

The Application of Human-Computer Interaction Idea in Computer Aided Industrial Design

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Abstract—The interactive, experiential, real-time, efficient and comprehensive features of human-computer interactive technology in virtual display make it possible to virtualize products with panoramic, instantaneous and experiential features. The computer aided design based on human-computer interactive technology, through the design and present from shape, color and structure of products, enables designers to pre-design in advance to avoid the mode of production then design in before, which can be a good reduction in industrial production and manufacturing costs, at the same time, it is possible to evaluate the possible problems in the design of industrial products and some defects in products, so as to improve to achieve a good design process.

Keywords—Human-computer interaction; Virtual display; Experience; Computer aided design; Products design

I. INTRODUCTION

With the rapid development of digital information technology, the research on the theory and method of modern industrial design has made great progress. The technology of computer aided industrial design fully involved in the field of industrial design and the idea of human-computer interaction makes people have an urgent demand for a dynamic, three-dimensional, real-time and realistic display experience. So, the computer aided design based on the idea of human-computer interaction has injected new vitality into industrial design.

The unique interactive features of computer technology gives the product display a strong visualization. Designers can quickly demonstrate the scheme designed at the conceptual stage by computer and make of three-dimensional model, so that the designers can real-time visualize the various parts of the works in the design process, find out the shortcomings to modify in the next step, until to see the results of design intuitively. The whole process can be seen through virtual display platform, so that customers can see in advance the real effect of the design after the work is really finished and then make suggestions for modification of the

design proposal. The combination of human-computer interaction idea and computer-aided design shows for people the design process ,the actual image and application effect after the completion of the design comprehensively, specifically and in real time.

II. THE CHARACTERISTICS OF HUMAN-COMPUTER INTERACTION IN COMPUTER AIDED DESIGN ENVIRONMENT

A. Interactivity

Interactivity refers to the degree of operability and responsive to user actions of the display in a virtual environment. In the virtual product exhibition design based on human-computer interactive technology, the computer can generate a virtual environment consistent with the characteristics of the product and the original design, so the users can take the initiative to receive the information conveyed by both the virtual environment and the digital display [1]. Virtual display design is not a static closed world, but an interactive and open system, which can affect the users or be affected through the design, control, management and device mobilization.

B. Experience

The display of design based on human-computer interactive technology can create a real virtual environment for viewers, and through the three-dimensional digital model by computer, so that people can receive a comprehensive experience in visual, auditory, tactile and other sensory organs.

C. Immediacy and efficiency

The display of design based on human-computer interactive technology can directly across the time cost consumed by the traditional display, directly display the latest products and their characteristics to the users through the digital technology, multimedia tools and virtual reality network platform. The target customer groups and users of

the product can receive and browse the information in a timely manner, which reflects the efficiency of virtual display.

D. Comprehensiveness

The virtual display design system based on user needs can build a product model with 3D entity to fully and accurately show the structure and performance of products, at the same time, transmit the information to the user in a timely manner through the network, so that users can fully grasp the product information in the virtual display system. In general, the product information mainly includes the product's 3D model information and performance information. The former includes static information, such as appearance, color, structure, material and so on, the latter refers to the dynamic operation of the product information, such as the use of the characteristics of the process and the performance and status. The most important thing is that these physical information will be transformed into digital information in the virtual display design, so that the users can grasp the product information fully and accurately.

III. THE OVERALL FRAMEWORK OF COMPUTER AIDED INDUSTRIAL DESIGN SYSTEM

The development trend of computer aided industrial design technology mainly focuses on product design research, computer application technology research, and on the whole, provide technical support for the whole process of industrial design. The overall framework of the computer-aided industrial design is shown in Fig. 1.

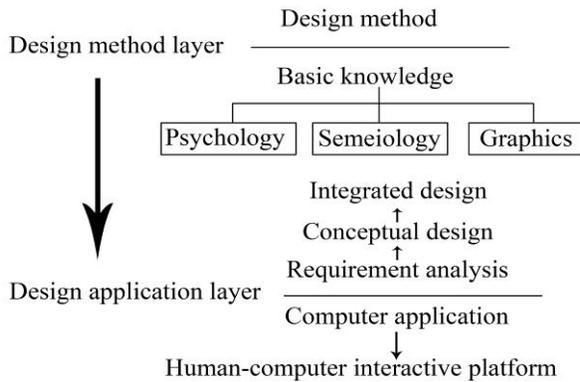


Figure 1. Computer aided industrial design overall framework

The design methodology layer mainly includes two layers: the knowledge base and the design method. The design method layer mainly refers to how to carry out the activities of industrial design on the basis of computer aided industrial design, and to seek and improve the guiding theory and method of industrial design [2].The continuous exploration and innovation of the knowledge base layer is beneficial to human-computer interaction, user requirements, artificial intelligence, and more scientific modeling design methods.

