Research of Irrational User Model on Subway Emergency Product Design

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Abstract. Based on the existing user research methods, this paper explores how to apply the irrational user model as a guide to the specific emergency product design research process. Through qualitative and quantitative user research tools, it develops a user model of subway users in emergency situations. It is expected that the research in this paper can provide a kind of idea and perspective for the research and development of emergency products, so that emergency products can really become a reliable guaranteed link of public safety.

Keywords. Irrational user model, user research, emergency products, mental model, task model

1. Introduction

With the development of urbanization, we are living in an environment that has reached the stage of a "risk society". Various factors in society constrain each other, intricate and complex, and all kinds of accidents occur frequently. Urban rail transportation has had a profound impact on the mobility of residents. The area centered on the subway station forms a highly dense public space gathering node. Due to the mechanism of large linkage, subway safety and security is extremely important. Emergency products are at the end of the overall emergency response system. In all kinds of man-made accidents and natural disasters, how to use emergency products in extreme scenarios has always been the focus of ordinary users. In many cases, we often see that the existing products do not play a role in the accident and danger. It fails to match the user's psychology and behavior, and often misplaced and ineffective in extreme events. In the design of emergency products, more attention should be paid to the study of the psychology, thinking and behavior of ordinary users, and it is possible to get more in-depth and practical design results by starting from this direction.

2. Frameworks of irrational user Model

Professor Li Leshan of Xi'an Jiaotong University proposed the framework of irrational user model on the basis of Norman's user-centered theoretical research. In his book Human-Computer Interface Design, he clearly elaborated the concept of irrational user.
He argues that existing user research is based on the theoretically normal thinking and actions of users. It ignores the situation when people are irrational and their behavioral thoughts are no longer bound by rules. Based on the complexity of users, he proposed that the connotation of irrational user model includes four aspects: "the task model and cognitive model of users' normal operation, the user's action and cognitive characteristics of non-normal environments, the user's wrongness, and the user's learning characteristics." Li Leshan proposed the framework of irrational user model (Figure 1) in Industrial Design Psychology, the user model should include two aspects: "Mental Model and Task Model". In both of them, the interrelationships of users, products and environment should be fully considered, and the factors related to non-normal environment and non-normal state users should also be taken into account.

3. Frameworks of irrational user Model

Exploring the construction of user models of subway users in emergency situations through existing qualitative and quantitative user research methods is one of the research focuses of this paper. Through the methods of questionnaire research and deep interviews with typical users, the user persona is established. In this way, the mental Model of subway users is organized to understand user characteristics. In order to be closest to the real fire environment, the decision-making behavior of subway users in the subway environment is deeply observed through simulation experiments and case studies. This provides the basis for constructing a task model of subway users.

3.1. Mental Model of Subway Emergency Escape Users

Through qualitative research and quantitative research, the mental Model of subway escape users is summarized according to two typical population classifications. Young passengers are mainly survival-oriented, with the best period of physical function and energy and stamina. Relatively speaking, they are more agile in thinking and more likely to receive all kinds of new information. While the elderly group is mainly life-oriented, with declining eyesight and physical strength in body functions. They are slow to react.
and easily fatigued. After experiencing many events in their lives, they are relatively gentle and calm in their personality traits, however, they are slower to accept new things. In mobility and commuting habits, young passengers generally commute to work. They commuting in the morning and evening peaks on weekdays, and the subway environment they encounter is heavily congested, with a high density of people and a poor ride experience. Due to the time pressure walking speed is faster, they closely follow the speed of the crowd. As the lines are relatively fixed, they are quite familiar with the station space and rely mainly on their sense of direction for way finding. When occasionally confused they find their way through self-reading maps. Middle-aged and elderly passengers, on the other hand, travel by subway for more casual purposes, mainly for shopping, meeting friends and other affairs. They do not have a fixed commuting time, but most of them will stagger their travel during peak hours, thus encountering less crowds and riding in a relatively comfortable environment. Without time pressure, their pace is slower, not affected by the crowd, and they pay extra attention to their belongings during the ride. Older people are often confused in subway stations and find it difficult to determine their target location. In such cases they mostly rely on their own impressions to find their way, are less likely to read the map themselves, and ask others as a last resort. In the subway safety awareness and emergency product demand, young passengers are not very concerned and alert about subway safety. They are exposed to many sources of information about escape and self-rescue knowledge but have difficulty applying it when they actually use it. Elderly passengers are more alert throughout the ride and pay attention to avoiding dangers. They have accumulated more life coping experience than young people but receive less knowledge information. Both the elderly and young people have little knowledge of subway safety facilities and few opportunities for training in the use of emergency facilities. They have the highest demand for respiratory protection and distress alarms in the subway. Young people are more interested in the performance and reliability of emergency products. Older people emphasize the ability to solve all problems with the simplest operations, as well as seeking psychological comfort during emergencies.

After realizing the danger, the first physiological instinctive reaction of all users is more or less the same: the heart rate and breathing rate are accelerated, the hands and feet are sweaty and cold, or there will be shrieking and panic. People experience psychological reactions of nervousness, anxiety, fear, and anger. Decreased comprehension of images and increased sensitivity to odors and sounds in a fire. Will choose to follow the crowd when there is little valid information. Young users will be relatively aggressive in their behavior or appear to be courage inspired. Whereas older users are relatively slow and difficult to think, so they are dependent on others and behave in a way that is mostly avoidance and self-preservation.

