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Redesign of the Control Panel of Central Air Conditioning Based on Users' Experience——A Case Study of CJ International Dorm of Korea University

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Abstract: *In the light of ergonomics, design psychology and experimental psychology, this paper centers on users' experience and conducts a research on the interface design of the central air-conditioning control panel in the CJ international house for international students of Korea University. Based on an initial analysis of the overall system composed of human-machine-environment in the dormitory, its input and output information has been introduced. After that, it also analyzes a series of users' behaviors, which needs to be done to complete the target instruction as an operator.*

Keywords: *Users' experience, interface redesign, design psychology*

1. Introduction

With the development of science and technology, user experience has drawn increasingly wide attention, including system service design based on ergonomics and human-machine interface interaction design. Based on the author's deeper understanding of users' experience theories with during the academic exchange in Korea, this paper centers on the interactive interface of the control panel of the air conditioner as an example to redesign in the light of psychology, which aims to make the information displayed in a clearer way and more in line with the design standards of simplicity and ease of use.

2. Research methods

This paper is written based on the following methods: theoretical position method, observational method, and interview questionnaires. With the help of these research methods, actual users' experience can be illustrated and analyzed in a more theoretical and convincing way.

3. Research on the human-computer interaction interface of central air conditioner in the CJ international dormitory of Korea University

CJ international house is the dormitory for foreign students of Korea University. The interface of the Korean panel should be more concise with clearer and distinct button shapes and more direct pattern instructions. Therefore, understanding and analyzing the features and function arrangement of the central air-conditioning human-machine interactive control interface is conducive to the subsequent design. This part mainly focuses on the device features of this control panel. Design elements such as function arrangement and information hierarchy are analyzed to provide a theoretical and practical basis for subsequent redesign.

3.1 Overview of the human-machine interface of the air conditioning control panel

3.1.1 Definition

The human-machine interface is a platform for information interaction between humans and machines. Users input information and requirements into machines (such as touch screens, keyboards, keys, etc.), and receive feedback converted from machines in various forms (such as sound, graphics, light and shadow, etc.) in order to realize the interaction between human, machine and environment.

For users, the control panel interface in the dormitory room is the medium for information

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transmission between residents and surrounding environment. The control panel should contain control buttons with different functions. When the user receives stimuli caused by the environment (such as entering and leaving the room, temperature changes, humidity changes, etc.) or any different information, they need to operate the machine (air conditioner) through the control panel. After the operation panel receives the instruction, a series of processing adjustments will be done in the internal system of the equipment. Then the user's external commands are converted into feedback of the mechanical performance of the air conditioner (such as switching, adjusting temperature and setting wind speed, setting time, etc.).

Therefore, a well- designed control panel can bring a more comfortable experience to users, and provide a better operating experience, which is beneficial to both users and brands.

3.1.2 Interface Features of Air Conditioner Control Panel

When entering or leaving the room, users need to predict the next required environment based on his/her own perception of the ambient temperature and the predetermined duration to ensure that it can meet the needs. The control panel has become the only device for precise adjustment and feedback of the above content. The interface has the following features:

1) The area of human-computer interaction is small. Compared with the electronic devices such as televisions and computers, the air conditioner control panel has only a small area of 10x15cm. This includes both a monochrome display screen, switches, changes, and wind directions. There are several functional input buttons but limited display area.

2) Interface functions are too rich to contain all. The visual screen area is divided into five parts by thin lines, which display different information of temperature, timing, wind direction, intensity, and mode; the button part is divided into two kinds of buttons: the round button on the upper right and the square rounded corners arranged on the lower part. There is a mini indicator light above the circular switch to indicate the working status of the machine.

3) It’s likely to cause misoperation. Because of the particular environment, the control panel in the international student dormitory should place key information recognition on the pattern recognition based on the Korean language, and distinguish different information by using simple and understandable signs. At the same time, due to the hectic learning, getting up early and performing corresponding operations before going to bed may cause misoperations due to fatigue and intensive keystrokes.

3.2 Analysis of design elements of man-machine interaction interface of air conditioning control panel

3.2.1 Interactive mode

The main interaction mode of the control panel is button interaction.

After the user accepts the feedback of the display screen, the command input and control are realized through various buttons on the panel, which produces a comfortable environment for adjusting to a suitable mode. The ten buttons on the operation panel respectively represent different functions, and they all need to be operated according to requirements when used.