The design application layer is embodiment of the entire computer-based industrial design process. Computer aided technology for technical support of industrial design is mainly reflected in the demand and industrial design

development trend of users [3].Among them, the user needs design, mainly to solve how to integrate the user into the loop design, and also consider the user needs of the specific and targeted.

The problem that urgent needs to be solved in designing application layer is how to design interface for user's requirement design, detailed design and conceptual design.

IV. PRODUCT DESIGN PROCESS UNDER THE IDEA OF HUMAN-COMPUTER INTERACTION

The globalization of computer information network has occupied an unshakable position in people's life and work, and the modern society has changed from "technology as the foundation" to "information technology as the foundation" [4], which indicates that the society is advancing with the times, but also brings some problems to industrial designers.

On the premise of human-computer interaction, all the connections between human and computer need to be maintained by human-computer interface. Human computer interface is the link between human and computer interaction and connection. It is based on the information tradition of dealing with "people and things". It not only studies the use of computers, but also emphasizes the importance of human beings [5].The purpose of man-machine interface is that it deals with the relationship between industrial designers and computer software and hardware, studies the design of man-machine interface model, the design of virtual interface, the design of multi-user and multi-sensory interface, and so on, so as to provide a good technical foundation for industrial design.

In order to effectively use the computer to assist the design, and the design information accurately conveyed to the customer, when the designers deal with every detail of the product in the use of computers as a means ,they must ensure that customers and industrial products be accessible communication between the interaction .Therefore, human-computer interaction is particularly important in the process of industrial design. At present, in the computer-aided industrial design, human-computer interaction is mainly reflected in the product design process based on conceptual design, personnel collaboration, product design, virtual display, design feedback and product improvement.

The human-computer interaction in the product design process is shown in table 1.

TABLE I. HUMAN-COMPUTER INTERACTION IN PRODUCT DESIGN PROCESS

The process	Human - computer interaction target		
	computer	counterparts	customer
conceptual design	YES		
personnel collaboration	YES	YES	
product design	YES		
virtual display	YES	YES	YES
design feedback	YES	YES	YES
product improvement	YES		

A. Conceptual Design

The conceptual design of industrial products is to explore the combination of the functions and structures of industrial products, so as to get the best combination of the product in the design stage, which is a design process that designer give full play to the imagination and creativity. Computer aided industrial design technology will provide technical support for conceptual design of designers throughout the process, that is, from the design inspiration to the specific design implementation will provide aided design help.

Although computer aided industrial technology allows the concept of designers to be represented by two-dimensional or three-dimensional graphics, but the latter part of the modification and maintenance is not very convenient, therefore, at this stage, human-computer interaction based sketch aided design system can help designers get rid of repeated manual drawing work, and can easily express innovative design [6].

B. Personnel Collaboration

Modern industrial design has long been out of the traditional manual design, but the design structure, aesthetic point of view, interactive information and design resources put forward a higher requirements. In the specific process of industrial design, designers of different styles and different academic backgrounds should be gathered together to cooperate with each other to provide technical support for industrial design. In the concept of human-computer interaction, computer aided industrial design technology can help designers in different places jointly design and develop industrial model by using synchronous and asynchronous technology, so that designers can easily share industrial design information and design inspiration, thereby significantly improving the efficiency of industrial design.

C. Product Design

In the process of product design, virtual assembly and virtual simulation can effectively reduce or even avoid errors. The maintainability, configurability and compatibility of industrial products are key to the constant error of the designers. In the past, during the final assembly of the product, it was not until a long period of time that to find the parts in the assembly were broken or even scrapped. Virtual assembly refers to the industrial product design stage that designers use the way of human-computer interaction directly three-dimensional assembly for industrial products, and in the assembly process make designer's creativity to maximum. At the same time, in this three-dimensional three-dimensional effect, designers observe the industrial products as in real life which can be the fastest speed to accurately find the flaws in technological design process.

The application of virtual simulation technology in industrial design refers to the accurate judgment and design of human-computer interaction through the technology of virtual simulation in computer system [7]. Through the virtual simulation technology can achieve a goal that operate and test each of the design process to help the designers faster and more accurate to complete or modify the design scheme, reduce unnecessary time and mental labor, strengthen the

technical communication with the design members, explore the resources, and improve the design speed of industrial products.

Today's industrial products not only meet the user's normal functional requirements, but also meet the aesthetic needs of users, which requires designers to increase the importance of the product's appearance, material, overall structure and color matching, and even can use the computer-aided industrial design technology for all aspects of the above to achieve the ideal product design by analogy, analysis, selection and arrangement [8].

D. Virtual Display

Design and display based on the idea of human-computer interaction is designed to meet the needs of users and improve the quality of interaction. The interactive quality is decided by two aspects: One is usability, the other is the user's experience. This paper analyzes the important role of human-computer interaction idea in industrial design through a car showcase [9].

