Research on Human-Computer Interaction Design of Office Chair Based on QFD Method

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Abstract. Based on quality function deployment (QFD) and emotional design theory, the psychological needs of users are explored, and the interactive design system of office chairs is developed centering on users, thus solving the problems of space efficiency, office mode and human-computer interaction. First of all, through the relationship between the emotional concept and "function-behavior-benefit" in QFD method, from the perspective of emotional experience, the man-machine relationship is analyzed, and the principles and methods of contemporary office chair comfortable and healthy experience design are summarized. Secondly, based on the product structure and human-computer interaction design, the internal demand of consumers is transformed into the actual demand of products, and the QFD house of quality model is output to obtain the best design scheme. Finally, through design demonstration, the integrated application of emotional design and QFD method is feasible and effective, which can form a mapping relationship between product benefits and user needs, thus realizing the man-machine interaction design of multi-adaptive office chairs.

1. Introduction
Among the professional population in major first-tier cities, white-collar workers account for more than 50% and have become the main population in cities [1]. As far as the current working environment is concerned, office people may spend 1/3 or even 2/3 of their time on chairs every day. Such living habits can easily lead to diseases, so it is necessary to improve the comfort of office chairs. Keeping a good sitting posture can improve work efficiency and relieve people's work pressure and fatigue, so that all systems of the body can be relaxed and rested [2]. Therefore, through emotional design and QFD method, the article studies the lunch break behavior of the office. It takes the behavior style and habits of the office crowd as the basic elements to find and establish an efficient and comfortable office environment, and optimizes the office chair to complete the innovation of its function and form.

2. Emotional Concept and QFD Method
Emotional design is that designers add certain emotional components to the product design process, so that the product has certain emotional color and the relationship between human and things is unified. Emotional design mainly includes instinct level, behavior level and reflection level [3]. These three different dimensions are interwoven in any practice. Emotional design emphasizes the emotional communication between man and machine, which makes the design more in line with people's emotional needs (Figure 1).
2.1. QFD method
QFD (Quality Function Deployment), that is, quality function deployment, was proposed by Japan's Yoji Akao and Shigeru Mizuno in the 1960s [4]. The aim is to ensure that product design meets customer needs and values at all times. It is a method system to ensure product quality, cost, benefit and reliability at the stage of product development and design. (Figure 2)

The combination of emotional design and QFD to develop products can realize complementary advantages and humanize product function design for the purpose of user needs. (Figure 3)

3. Analysis of User Experience Based on Emotional Concept

3.1. Emotional Interaction Design of Instinct Layer
Instinct hierarchy design is the objective existence of human instinct, and human instinct perception is mainly the cognition of product CMF (Color Material Finishing) [6]. Consumers will only consider the functionality of the product if they get the first feeling. Usually people work all day with office chairs. Different jobs have different behavior habits, and these habits will become a reflection in the long-term accumulation. Whether chairs can make them feel comfortable or not has a basic measure in their mind. This measure has become an instinctive thing with the accumulation of time, forming aesthetic integration with their life experience. Only suitable chairs can stimulate their instinctive pleasant emotional experience. Through context analysis, accurate information can be effectively collated to meet the internal needs of users (Figure 4).

3.2. Emotional Interaction Design of Behavior Layer
According to the survey, 78.57% of the population in China basically have a lunch break of 30 minutes to 1 hour (fig5.). during the lunch break, there are mainly three behaviors: eating lunch, leisure and entertainment, and taking a nap. in order to improve this state and work efficiency, it is particularly important to create a comfortable lunch break environment. Excellent behavioral experience design should first be based on meeting and facilitating people's needs. Office chairs meet the behavioral needs of sitting during office hours, but at the same time, they need to meet the comfort and health of sitting for a long time. All chairs can complete their basic functions well, but the satisfaction of their subsidiary functions is not high. These are all issues that need to be considered in design. [7].
3.3. Emotional Interaction Design of Reflective Layer

The high-level experience of emotional experience is no longer instinct and behavior, but a reflection on instinct and behavior. It is a kind of reflection aroused by people after they have a certain understanding of products and experience in use. With the acceleration of the modernization process, people's office "hardware" level is gradually improving. At the same time, the requirements for office environment are becoming higher and higher, and the influence of office environment on people's working conditions is also becoming greater and greater [8]. Sitting in a chair for a long time will feel waist soreness, back pain, myopia and other symptoms. When people feel this physiological reaction, they will reflect on the realization of the function of the chair. Whether this physiological damage can be avoided by changing some details is also a question that needs to be considered when designing.

