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Research on interactive experience design of tram charging pile based on user perspective—Taking Quanzhou Normal University as an example

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Abstract: *This research takes the target user experience and interaction optimization as the core, AEIOU, ELITO, weight matrix analysis model as the research basis, Quanzhou Normal University charging pile online operation model as the research object, adds quantitative design research scheme analysis, builds a new interaction model, comprehensively covers each contact and crowd status, behavior, etc. in the charging step, makes a comprehensive analysis, and puts forward key issues in different emotional points The significance and purpose, and the design goals and ideas are given in order to find new design opportunities for the interactive design of the charging pile.*

Keywords: *charge pile; UI; weight matrix; quantitative analysis; AEIOU*

1. Introduction

The development direction of new energy vehicles is to increase the interaction frequency of people and vehicles. The vehicle owner implements remote status monitoring and control of the vehicle through mobile terminal equipment, that is, remote terminal interaction is a key link in the current vehicle interaction design. In this regard, electric vehicles and automobiles are also of the same origin, and the control methods of the vehicle's regularity, real-time and mobility in complex environments are gradually penetrated.

At present, Quanzhou Normal University in Quanzhou City, Fujian Province has 7 tram charging sites, 388 charging ports in total, which is very insufficient compared with trams. Except that the charging piles below the administrative building, other charging piles need to go up the slope, and the slope is high and the distance is far. When the tram is not powered, it needs to climb the slope, which is highly dangerous. However, the charging piles are distributed evenly, and there is no particularly remote or concentrated situation. and the charging pile itself was partially missing two-dimensional code, which would lead to the "vehicle mouth" mismatch. In conclusion, the charging pile and the surrounding environment still needed great optimization and adjustment. As far as the charging process is concerned, the online operation steps of charging are rigid and tedious, lacking certain intelligence and selectivity, and there is no manual service window configuration, so it is difficult to find relevant personnel to solve the problem. Reviewing the relevant structure, development trend and practice in the construction process will help to plan a mature logical process based on user experience, which is both practical and planned[1].

This research has designed a specific AEIOU+weight matrix analysis model based on the AEIOU. It can more comprehensively analyze and compare the whole process from the use experience of students and faculty to the charging target activities, from the macro overall environment to specific human-computer interaction to the final user sentiment, so as to find synaesthesia problems in each link, and summarize the core needs of target users, The purpose is to design a more mature online operation service scheme of charging pile, build a new interaction model, and point out the effective and valuable design goals and ideas for the future through quantitative analysis of the psychological needs of target users.

1.1 Introduction to AEIOU basic model

AEIOU model is the analysis, recording, processing and decision-making based on the five

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perspectives of specific activity, event environment, role interaction, object and user, and produces analysis data that fits the actual scene. Its main purpose is to obtain basic common conclusions and make more in-depth design analysis based on the actual theoretical elements. Specific activities, time scenarios, role interactions, target objects and participants are the five essential elements for the occurrence of an event. This design analysis method can integrate multiple elements related to each single point element, which can make many common problems clearer when focusing on single point elements and highlight hidden factors [2].

1.2 Construction of AEIOU+weight matrix analysis model

After investigating the charging behavior through activity experience, field survey, user interview and questionnaire survey, it is found that there is a large difference in the way of thinking between the target user and the designer on the AEIOU basic model. Therefore, the common needs of the two groups can be analyzed according to the weight matrix, incorporated into the analysis model, combined with the AEIOU model, and the appropriate interaction model that best suits the user needs can be derived.

2. Construction and analysis of AEIOU model+weight matrix

2.1 AEIOU model construction and analysis

Through the analysis, sorting and induction of the five elements of AEIOU, we found the hidden event elements, provided specific data for the next stage of design and research work, found problems, summarized the design improvement points of charging behavior, and carried out systematic analysis, research and improvement. Table 1-5 shows the specific experimental observation data results of AEIOU model in this event [3].

