INTERACTIVE DESIGN STRATEGY FOR SUSTAINABLE BEHAVIOR CHANGE BASED ON OPEN SOURCE HARDWARE

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ABSTRACT

In order to cultivate students' environmental awareness and sustainable design thinking, and try to guide users' sustainable behavior through design. First, typical environmentally friendly interaction design cases are collected and divided into corresponding intervals of behavioral influence based on the product influential types framework. Then, the multi-sensory experience map and user experience five levels are used to explore the relationship between behavior influential types and key interaction design elements. Through case analysis, the design strategies of different types of behavioral impact are summarized. Finally, based on open source hardware Arduino and sensors, intelligent interactive products are designed. The effectiveness of the design strategy is verified and optimized by curriculum design and exhibition. And the feasibility of carrying sustainable education training mode in intelligent interaction design is also verified.

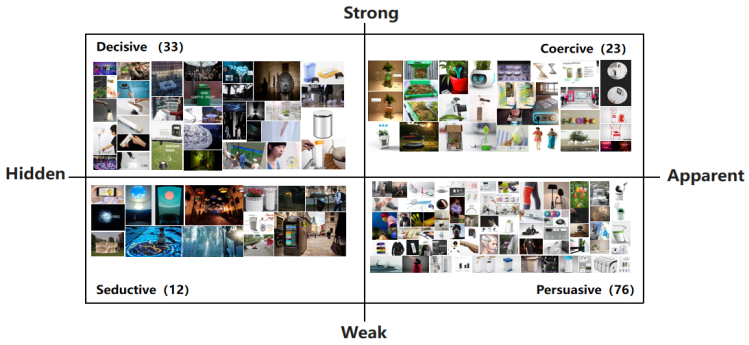
Key Words: Behavior Change, Interactive Strategy, Arduino, Environmental Protection

3.INTERACTION DESIGN STRATEGY EXTRACTION OF SUSTAINABLE BEHAVIOR CHANGE

3.1Case Collection and Classification

Firstly, typical environment-friendly interaction cases is collected. In the process of case collection, students discuss the relationship between environmental protection methods and interactive behaviors, design concept expression, human interaction, information input/output mode, etc, which guides students to understand the design concept of environmentally friendly interaction to promote sustainable development of the environment. For example, in the case of "Dancing Floor Generated Electricity", the power generation of floor generates electricity by the users jumping, and the built-in light are lighted. There is a direct causal relationship between interaction behavior and product environmental protection mode, which conforms to the characteristics of environment-friendly interaction design cases. 144 suitable cases are selected.

According to the Types of Influence framework with Nynke Tromp, 144 typical environment-friendly interaction design cases are divided into different types of influence based on user experience. Focus group and KJ method are adopted to classify cases, and the results are shown in figure 3. There were 23 coercive, 76 persuasive, 12 seductive and 33 decisive behavior influential cases.

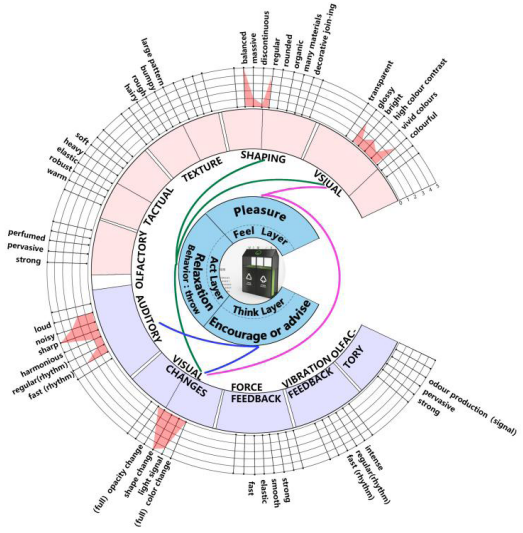


[Figure 3] The result of case classification

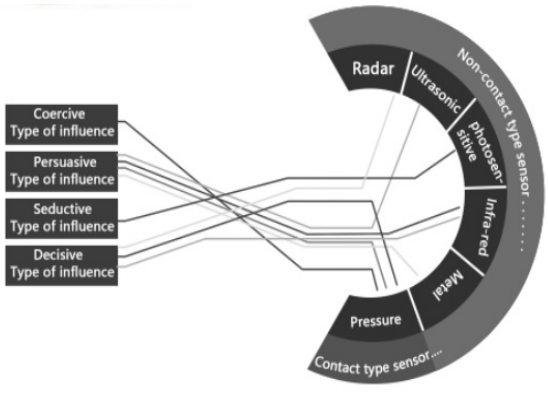
3.2.User Experience Factor Decomposition of the Case