4. Design and Application of Multi-adaptive Office Chair Based on QFD Method

In view of the fact that the multi-adaptability office chair design in this paper is based on the mainstream design of existing ordinary office chairs, reasonably integrates the special needs of users, and meets the differentiated needs of different user groups with multi-adaptability, therefore, the main research object of this paper is white-collar groups.

4.1. User Demand Acquisition

First of all, based on the office behavior process, the initial needs of users were obtained through literature review and questionnaire interviews with 355 representative office workers aged 20-40 in Chengdu's comprehensive community. After analysis and screening, 7 typical requirements were finally obtained. They were compared with each other and scored with a 5-level Likert scale [9]. A total of 360 questionnaires were distributed and 290 valid questionnaires were recovered. Finally, the user's subjective evaluation is processed and expressed in the form of data, and the weight of user's demand is calculated by AHP [10]. The value of user demand C and user demand weight K (Table 1).

| User demand C                              | Demand weight K |
|--------------------------------------------|-----------------|
| C1 Easy for Users to Work                  | 0.189           |
| C2 It is convenient for wheelchair users to shift. | 0.198           |
| C3 The seat is labor-saving and simple to operate. | 0.204           |
| C4 Keep the user's sitting posture balanced. | 0.095           |
| C5 Sitting for a long time is not easy to fatigue. | 0.045           |
| C6 Comfortable use                          | 0.038           |
| C7 Safe use                                 | 0.026           |

4.2. Determine design requirements and design requirements objectives

The design requirements are derived from the transformation of user requirements, which are transformed into design requirements according to the emotional concept and QFD method. In order to
meet the needs of multiple types of users as the goal, determine the goals of these design requirements. Design Requirements D and Corresponding Design Requirements Targets (Table 2).

Table 2. Design Requirements and Their Corresponding Targets

| Design requirements D | Design Requirements Objectives |
|-----------------------|-------------------------------|
| D1 Get up and design  | Assist in getting up           |
| D2 Direction of Use of Office Chair | Avoid the user turning around       |
| D3 Shift Design for Office Chair | Auxiliary office chair shift |
| D4 Office operation mode | Suitable for office workers |
| D5 Office operations | Avoid fine movements |
| D6 Operating Direction of Office Chair Users | Consistent with office direction |
| D7 Office chair user shifting mode | Simplify shift action |
| D8 Fatigue mitigation design | Use posture to relieve sedentary fatigue. |
| D9 Body balance design | Assist body balance Beautiful and |
| D10 Form of Office Chair | comfortable |
| D11 Functions of Office Chair | Multi-function, form of use |

4.3. Determine the Relationship between User Requirements and Design Requirements

Build the relationship matrix between user requirements and design requirements [11]. By analyzing the relationship between user requirements and office chair design requirements, the importance of office chair design requirements is calculated. Wherein: $R_{ij}$ is the relation value between item $i$ user requirements and item $j$ design requirements; $N_i$ is the user demand weight of item $i$. The relationship matrix between user requirements and design requirements (Table 3).

$$W_j = \sum_{i=1}^{n} R_{ij} \cdot N_i (i = 1,2,\cdots,8; j = 1,2,\cdots,10)$$ (1)