Table 1: Activities (self drawn by the author)

General Impressions/Observations		
① The cyclist comes to the charging area to find the parking space and the free charging port (if there is no free charging port or parking space, it is necessary to move other people's cars)		
② Move the car to the free parking space and take out the charger		
③ Connect the charger with the car and the charging pile		
④ Scan the code with a mobile phone, select the charging port 1 or 2		
⑤ Press the button on the charging pile		
⑥ to complete a series of operations on the APP, select the charging time and pay the amount, Start charging		
⑦ Mobile phone APP prompts the end of charging or withdraw the charger after the specified time, push the car out and drive away or move the car to another place		
Elements	**Features**	**Special Notes**
Mobile phone	Single threaded operation	Something urgent
vehicles	Relative independence	The car was unplugged
Charger	Instability	Problem in app
Charging pile	Diversity	The program reported an error
People	Intersection	Plug loosing

The whole process of activities is shown in *Table* 1. It can be seen that during the whole charging process, there may be exchanges between different people. In reality, the charger of the car will be unplugged by others, the car cannot be identified by the charging pile. The process operation logic specifically refers to the sequential process of operation movement and its related coherence, relevance and frequency; Sensory cognitive logic is a quick understanding of the structure of complex situations, including recognition, separation, sense of hierarchy, information expression forms and feedback; Cognitive experience logic refers to appropriate organization, details and attractiveness, including aesthetics, functional organization form, attractive focus, visual perception, simplification, etc. These can be applied to the design and evaluation of complex intelligent interaction, mainly by means of task testing, prioritization, combined with observation and interview for evaluation.

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Table 2: Environment (self drawn by the author)

General impression of the themes
There are seven charging piles in the school as a whole, which are less than the number of trams. The charging piles opposite Chen Zhaoqing Experimental Building are sloped, which is more dangerous. The rest are flat. The overall health quality is poor. Dead leaves and abandoned vehicles are piled up. The trams are placed in disorder. The ceiling of the charging piles is short, which has poor rain protection performance. The maintenance of fire extinguishers is relatively stable. Once a month, except for the charging piles under the administrative building and on the side of the first and second canteens, Other charging piles need to go up the slope. The slope of the charging pile in the student apartment is far away from the teacher, so it is difficult to deal with unexpected problems alone. The advantage is that there are charging piles in the student apartments, which are evenly distributed.
Notes
① The ground where some charging piles are located is a slope with high risk ② The maintenance efficiency of the fire extinguisher at the location of the charging pile is not high (check once a month) ③ Some charging ports cannot identify the vehicle or report an error (interactive) ④ The overall environment is relatively bad, no one cleans, there are many fallen leaves and sundries, and vehicles are placed in disorder ⑤ The shed roof is short, about 2m, with poor rain proof effect, large ground space, and relatively enough vehicles. ⑥ Some charging piles are remote and difficult to find ⑦ The charging behavior is not standardized, such as the charger hanging or contacting with other combustibles, and a small number of vehicle keys are not removed.

It can be seen from *Table* 2 listed in the environment survey that, in terms of the overall environment, some charging piles in the school are slopes with high risk; The environment is poor, the cleaning efficiency is not high, there are many fallen leaves and sundries, the vehicles are placed in disorder, the roof of the shed is short (about 2 meters), and the rainproof effect is poor. In addition, the maintenance efficiency of the fire extinguisher at the charging pile location is not high; Some charging ports cannot identify the vehicle or report an error; As far as human factors are concerned, some person have irregular charging behaviors, such as the charger hanging or contacting with other combustibles.

Table 3: Interaction (self drawn by the author)

General impression		
User-Machine-Environment ① People and trams: the user transfers the vehicle to the vicinity of the charging pile ② People and charging pile: users connect trolley charger and charging pile ③ The main body needs to start charging by pressing the electric stake button with your finger ④ People and mobile phone app: the main body starts charging by operating the app ⑤ Mobile app and e-post: the app scans the QR code of the e-post to complete the setting time and payment activities ⑥ People to people: people to people interaction in charging activities - charging users, security personnel, parking personnel ⑦ vehicle to vehicle: interaction during parking during vehicle charging ⑧ Charging pile and tram: charging activities are completed through intermediary connection		
Elements	**Features**	**Special notes**
Students	Self service	Confirm safety
Teachers	Online trading	Confirm remainder

In terms of human-computer interaction which described by *Table* 3, there are some problems and shortcomings in the interaction between people and objects. There are some phenomena such as there is no reservation function on the mobile phone APP. The interactive operation process of the app is becoming increasingly complex. At the same time, without effective and timely guidance, learning costs increased significantly. Therefore, it is necessary to conduct systematic remodeling research based on multi terminal interaction and experience, sort out the interaction logic of charging process, optimize the guided communication form and visual texture, etc., so that consumers can obtain a direct, natural and smooth interaction experience in operation.