3.2. Task Model of Subway Emergency Escape Users

Due to the special environment of the subway and the contingency of emergency events, it is difficult to conduct a real live experiment to observe the users. Therefore, through simulation experiments, the viewing environment in the actual emergency escape is simulated in order to gain insight into how subway users make behavioral choices in the subway environment, and to provide valuable first-hand information for the establishment of the user model.

The experimental process is mainly divided into the following steps:
Step 1, before entering the subway, the test subjects were prepared in a simulation. Some data show that when the light reduction factor is greater than 0.5/m in an irritating smoke environment, the pedestrian's speed is reduced to 0.3 m/s, which is equivalent to walking blindfolded. To try to resemble a real initial fire scenario, subjects were made to wear sunglasses with low light transmission to simulate visual conditions. They were made to wear masks to increase breathing resistance to simulate a smoke environment with breathing difficulties. At the same time, the simulated noises, distress calls, alarms and footsteps during the escape were played on a loop in the headphones to increase the realism of the environment and create a tense atmosphere.

Step 2, after riding the subway, the subjects were asked not to use any elevator carriers such as straight elevators or escalators during the participation period. Before arriving at the Haidian Huangzhuang Station, the subjects were told that there was a fire and that they needed to go to the Haidian Huangzhuang Station for a quick escape, and that they could not complete the task until they returned to the wide outdoor ground. Observers were required to pay attention to the subjects' reactions and states throughout the whole process, especially observing the subjects' behavioral actions at each turning node (carriage, platform, passageway, staircase, ticket hall, gate, exit, and other connecting points), as well as speculating on the motivation of the subjects' decision-making. At the same time the observer used a stopwatch to record the length of time spent at each node.

Step 3, after the task is completed, the observer and the subject return to the starting point of the escape together, recalling the process that has just taken place. They deeply communicated with the subjects about the mental process and the basis of behavioral choices at that time, and recorded the interviews.

Step 4, the results of the experiment were structured, from which a task model of the escapee was constructed.

![Figure 2. Schematic diagram of the psychological change of passengers' panic](image)

As shown in Figure 2, when the realization of danger occurs, the first reaction is an instinctive stress reaction, the unknown state brings great pressure, at this time the lowest sense of security, the most disordered. After the subway stops to the platform, the panic
of the passengers is relatively relieved, and they gradually open the rational thinking mode to find the evacuation path. In the process of evacuation, encountering bottlenecks such as staircases and aisles with narrow space and large crowds, people's psychological panic increases and their sense of security decreases. When seeing the green emergency exit sign or relevant evacuation help information, passengers' psychological panic recovered and became more rational. When passengers see the outdoor light, panic instantly decrease and gradually regain calm.

When passengers just realized that the fire occurred, the first reaction was to quickly escape, and the escape posture was mostly upright running. As the panic, panic stress response recedes, the spread of the fire leads to the spread of smoke, the escape posture will gradually choose to bend forward, in order to reduce the inhalation of harmful gases. Due to the large number of people, out of the instinct to protect themselves, passengers will gradually choose to escape along the walls, staircase handrails, railings and other solid dependence on the position, to avoid being rammed by the crowd. Due to the blockage of vision caused by smoke in the event of fire, passengers have an obvious orientation to light when choosing escape routes, and green escape signs and the light of subway station entrances and exits are important bases for judgment. At the turning points of different spaces (e.g. staircases between platforms and station halls, and selective exits in station halls), which are the places where the most confusion occurs, it is easy to get stranded.

As shown in Figure 3, based on the subway escape simulation experiment and the analysis of related cases, the task model of subway users during fire escape is derived. There are multiple reasons that affect the behavior of subway users during fire evacuation. The first cause of the task is the odor and temperature triggered by the subway alarm announcement or the point of ignition. As the fire develops differently, the user's behavior shows different results, e.g., when the smoke reaches a certain level, the breathing and vision of the passengers are severely obstructed, making escape difficult. The mental Model of the subway users themselves is the most important factor that affects the judgment of passengers, including the commuting mindset, habits, vigilance, body functions, intellectual skills, metro space familiarity and so on. As users with different thinking models cluster in the same space in the subway, their behaviors show disordered characteristics, and individually they are characterized by behaviors such as fleeing, bending over, leaning against the wall, and turning toward the light. The limitations of individual users' information mastery led to mutual influence, and it is easy to appear herd behavior, and group behavior has a great effect on individual users.
4. Conclusion

This paper explains in detail the theoretical concept of irrational user Model and the content framework included in irrational user Model. Most of the user research is based on the user's cognitive thinking and action logic is normal, while in relatively extreme environmental conditions, when human behavioral thinking is no longer constrained by the rules, the user model and design research is less involved. The irrationality model provides a path for research, especially for user studies on the design of emergency safety and security products in disasters.

The purpose of irrational user Model is to better understand users in product development and apply it to actual design practice. Through the existing qualitative and quantitative user research methods, exploring the construction of user models for metro users in emergency situations is the focus of this paper. This paper practices and verifies the operability and guidance of the irrationality model. The design orientation and design principles proposed on top of this research can only form a targeted solution for subway escape product design.

References