Table 3. Relationship Matrix between User Requirements and Design Requirements

| User Demand | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 |
|-------------|----|----|----|----|----|----|----|----|----|-----|-----|
| C1          | ●  | ○  | △  | ○  | △  | ●  | ○  | ●  | △  | ○   | ○   |
| C2          | ●  | ●  | ○  | ○  | △  | ●  | ○  | ●  | △  | ○   | ○   |
| C3          | ●  | ●  | ○  | ○  | △  | ●  | ○  | ●  | △  | ○   | ○   |
| C4          | ●  | ○  | ●  | △  | △  | ●  | ○  | ●  | △  | ○   | ○   |
| C5          | ●  | ○  | △  | △  | ○  | △  | ○  | ●  | △  | ○   | ○   |
| C6          | ○  | ●  | ●  | ●  | △  | △  | △  | △  | ●   | ○   | ○   |
| C7          | ○  | ●  | ●  | ○  | △  | △  | ○  | △  | ●   | ○   | ○   |
| Sorting     | ●  | ○  | △  | △  | ○  | △  | △  | △  | ●   | ○   | ○   |

Note: the symbol ● in the table is "strong" correlation, with a value of 5; ○ is "medium" correlation, with a value of 3; Delta is "weak" correlation, with a value of 1; Blanks indicate no correlation.
4.4. Transformation Analysis of "Function-Behavior-Structure" of Multi-Fitness Office Chair

Fig 6. Transformation process of multi-functional office chair function-behavior-structure-benefit mapping

Through the analysis of matrix data, the key design requirements of the product are determined, and the corresponding design requirements are summarized and analyzed, which is used as the functional element of office chair to guide the QFD mapping process [12]. In the two transformation processes of QFD method and emotional concept: 1) function-behavior transformation, which transforms the extracted sub-functions into specific implementation mode and interaction mode with users respectively. For example, in the sitting posture-standing posture operation mode, a lifting system control mode which is more suitable for the user's operation ability is designed, which avoids relatively fine operation actions and is convenient for office group operation; 2) Behavior-structure transformation, which refines the behavior into components or structural forms to realize its corresponding functions. For example, based on the same behavior subject, the buttons of the lifting system are designed in front of and behind the armrest, which is convenient to operate. 3) Structure-benefit transformation, which transforms components or structural forms of corresponding functions into living pain points and solves practical problems. For example, the adjustable lifting system is a multi-functional and formal embodiment to meet the needs of the office community (fig 6).

5. Design examples
A multi-functional office chair designed based on QFD method and emotional concept (Fig 7). The sitting and lying-down dual-purpose type simultaneously meets the use requirements of general groups, office users and other users. The office chair adopts a lifting system, and the office operation form is designed as a lifting button to control the chair, which can adapt to the operation capability of most office users, is easily accessible under the armrest, and is labor-saving and simple in office operation.
(fig 7d). The grip part of the armrest is designed to move left and right and made of non-slip materials, which can effectively prevent the accident of both hands falling off during gripping (fig 7a). The back of the chair is the most important part of the ergonomic chair, which should conform to the natural curvature of the human spine to provide firm support for the waist. And that inclination with the seat surface is more than 90-110 degree. On the one hand, it provides auxiliary support for users when sitting, maintains body balance and corrects sitting posture. On the other hand, it can also relieve fatigue caused by sedentary posture and improve the comfort experience of users. Both sides of the backrest are provided with inclined armrests which assist in displacement, and the inclined design ensures a more natural force application posture and more comfortable operation when the user pulls the armrests with both hands; When assisting wheelchair users to get up and shift, the force application can be decomposed into upward and forward forces (fig 7b). The front end of the seat cushion has a waterfall shape, which can reduce the pressure of nerves and blood vessels in the buttocks and legs (fig 7c). Five-leg base (best stability), hard chair wheel for carpet, soft chair wheel for wood floor or tile floor (fig 7e).

6. Conclusion

Based on QFD method and emotional concept, chair multi-adaptability design is developed to explore the needs of office users and integrate them into mainstream design, and finally structural information of office chairs is obtained, so that different users can use the same method or different methods to achieve the purpose of use. In the whole research process, from the prospective assumption of the demand layer to the maximum fitting of the behavior layer, it is gradually concluded that the interaction of the structure layer is natural and reasonable, which can not only fit the physiological characteristics of office users, but also guide the user's behavior, thus greatly enhancing the versatility of the office chair. Through its external presentation, to a certain extent, it arouses people's health awareness and triggers the decision-making process of users. Through the analysis of office space and office behavior, office products can restrict the user's behavior, thus enabling users to form good behavior habits.

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