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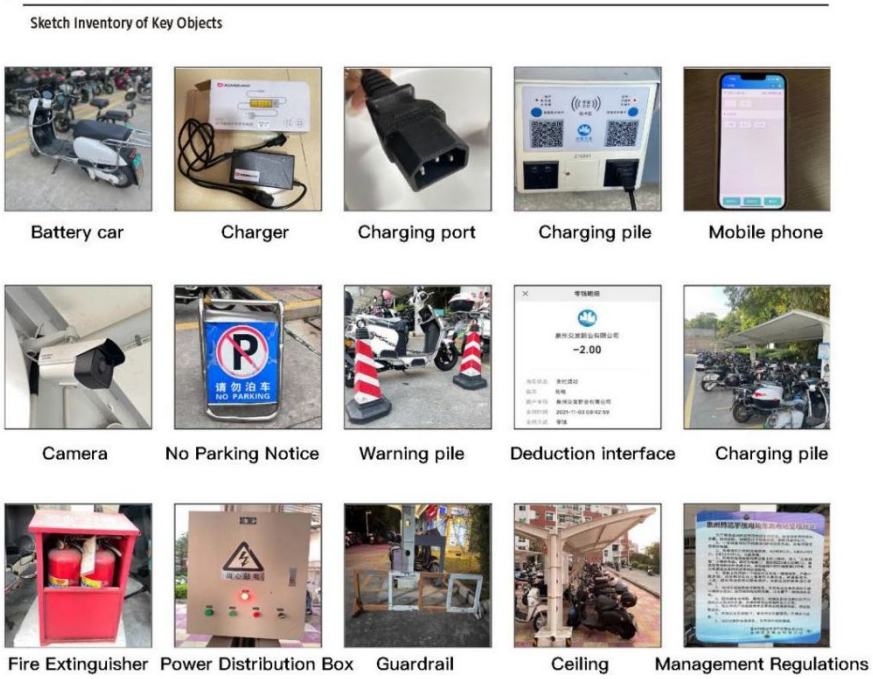

Figure 1: Articles (self drawn by the author)

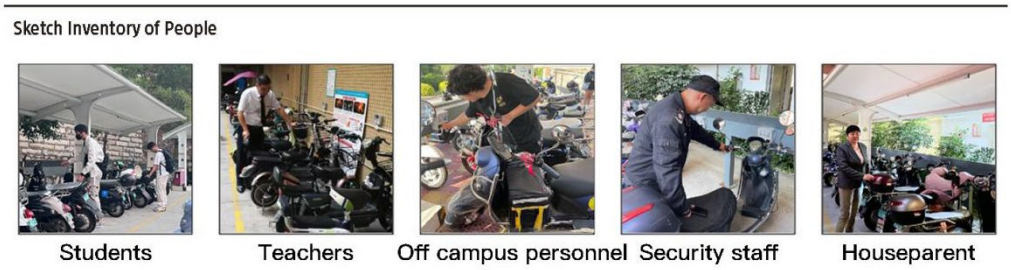

Figure 2: Users (self drawn by the author)

Objects and users appearing in the overall activity are shown in figure 1 and 2. The common behavior of users in the entire charging interaction scenario is to look at mobile phones, pay for charging through applets and apps, search for the location of charging piles through maps, and ask for information about charging piles through social media. Such behavior has continuity, contingency and uncertainty. The connection problem between the charging pile and the tram adapter, as well as the uncertainty of human behavior and activities, will cause users to be generally tired. In addition, the design of small programs or apps is not satisfactory in terms of visual texture and interactive experience, which is too rigid in an era of rising aesthetic standards, with extremely low humanized and emotional elements. In terms of security, some charging ports that are damaged or lack two-dimensional codes have not been treated. The geographical locations of the seven charging piles are not well marked on the map, which is difficult to find.

2.2 Construction and analysis of weight matrix

The weight matrix is a matrix that describes the degree of interaction of various elements in a specific event and reflects the interaction and dependence of individuals. The vertical axis is the experience level that consumers hope to obtain on the APP, and the horizontal axis is the design analysis elements of the design experience team. Through the scoring of the expert team, the proportion of each element in the entire use process is obtained.

