Research on Design of the Portable Toilet Based on Human-machine Scenario

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Abstract: In recent years, traditional public toilets can no longer meet demands at a time of sudden population growth. And functions and design details of the portable toilet cannot meet the needs of users, which made users unwell. This study explored the behaviour of users in the portable toilets and summarized user needs. In order to more potential users' necessities, this paper combines the user's behaviour level with 5w1h based on the ergonomics scenario to obtain the needs of portable toilet users. By the construction of portable public toilet usage scenarios to users' emotions in different scenarios. There are descriptive statistics, gender difference analysis and 5w1h analytical method to infer user requirements.

1. Introduction

This scenario construction is based on existing data and customers' surveys, which conclude environments, steps, products, information, time and other elements. In this paper, it's primary in the behaviour level of the emotional design and building a scenario. Combine instinctive level, reflective level, descriptive analysis, and differential analysis to obtain user requirements to guide product design innovation of portable toilets.

2. Build action scenario

Scenario building, as an ergonomics method in product design, has its roots in the more traditional techniques of user prowling, task analysis and systems ergonomics. Its value is to provide easily shared evidence of human factors issues for design teams. The process begins by identifying the range of users, goals, tasks and activities which need to be considered [1]. Norman's emotional design divides human brain activity into three levels: visceral level, behaviour level and reflective level. The instinct level refers to the innate part, which is dominated by the human body's perception system, and obtains the first information in contact with the outside world and makes a quick judgment, behaviour level refers to the part that controls the daily behaviour of the body. It is the place where the most human actions are. Its activities can be enhanced or suppressed by the level of reflection. In turn, it can increase or inhibit the instinct level.

The process of using the product by the user is biological: the users' instinctive level is equivalent to the user being stimulated by the product. The user's visual, auditory, olfactory and tactile sensation is stimulated. The information is transmitted to the brain through the spinal cord. The processing process is the reflection level of the user. The three levels interact and eventually react with the behaviour level. Therefore, this paper to conduct hierarchical portable toilets constructed on the basis of usage scenarios. There are five steps in a portable toilet scenario building which is shown in Figure 1. The second grading of the five steps is shown in Table 1.

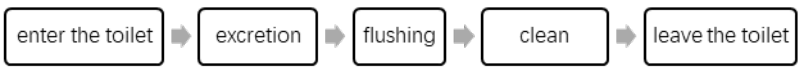

Figure1 Five steps in the portable toilet

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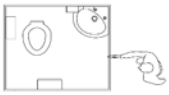
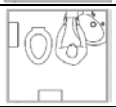
Table1 The behaviour level of portable toilets users

Level1	Level2
enter the toilet	Enter the toilet
	Place items
excretion	Excretion
	Throw away garbage
	Wear cloths
flushing	Flushing
clean	The first cleaning
	Get hand sanitizer
	Deep cleaning
	Dry hands
leave the toilet	Leave the toile

Table 2 Scenario building

Person	Surrounding	Key		Behavioural level	Visceral level
Portable toilet user Mark	Park	B01		Enter the toilet	See the shape of the portable toilet
					See the entrance
					See the open button
					Touch to the entrance material
					Touch the open button
		B02		Place items	See the interior layout
		B03		Excretion	Hear the sound outside
		B04		Throw away garbage	See the interior layout
					Hear the sound outside
		B05		Wear cloths	
		B06		Foot rubbing	See the flush button
					See the interior layout
					Hear the sound of water
					Stepping on the toilet key
		B07		Hand pressing toilet	See the flush button
					See the interior layout
					Hear the sound of water
					Touch the flush button
		B08		The first cleaning	See the shape of water-tap
					See the water-tap button
					Hear the sound of water
					Touch the water-tap button
		B09		Get hand sanitizer	See the button of hand sanitizer
					Touch the button of hand sanitizer
		B10		Deep cleaning	See the water-tap button
					Touch the water-tap button
		B11		Dry hands	See the Hand dryer
					Touch the Hand dryer
					See the interior layout
		B12		Leave the toile	See the open button
					Touch the open button
					See the entrance
		B13		Moving in portable toilet	Interior layout
		B14		Overall environment	Interior layout
					Taste
		B15		Exterior design	See the shape of the portable toilet

Visceral level of portable toilet includes visual, hearing, smelling and touching, these four senses are the first way to obtain information about the environment. Users know the product appearance of the portable toilets first and have an impact on the user's behaviour. This behaviour level for combined action with instinct, a user behaviour scenario of scenario analysis.