3.2.2 Analysis of interactive interface functions

The interactive interface of the air conditioning control panel can be divided into the following functional areas

1) Screen digital display area

This is the output area where the device feeds back its own information to the outside world. It is located within the standard line of sight when the user stands naturally facing the wall. It includes mode display, temperature display, air volume display, wind direction display, and current room temperature display.

2) Function buttons

This functional area contains ten functions including master switch, high/low adjustment, filter check, view number, duration, setting, air volume, and mode.

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Fig.1 Old panel of conditioner

Table1 Visual elements

Display characters	Practical meaning	Code name	scenes to be used	usage frequency	Importance ranking	Browse time	Reference button size design	logo design
필터리셋	Filter reset	A	Restart after long-term non-use	About 60 days/time	8	4	small	
에어콘 NO 점검	Air conditioner NO inspection	B	Need to display the number of the air conditioner when in use	About 120 days/time	9	5	small	
타이머	time	C	Need to show appointment working time	About 2 times/day	7	8	small	
SET		D	Need to modify the basic display information	About 120 days/time	10	10	small	
온도설정 (⇧)	Temperature setting	E1	Set the predetermined indoor temperature	About 4 times/day	2	20	Middle	
시간설정 (⇧)	Time setting	E2	Set time	About 2 times/day	5	8	Middle	
풍량	Air volume	F	Need adjusting the air volume (strong, medium, weak)	About 4 times/day	4	10	Middle	
오토스윙	Auto Swing	G	Automatic wind	About 1 time/day	6	5	small	
모드	mode	H	Switch air conditioner working mode	About 1 time/day	3	30	Middle	
운전 / 정지	Run/stop	I	Turn on before use or turn off the device after finishing use	About 4 times/day	1	10	Big	

3.2.3 Analysis of the information hierarchy of the control panel man-machine interface

Information level is to organize and optimize information reasonably. When there are multiple functions and multiple tasks, a set of reasonable and orderly information interfaces with maximum efficiency are designed. It's the final goal to facilitate users with focus on the arrangement and presentation of information by means of different permutation and combination methods and arrangement divisions for different contents. The layout method generally consists of the time spent on viewing display elements, ranks in order of importance, use of frequency and relative importance of the display elements.

The order of use is based on the observation and study of the users' experience. The order of using the buttons for the first use is: main switch, control temperature (large/small), and mode-changing. Among them, the longest is the mode-changing.

For the air conditioner control panel, the areas described above can be combined. The main switch of the key zone and the screen temperature display area belong to the first level, the temperature adjustment

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and mode display are on the second level, and the remaining buttons are on the third level. In the control area, the screen display area contains a large amount of setting information. It is difficult to distinguish the primary and secondary importance and the purpose of use.

Through the above analysis of design elements, the following points are summarized:

1) At present, the mainly interactive mode of the air-conditioning control panel in the international student dormitory is still buttons, and other more advanced interaction methods such as touch or voice are limited by actual conditions.

2) The design of each functional area is relatively vague and the partition grouping is not clear, and the key shape, icon, and partition classification lack the necessary connection among them.

3) It is difficult to distinguish the priority between various functions and levels, especially each function is on a single button, which costs more time to identify and brings about poor users' experience.

3.2.4 Chapter summary

This part mainly introduces and analyzes the concept of the human-computer interaction interface of the central air-conditioning control panel and the characteristics and components of the equipment. Its design elements have been illustrated from three aspects: interaction mode, functional dividing and information level, to provide support and support for subsequent redesign

4.Operation interface design

4.1 Design process and evaluation methods

4.1.1 Layout design

In the process of designing, the number of keys, types, frequency of use need to be taken into consideration. The following principles should be followed during design:

1) The overall control panel should be placed within the reach of the user, with a height of about 140cm above the ground, and should not be blocked.

2) The functional areas are arranged in zones, and the buttons in each zone are distinguished by visual images such as color and shape. The shapes and areas of the buttons with higher frequency of use/more frequent use are enlarged and distinguished, and the user's cognition load is reduced at the same time.

3) Major changes of the position of each button will not be made unless necessary in order to shorten the adaptation time.

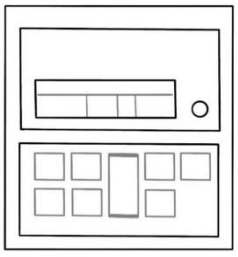

Fig.2 Original layout diagram

4.1.2 Interface redesign

Base on the above analysis for the design guide, I launched on the re- design project control panel, air-conditioned interface:

(1) The text area and the image display area are separated and distributed side by side. The image area gets more attention while the text area gets less attention and assists in understanding.

(2) Distinguish by color, pattern and text .