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WEIGHTED MATRIX

	weight	Operation process	Interactive logic	Appearance design	Complete functions	After sales efficiency	Application affects	Privacy protection
Taste	6	0	2	5	5	0	3	2
Expenses	8	2	0	4	4	1	4	3
Practical	9	5	3	1	0	0	4	2
Convenient	7	1	5	2	4	4	3	4
Security	3	0	1	0	3	3	5	0
Details	4	3	3	4	2	1	1	1
		80	89	101	107	49	126	86

Figure 3: Weight Matrix (self drawn by the author)

It can be seen from the figure 3 that functional integrity is the most common element that fits the consumer group and design team. Therefore, this design element can be emphasized in the conclusion of AEIOU model.

3. Design practice under analytical model

We found a lot of details from the user observation framework of the AEIOU model and weight matrix. The purpose of this framework is to find out the functional requirements of actual users for the APP and the pain points of the charging problem. The pain point is that the experience design of the existing APP structure framework is not suitable for freshmen or emergency users. It is worth noting that the existing applet does not have the function of using by appointment or finding the location of the charging pile. At present, the most important thing is to simplify the APP charging process, and improve the ease of use and pleasure. In combination with this scenario, the overall classification and analysis of the AEIOU framework of the live investigation can be carried out, and five design elements (functional elements, color elements, modeling elements, structural elements and material elements) required for the design of the charging pile can be obtained, so as to put forward design principles and design strategies to meet the needs of different levels of people with different degrees of adaptation, and provide a data-driven innovative idea for APP design [4].

3.1 Design architecture of charging pile APP based on AEIOU+weight matrix

This study conducted expert analysis and online questionnaire survey on target users. The questionnaire included priority scoring of functional requirements and weight coefficient scoring of efficiency, effectiveness and supervisor satisfaction. A total of 97 samples were screened, and the design team classified and prioritized the requirements of each function. Among the realized functions, the most important thing to be improved is the smooth optimization of the charging function process. Among the potential demand functions, the iterative design should focus on: the campus map search, the visual display of the operation process, and the test function of charging reservation.

The optimization strategy design can be carried out for the current APP supporting this charging pile: (1) based on the actual operation scenario needs, improve the process optimization and improvement of the basic charging function of the product, meet the iteration of potential needs, focus on the sorting and coordination of the operation logic of scheduled charging, and use this as a breakthrough to improve the competitiveness of their products and stimulate consumer desire; (2) Optimize the overall hierarchical logic according to user functional requirements, reduce the frequency of operation, reduce user learning costs, and improve user efficiency; (3) The guidance and feedback during the interaction of various functions should be modified based on the user's usage habits, and the user's anxiety during waiting for feedback should also be paid attention to, and a more user-friendly UI design should be provided on the default page; (4) Build interactive object features that conform to users' cognitive habits, and reduce users' load cognition in the interaction of charging piles.

3.2 Optimization design of charging pile APP interactive interface

The data analysis results are used to optimize the mobile phone interactive experience design. The goal is to focus on improving the audience's operating experience, optimizing their interactive logic process, enhancing the old users' sense of surprise and happiness about the product function update, reducing the new users' initial use learning costs, and seeking the key practical path to complete the product charging operation in the carrier of the minimum amount of information [1]. The operation path is subdivided, and each sub path is systematically analyzed. The main interaction content between the charging pile and the user is defined as interactive communication, interactive operation, process

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data visualization and controllability. It is specifically embodied in determining the core needs -- charging operation, secondary needs -- searching, booking, management, monitoring, taking humanization and lightweight as the overall design style, focusing on meeting the operation and interaction of the main interface, organizing standardized information of the interface, minimizing the degree of thinking of users, making users understand the operation in the simplest way, providing guidance, and providing clear and solid interaction feedback, Realize the closed-loop and information coexistence of the entire interaction process.