Virtual display based on human-computer interaction idea does not appeal to users only through pictures, text or video music, but interactive design plays a decisive role in it. In order to make the experimenter fully interact with this presentation, the interaction of the whole framework includes perspective interaction, color material interaction, performance interaction and feedback, driving mode interaction and so on. Its structure is shown in Fig. 2.

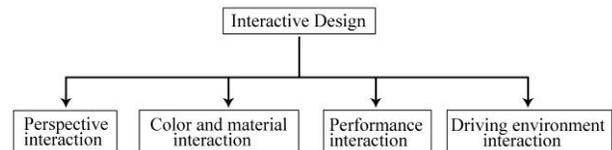


Figure 2. Interactive system for vehicle virtual display design

Take the perspective interaction as an example. In order to give the user the most real and natural visual experience, there is a variety of perspectives for users to choose, including control the angle of view through dragging the mouse and local features [10]. People can also add more navigation on this basis, such as through the keyboard to control the rotation of the field of view, and create an external interface, through relative devices to capture the experience of the head or body positioning, according to the experience of the real-time perspective angle replacement, together with three-dimensional glasses and other external devices, restore the user a real and easy to use man-machine interface [11].

In addition, different configurations will be brought into the driving mode, so that users can really feel the appearance, interior and performance of the car when driving, which will help users gain a sense of experience.

The virtual environment of the car is divided into browsing the environment and driving environment, browsing is divided into multi-angle view and the car driving angle; driving environment for the third-person camera perspective, the perspective can clearly see the car

driving state, including wheel steering and body with the ground ups and downs.

In the browsing environment, user control of the camera as the free navigation mouse interaction: press the left mouse button and move the mouse to control the angle of rotation, if fast rotation also joined the buffer visual effect, that is, the mouse will not immediately stop after the release of rotation, it will be in the original rotation on the basis of a inertia, and gradually stop.

The activation key of the driving mode is the E key on the keyboard, which is located in an open mountain environment where scenes and cars are given a very real physical property, including gravity, collision, and so on. In this mode, the user can visually observe the state of the car, fully feel the flexibility of the car. At the same time, the given physical attributes can be adjusted according to the actual conditions of the car, so the final driving state of the car is more realistic.

E. Design Feedback

In virtual display, in order to facilitate the communication between the designer and the end user, can provide special modules for users to choose the configuration freedom and feedback. In this case, wheels and car interiors are taken as examples.

The user switches through the selection button of the main interface, in addition to real-time rendering in appearance, it will also change the background database in real time and feedback the data to the designer. For example, in the color and material interaction module, parts related to color and material change including body, ceiling, seat and so on. These interactive parts are triggered by buttons.

When the customer clicks the button, the computer system retrieves the current color information from the background database and passes it to the main interface's information statistics panel to display the color information visually. At the same time, this information can be saved as a final customer selection scheme and submitted to the designer to achieve personalized customization. This process is shown in Fig. 3.

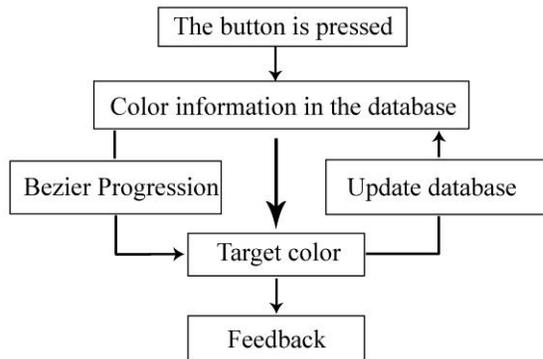


Figure 3. Sketch map of color and material interaction program

F. Product Improvement

In the future, the resonance of industrial products and consumer sentiment will become one of the important factors

for consumers to choose industrial products, simply paying attention to the aesthetics of industrial products has not been suitable for the development of computer aided design [12].The application of computer-aided design in product design should be based on the principles of ergonomics, human nature design and sustainable design, in the process of computer aided design, more humanized design elements are added, and the interaction design and emotional design of products are taken as the main factors. Therefore, the designer should follow the customer feedback and computer system information records, re-examine the product modeling, color, materials, structure and other elements, take human-computer interaction and experience design as the guide to improve and optimize the products.

V. CONCLUSIONS

From the industrial design itself, with the continuous development of artificial intelligence, virtual simulation and other technologies, designers' thinking will also undergo major changes. The CAID of human-computer interaction mode will be the inevitable trend of the future industrial design, and the more humane, fast and real human-computer interaction will be the inevitable result of human-computer interaction in CAID.

In the field of computer technology and human-computer interaction, more bold and innovative concepts have been put forward. Language identification, infrared remote sensing, video capture and so on, will inevitably bring more technical improvements to human-computer interactive technology. The new human-computer interactive technology has been emerging, and it can bring more scientific and technological innovations and expectations. In the future computer industry design, human-computer interaction should strengthen the "human centered", "harmony" "unified" interactive model, so as to improve the efficiency of human-computer interaction.

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