3. Reflective level

The reflection level is the highest level of human cognition and the part of the users' thinking. The emotional of the user cannot be learned by observation, so this paper uses the five-point scale method to design questionnaires to obtain the emotion. A total of 110 questionnaires were distributed, 110 were recovered and 103 were valid questionnaires, of which 41 were men and 62 were women. And dates analyzed in SPSS.

3.1. Descriptive statistics

The mean data represents the users' emotion in different scenarios. This study considers the dates more than three are urgently needed to change, and less than 3 are discomfort.

According to the Rounding rule and the mean value of questionnaires, emotional scenes were graded, as shown in table 3.

Table3 The level of scenarios

Scenarios	Level	User emotion
B02, B03, B07	Level 1	negative
B01,B04,B05,B13,B14,B15	Level 2	a little bit negative
B06,B08,B09,B10,B11,B12	Level 3	positive

3.2. Gender difference analysis

There is an interesting thing in the recycled questionnaire, some choice between men and women are different. In order to verify this difference, we conducted a gender test for genders to verify whether there is a difference between men and women, and whether this difference is reclassified in the analysis for discussion.

From the mean, there are some scenarios that feel different between women and men.

To verify whether gender discussion was needed, this paper independent sample testing was performed on both groups. (1) In scenario B01, $p<0.05$, $sig>0.05$, indicating that the difference is not significant; (2) In other scenarios, $p>0.05$, indicating that the difference is not significant;(3) There is an absolute difference between male and female users. The difference is not substantial. If the number of samples continues to expand, the disputes between male and female users will become smaller and smaller. Subsequent work does not need to be grouped.

4. User needs for portable public toilets

The main analysis scenarios in this paper are B01, B02, B03, B07, B13, B14, B15, B06 and B07 are two control scenarios. This survey shows that foot flushing is more popular than pressing flushing. Based on the behaviour level usage scenario, combined with the 5w1h method (also called the six-he analysis method, it is a method of thinking and a method of creation) and previous research, the reason for the user's negative emotions is inferred for the subsequent design research.

In this paper, 5w1h is adopted to predict the causes of users' negative emotions based on previous research problems and behaviour scenarios, so as to lay a foundation for subsequent design.

4.1. Summary of research

Before conducting the questionnaire survey, we did research on public toilets and portable toilets in parks with substantial traffic in Haidian District, Beijing, and communicated with individual users to find problems. (1) The shape of the portable public toilet is single. (2) The indoor height is not level with the ground and the height of the step is not suitable. (3) Most operating products have no guiding signs. (4) The doors of some portable toilets are too heavy. (5) The internal

infrastructure of some toilets is not comprehensive; the air is not circulated. (6) The outside world urges the voice to cause uneasiness. (7) The majority does not have space for storage. (8) The single-type portable toilets are mainly squat pan without protected, and fewer toilets.

4.2. User Needs Inference

Taking B01 as an example, there are five steps in B01, finding portable toilet, finding entranced, opening the toilet, opening the door, entering the toilet.