(3) Add life information such as date, weather, outdoor temperature, etc.

(4) According to the importance of functions, cognitive priority and human visual habits, combined with the link analysis learned in the course, optimize the interface layout and redesign.

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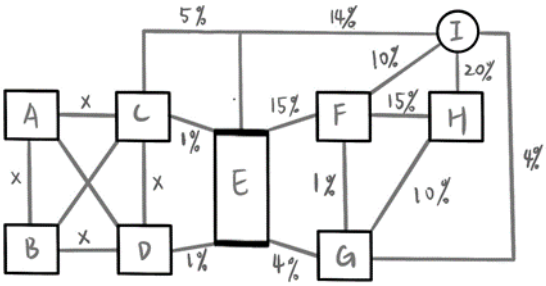

Fig.3 Original layout diagram

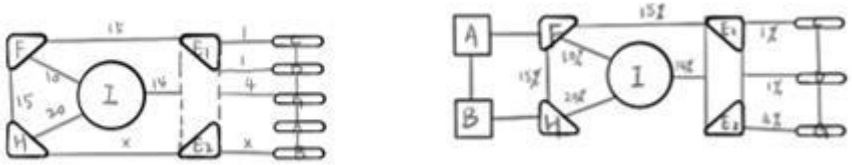

Fig.4 Plan 1 and Plan 2 of visual link analysis

In accordance with the above description, the layout plan of the interface buttons for the air conditioning control panel is as follows:

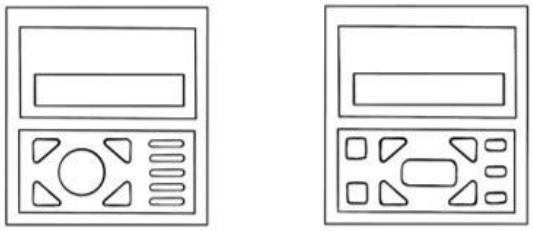

Fig.5 Plan 1 and Plan 2 of redesigned planar layout schematic

4.1.3 Schematic diagram of establishment and effect of control panel interactive interface model

According to the layout design of the function buttons of the control panel, Rhino is adopted (a modeling software) to build a model of the entire operation interface, as shown in the figure.

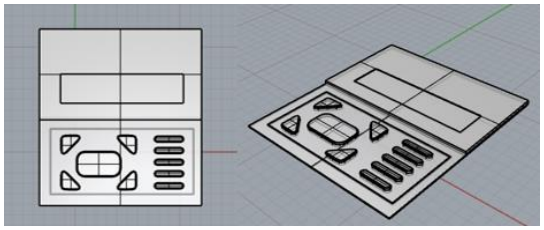

Fig.6 3-D Model of Option1

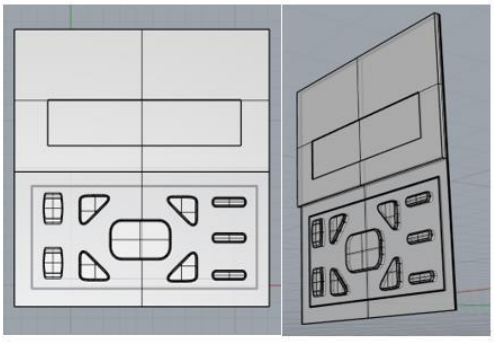

Fig.7 3-D Model of option2

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Through the establishment of the above model, combined with the control panel design, Keyshot (a rendering software) is used to render the model, and the effect diagram of the operation interface is obtained, as shown in the following figure.