The mobile terminal interface acts as the hub function in the interaction behavior, and the key to improve user satisfaction is the reasonable arrangement of function levels. Hierarchical logic is to ensure that users can quickly obtain the required information by constructing the logical relationship between various functions of the APP. In the hierarchical structure design, according to the different categories of target levels, it can be roughly divided into two types, namely, level priority and project scope priority. The level priority type is applicable to types with complex logical relationships and a large number of levels; The project scope priority type is applicable to the structure type with simple hierarchy logic but a large number of projects. Through the above research, it can be concluded that the functional requirements of the mobile terminal APP of the tram users can be divided into two levels at most, of which the maximum number of operating steps is 5. The first level interaction framework sorts out the operation process of the three common functions of reservation function and map search, as shown in figure 4.

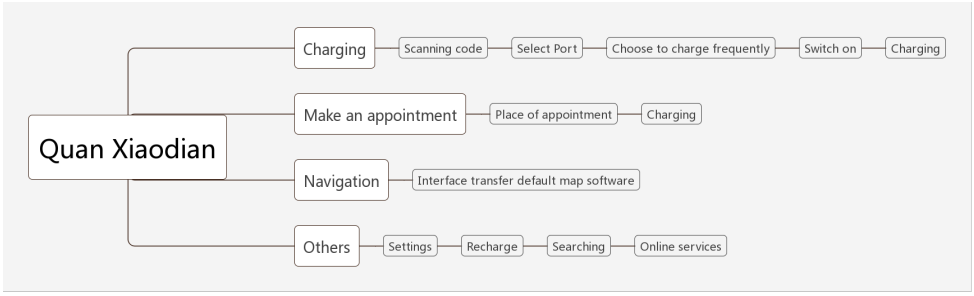

Figure 4: Functional Hierarchy (self drawn by the author)

Based on the function importance ranking obtained from the weight matrix, it can be seen that the highest score level is the optimization and improvement, and "map navigation" and "reservation function" are also the focus of users. Therefore, this campus tram charging mobile terminal APP interface function focuses on the operation fluency during the charging process and the information feedback after the operation, and designs different display sequences and visibility. Optimize the original APP interface, improve the visual texture, optimize the visual experience of fonts, color matching, overall framework, coordinate and match with the operation logic on the premise of visual satisfaction, highlight key keys, and optimize the animation during the waiting period to divert the user's attention so as to reduce the anxiety during the waiting period, and then optimize the functional layout of the main function page to reduce the function opening steps, Through animation demonstration, the user can vividly introduce the function purpose when using the function for the first time, and give more detailed guidance prompts for the operation mode. As shown in Figure 5, the UI design after the optimization of "charging process".

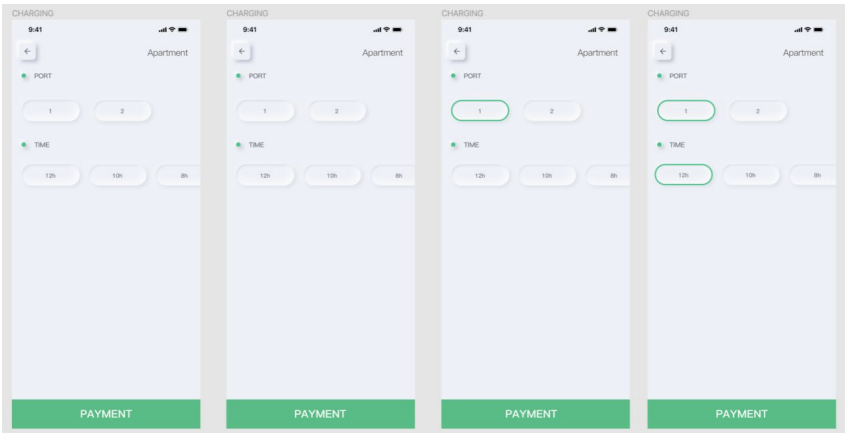

Figure 5: Functional Hierarchy (self drawn by the author)

