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A product design based on interaction design and axiomatic design theory

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Abstract

With the development of technology, the improvement of living standards, personalized designs that emphasize diversity and self-fulfillment are becoming more and more popular. As a result, designers must focus more on user needs. Traditionally, most of designers only focus on satisfying users' functional needs and often ignore users' emotional and psychological needs. This paper presents a design method that combines interaction design with axiomatic design. The proposed method first employs interaction design to acquire user needs with respect to three aspects: "people", "products" and "environment" and then adopts axiomatic design to complete the conceptual design. The methodology is demonstrated and validated with a case study of children bicycle. The results show that the proposed method significantly enhances users' experience of the product and meets more comprehensive user needs, especially in terms of users' psychological and spiritual needs.

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Keywords: Interaction design ,Axiomatic design; User needs

1. Introduction

With the increasing intensity of competition and establishment of buyer market, customer satisfaction has become one of the most important driven forces to succeed in the market. Personalized designs that emphasize diversity and self-fulfilment are becoming more and more popular. Designers pay more attention to user needs for products. The acquisition and conversion of user needs have become the focus of the design method study.

Many researches on needs mapping have been carried out. For example, Suh proposed Axiomatic Design (AD) theory in 1990 which realized the mapping of user requirements to product structures [1]. Shigeru Mizuno proposed Quality Function Deployment (QFD) which is a customer-driven product design method [2]. Selcuk Cebi et al applied AD and fuzzy sets theory into traditional product design method to analyse the relationships between functional requirements and design parameters [3]. Renbin Xiao et al established mathematical model to realize the automatic distribution of the product configuration based on the mapping of functional requirements to design parameters [4]. Lee applied the fuzzy goal programming technique into QFD to determine the importance degrees of various technical features which provide the basis of product improvements [5]. Ref [6] used QFD and Kano model to classify user needs, which can be transformed into a product's functional characteristics, in order to realize customer satisfactions. Wasserman et al combined the fuzzy sets theory with the TOPSIS to determine the degrees of user needs importance [7].

However, previous studies mainly focus on the mapping of user needs to products and little attention has been paid to how to acquire user needs exactly. Designers often define user needs directly or only focus on satisfying users' functional needs. So, the products may not meet comprehensive user needs, and user satisfaction may decline.

In response, interaction design is introduced to acquire user needs. Interaction Design is a new discipline and it was raised by Bill Moggridge in a design session in 1984. It concerns on understanding the target users' needs. Interaction system is composed of people, products and environment [8]. We can get user needs from these three perspectives.

This paper combines interaction design with AD. First, interaction design method is used to acquire user needs. Then,

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AD is used to the mapping of user needs to design elements of products. At last, a case study of children bicycle is presented to verify the effectiveness and feasibility of the proposed approach.

2. Model Construction for a product design

2.1 Construction of interactive system

In this section, how to acquire user needs by interaction design will be presented. The interaction design is characterized by not only studying users' own needs but also attempting to put users into the system of "people-environment-product ". In the following, three aspects of "people", "products" and "environment" will be studied.

(1) The study of people

First, we study user needs based on Maslow's hierarchy of needs theory. According to this theory, human needs can be divided into five levels, namely physical needs, safety and security needs, social acceptance needs, esteem needs and self-actualization needs as shown in Fig. 1 [9]. It requires designers to capture user needs from this five levels. It will be better for designers to capture users' high-level needs, such as esteem needs and self-actualization needs.

(2) The study of product

Many elements of products will exert influence on user needs. Only the ergonomics is studied in this paper since it plays a significant role in user needs. To be specific, it includes the following aspects:

1) Product design needs to be consistent with human body size parameters.

2) Products should be coordinated with human beings' physical and psychological state.

3) The use environment of the product should guarantee the health, safety and comfort of human beings.

(3) The study of environment

Different environments also affect user needs. For example, people from different social levels may have different characters, so their expectations on a product's performance also vary accordingly. People from different places such as wealthy city and poor mountain area may also favour different product performances.

People, product and environment are interactive and interdependent. For example, rich people may like famous brand products more. But poor people may like cost effective products more. Another example, for the products which will be usually used in home or office, people may pay more attention to them appearance to present their personality. However, if the product will be usually used in harsh environment, the durability will be the most important element which people consider. The typical model of interactive system is shown in Fig. 2.

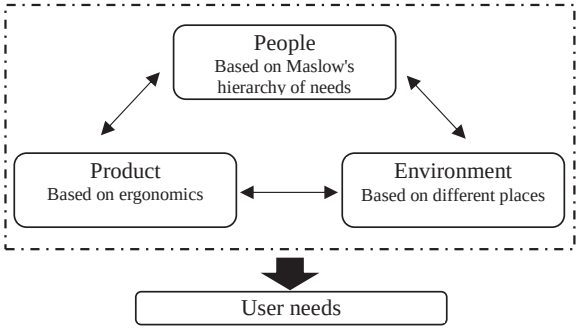

Fig 2. Typical model of interactive system

2.2 Axiomatic design based on interactive system

After getting user needs, how to map the user needs to product specifications by AD will be presented. Axiomatic design theory can be divided into four domains of customer, function, physical and process. Each domain has its own characteristics such as customer attributes, functional needs, design parameters, and process variables. Product design process is the conversion parameters between the two domains adjacent to each other in the process, as shown in Fig. 3 [10-12].

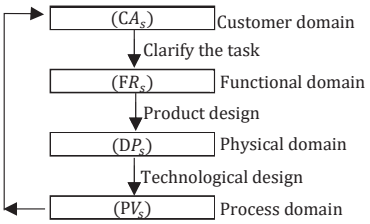

Fig 3. Conversion between four domains in axiomatic design

The validity of the design is guaranteed by two design axioms.

(1) Independence axiom: Maintain the independence of functional needs.

Mathematically, the relationship between FRs and DPs can be shown as follows:

$$\{FR\} = [A]\{DP\}$$

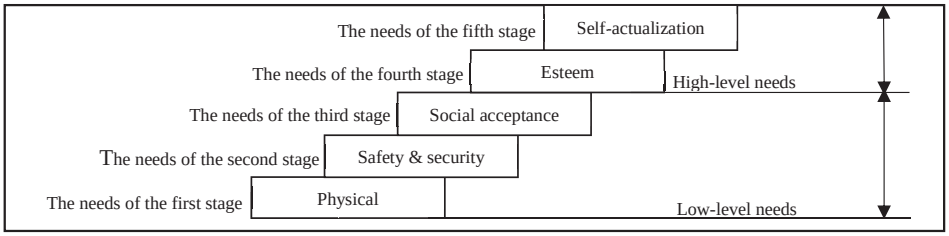

Fig 1. Maslow's hierarchy of needs