Analyze the harmful causes of B01. Step1, looking for portable toilets, there are specific difficulties in the search process of public toilets, indicating signs are not clear enough. The shape of portable toilets is often like metal suitcases, user feedback product modelling It gives people a sense of desolateness, instability, and anxiety. Step2, looking for the entrance, from the structural point of view, the lower part of the portable toilet uses for assembling the water tank, waste storage and other functions. The height difference between the indoor ground and the horizontal plane is vast, and it is necessary to climb the ladder to enter the portable toilet, but the ladder is generally too high. Step3, turn on the portable public toilet. The user's judgment on an opening method is derived from personal experience. In the actual use of the portable toilet, it is also found to be inconsistent with the experience of use. Step4, pulling the entrance door is one of the possible reasons for the inconsistency with the users' behaviour. Compared with the traditional public toilet, the portable toilet without foundation, and the material selection and structure use often increase the weight, which often causes the portable toilet door to be overweight. Step5, enter the portable toilet, the target object is the user himself. And specific analysis of the B01 scenario shown in the following table.

Table 4 Scenario B01

When	Step1	Step2	Step3	Step4	Step5
What	Finding portable toilet	Finding entranced	Opening the toilet	Opening the door	Entering the toilet
How	Negative emotions	Negative emotions	Negative emotions	Negative emotions	Negative emotions
Who	portable toilets	portable toilets	Open button	Door	Users
Where	Outside the toilet	Outside the toilet	At the portable toilet entrance	At the portable toilet entrance	Inside the toilet
Why	1. No clear indication;2. Shape gives a sense of unease	Ladder too high	The way to open is uncertain	1. The way to open doors are not conform to behaviour; 2. Opening doors are not easy	

4.3. Requirement induction

As shown above, this study combined with the survey results and 5w1h, a summary table of user needs for portable toilets is obtained, as shown in Table 5.

Table 5 Requirement induction

Scenarios	Why	User's requirement
B01	Finding is not easy; no signage or indication is not clear	Toilets have a clear identity
	The shape gives people a sense of desolateness, instability and insecurity	Safe appearance
	Need to climb the ladder, but the ladder is too high	Reasonable ladder man-machine size
	Open the way instructions are not clear	Explicit instructions
	It's hard to open the door for structure	Easy to open the door
B02	The storage space is too small, even without storage space	Storage space is easy to use and available
B03	Long-term squatting causes physical discomfort	Increase protective measures
	Urged the outside world leads to psychological panic	Reduce tension

B04	Trash in the visual blind spot, inconvenient	Internal layout is easy to use
	No trash can	Improve internal facilities
B05	Sitting up and cause long-term brain hypoxia, legs and feet numbness	Increase protective facilities
B13	There is water around the pit and the sink.	Increase protective facilities
		Reduce stagnant water
B14	The overall environment gives users a sense of indifference	The design has a sense of security
B15	The shape gives people a sense of desolateness, instability and insecurity	The design has a sense of security

According to the above contents, summarize the design requirements that can guide the design are shown in table 6.

Table 6 Hierarchy of needs

Level1	Level2
Basic requirements	Improve internal facilities
	Reasonable internal layout
	Storage space is easy to use and available
	Easy to open the door
	Explicit instructions
	Reasonable man-machine size
	Toilets have a clear identity
Reflective requirements	The design has a sense of security
	Reduce stagnant water
	Increase protective facilities
	Reduce tension

5. Conclusion

This paper captures users' emotions in different scenarios and analyzes the shortage of design through building scenarios. The purpose of scenario building is to obtain the users' requirements quickly and easily by building usage scenarios and refining the steps. The purpose of emotional design is to obtain the users' discomfort in use and improving it by deepening the concept of "human-machine-environment" in design. The purpose of 5w1h is to obtain the design requirements for the follow-up work by demand inference.

Obviously, this study still has limitations, the research scope cannot involve other towns that different towns may have differences in users' requirements. Scenario building and 5w1h cannot replace the existing technology, but it is an applicable method of design. Scenario building combined behavior level, summarizes the main points of users' requirements are infrastructure needs and emotional needs. Designers can do further user research in portable toilet infrastructure and user psychology, discovering design opportunities, building prototypes, conducting usability testing, and optimizing iteratively, which would be more objective for revealing ergonomic problems.

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