience, and the elderly also need to experience the convenience brought to life by technology through product interaction. In view of the above two problems, in the design of refrigerators, first of all, the interface function of refrigerators should be configured mainly based on the important needs of the elderly, making up for their daily life needs and psychological needs, and the elderly can supplement their individual needs with “added value” through customized functions; the combination of voice and touch screen technology can give the elderly more People bring good product interaction experience. Secondly, in the design of the smart refrigerator, in order to reduce the learning cost of the elderly to the greatest extent, the simplicity of the interface semantics, the operation of the video course, the enlargement of the text Icon and the contrast of the color all reduce the cognitive burden of the elderly from different levels, thus reducing the cost of learning, and avoiding the fear and exclusion of the elderly for intelligent products It is really designed for the elderly.

5. Conclusion

Based on the ergonomics, this paper analyzes the needs of the elderly in the process of using the refrigerator from three angles, selects the main product characteristics of the refrigerator according to the needs, and constructs the QFD / TRIZ model. In order to achieve the balance between the needs of users and the characteristics of products, a comprehensive house of quality for needs and product characteristics is constructed. Based on the analysis and summary of data, the priority order of product characteristics is extracted. For unimportant product characteristics, function customization can be carried out, and the contradiction between the elderly and product characteristics in the interaction process is also obtained. On this basis, by using tirz theory, the contradiction problems are transformed into solvable physical and technical problems, and then three main groups of contradictions are extracted, and then the contradiction is eliminated by the forty principles of invention provided by archishure contradiction matrix. In order to comprehensively improve the use experience of the elderly users, the interaction process combines the advanced technology of the contemporary, so as to truly achieve the aging design of the product.

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