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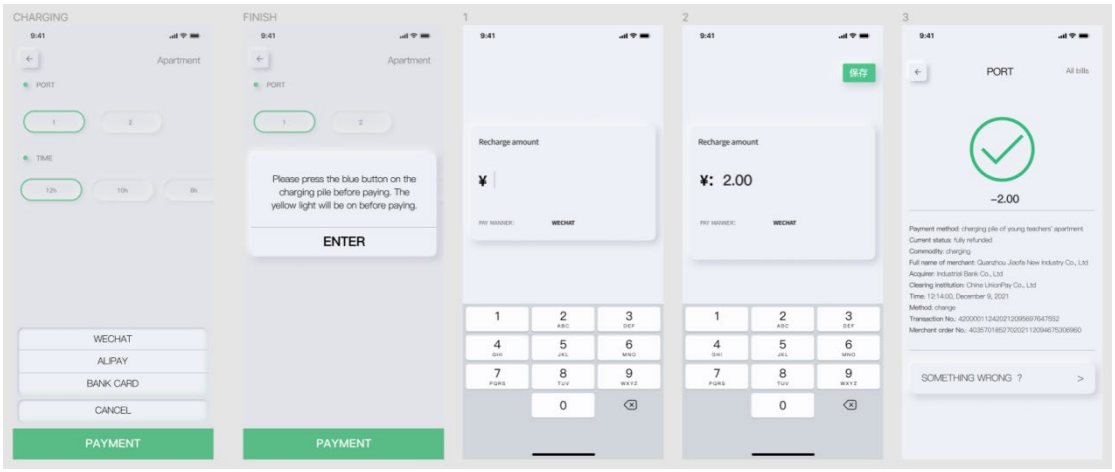

Figure 6: Functional Hierarchy (self drawn by the author)

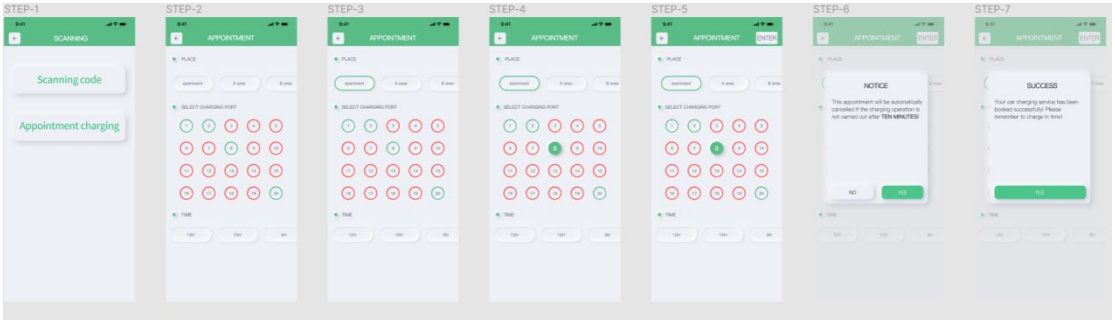

Figure 7: Functional Hierarchy (self drawn by the author)

Figure 6-7 is the secondary functional architecture design of the reservation function and map search. In the visual element design, the key points of user operation are prompted by font size and color. For example, the highlighted color is appropriately used as the symbol of visual center of gravity transfer in information such as selection of charging pile and charging duration. The color of people's daily cognitive habits is used as the identification symbol for whether the charging pile is in use. In ICON design, the logo that most conforms to people's cognitive habits is used as the function display. The overall visual design is checked by adopting Neomorphism Concept. The main color is green, which emphasizes the concept of environmental protection.

To make a product with a happy experience, we need to seek the experience needs that users have not found on the basis of meeting the core needs. The casual beauty is often impressive, so as to enhance user's liking, increase the interaction stickiness, and give users a reasonable and unexpected use experience in the emotional direction. This design also needs to be carried out according to experimental data and practical needs, to ensure the value of the product.

4. Conclusion

This paper takes the user behavior experience as the starting point, explores the potential needs of users when charging with charging piles and integrates them with the existing functional requirements. The AEIOU analysis model and weight matrix are used to prioritize the requirements. All the user needs in the early stage deserve the attention of designers. The functional requirements with higher priority are screened through tests to find out the specific problems that affect the user experience, and the requirements are quantitatively converted into functional importance. Through hierarchical analysis, it is transformed into visual interface design, optimized and improved, and improved user experience. Compared with the function of information resources, users pay more attention to technology and personalized experience in the era of Internet. At the same time, this design study uses static questionnaires to collect data. The sample size may have some limitations under the standardized situation. The two design methods cannot completely avoid more subjective judgments and adjustments in the actual use process, and such problems should be avoided in the subsequent research and design process; In addition, in practice, cost, resources and other practical issues must be prioritized to meet the needs of high importance.

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