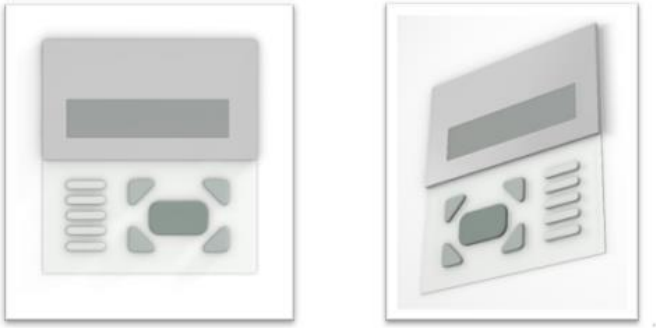

Fig.8 Model Option1 after rendering

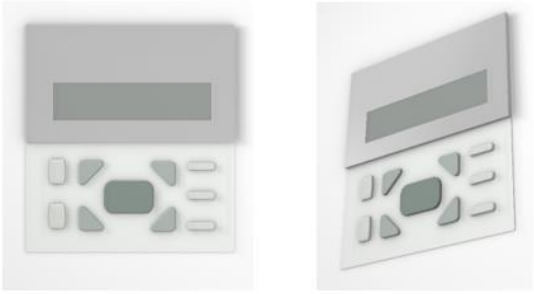

Fig.9 Model Option2 after rendering

4.2 Design Evaluation

For the evaluation of the design plan, three aspects, namely, user satisfaction, ease of operation (interface clarity) and cognitive efficiency (time required to complete the specified operation) are involved to verify whether the control panel interactive interface can better meet the target users' needs and improve the experience. This evaluation, with the help of test observations and user questionnaires, relies on the actual experience of the target users to get feedback towards the product, and evaluates the advantages and disadvantages of the improved interface.

There are 5 participants in the evaluation, all of whom are foreign students living in the CJ international house of Korea University. During the evaluation, the design is placed in a simulated use environment, and interactive behaviors are carried out in accordance with behavior instructions, intuitively feel and give feedback. The evaluation breakdown of each aspect is shown in the following table. At the same time, the Likert five-point scale is used to score the design satisfaction. The higher the satisfaction score, the greater the sense of identity for this item. After the evaluation, some participants were interviewed in order that shortcomings could be found out for subsequent improvement.

Table 2. Likert five-point scale

Evaluation dimension	Subdivision	Satisfaction
Product satisfaction	Appearance, color	5 4 3 2 1
Easy to operate	Interface, button layout, Operation fluency	5 4 3 2 1
Cognitive efficiency	Response time, errors	5 4 3 2 1

On the basis of the above evaluation table, the scores of each subdivision index have been added and the average value taken. The closer the average score of each item is to 5, the higher the user's recognition of the design. The average value of each evaluation index is shown in the following line chart:

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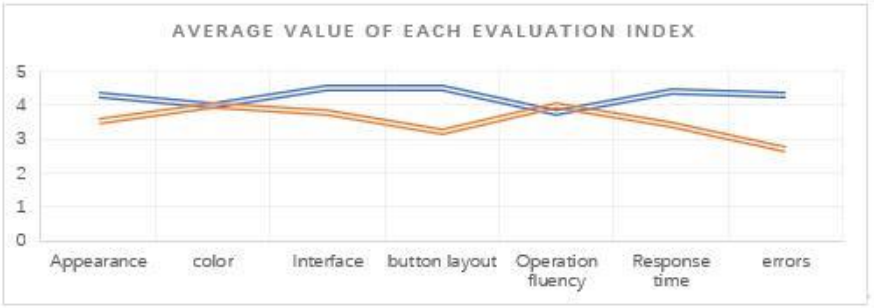

Fig.10 The average value of each evaluation index

As can be seen from the above line graph, the target users recognized more towards interface of option It means that the button layout is satisfactory to a certain extent, but the operation fluency got a lower mark. Thus, there is a higher demand for fluency (correlation between each of the keys connected), which needs to be further considered and improved in the follow-up design. And testing when atmosphere is closer to the actual operating, which can provide users with a better experience. Overall, the test results show that the testers prefer the redesigned interface, and the user experience has been improved. Moreover, this redesigned interface verifies the feasibility of the solution and meets the needs of users.

4.3 Chapter summary

This part is based on the design research on the relevant elements and requirements conducted in the early stage, carries out redesign practice for specific users and scenes, as well as the establishment of digital models and the display of renderings. Finally, with the evaluation method of the user's actual simulation process, the design evaluation of the interactive interface of the central air conditioning control panel has been improved. The overall redesign was relatively satisfactory.

5. Research result

The major research results of this paper are as follows:

(1) Apply psychology to the design of air conditioning control panels.

Find out the actual problems in daily life, analyze their feasibility, and make use of the expertise to improve the users' experience.

(2) Clear design features

Analyze the interactive mode, interface function, use element, and information level of the control panel.

(3) Clarify user needs

Explain the cognitive needs of target users (international students), analyze the main pain-points and establish design goals.

(4) Carry out design practice

Carry out redesign practice based on the preliminary summary to solve the problems and improve the user experience.

6. Conclusion

This design focuses on the human-computer interaction interface of the central air-conditioning control panel of the International Student Dormitory of Korea University based on psychology and user experience research, and takes into account the cognitive psychology of users under human-computer interaction, so as to achieve higher satisfaction of target users. Despite the considerable improvement, there is still room for better design in the future. It's hoped that in subsequent design iterations, users research can be enhanced, the group interview can be expanded and reference to interface layout of other industry brands can be drawn on.

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