Comprehensive consideration of the interactive experience of users and designers, combine the five user experiences with Bernd Schmitt and the Serena Camere multi-sensory Exp Map to subdivide the design elements of each behavioral type case. The relate layer representing the Statement of Product Vision is the innermost layer. Conceptual Exploration and Selection of Expression include thinking layer, act layer and feel layer, which is the middle layer. The outermost layer is Sensory Exploration and Sensory Analysis which is sense layer. Interaction experience characteristic decomposition of case is shown in Figure 4.

As the main technical support of interactive products, the sensor called "Electrical Five Sensors" has brought abundant interactive experience forms to users. The main technology of the theme case of "garbage collection" is extracted, and the corresponding relationship between the interactive products and sensors with different behavior types of influence is obtained as shown in Fig. 5, which is helpful for students to quickly understand and rationally use the technology.



[Figure 4] The interactive experience feature decomposition of case



[Figure 5] Relationship between various types of behavioral impact products and sensors

3.3Design Strategy Extraction

30 design cases with the theme of "garbage collection" are studied as samples, data statistics are conducted on the characteristics of interaction design elements of each product with behavior influence type and the proportion in each level of multi-sensory experience map, forming a general design strategy, as shown in table 1. According to the actual needs, such characteristics can play a guiding role in the design of environmentally friendly interactive products.

[Table 1] Key design characteristics and strategies for four types of behavioral impact

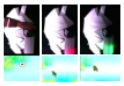
Type of influence	Main Characteristics		Reference Strategy
Coercive	Relate Layer	cultivate the behavior habit of garbage recycling	The product mainly uses the pressure sensor to interact with the user's delivery behavior, and requires the user to get some reward or avoid punishment by delivering garbage through the change of interface information, so that the user feel excitement.
	Think Layer	require users to deliver garbage	
	Sense Layer	visual interaction (change of interface information)	
	Feel Layer	excitement;	
	Act Layer:	delivery	
Persuasive	Relate Layer	cultivate the behavior habit of garbage recycling; persuade users to deliver garbage	Products usually make infrared, metal, ultrasonic sensors reduce the difficulty of user's delivery behavior, and through its visual changes, give users a relaxed feeling, persuade them to deliver garbage.
	Think Layer	reduce the difficulty of delivery behavior	
	Sense Layer	visual interaction (light, pattern, shape change)	
	Feel Layer:	relaxation	
	Act Layer	throw; touch; tread; press	
Seductive	Relate Layer	cultivate the behavior habit of garbage recycling; inform the bin sitting position	The products mainly use photosensitive sensors, through visual and olfactory changes and special appearance, attract users' attention. They are curious and told the location of the dustbin.
	Think Layer	attract the user's attention	
	Sense Layer	visual and olfactory interactions (light and odor changes)	
	Feel Layer	curiousness	
	Act Layer	delivery; Play	
Decisive	Relate Layer	cultivate the behavior habit of garbage recycling	The products use laser radar, pressure transmission, infrared and other sensors to monitor the specific behaviors of users such as "delivery; pressing; waving"and generate corresponding visual and auditory feedback, which brings a good experience to users and reach the purpose of encouraging users to adhere to the behavior or to persuade users not to litter.
	Think Layer	encourage users to deliver garbage;advise users not to litter	
	Sense Layer	visual and auditory interaction (position, color and sound changes)	
	Feel Layer	pleasure	
	Act Layer	delivery; pressing; waving	

4. DESIGN PRACTICE

4.1 Conceptual Design

In order to make the design work effectively promote the change of user behavior, the students are guided to use the design strategy of 3.3to carry out innovative design, investigate the user experience of the design work through the exhibition, and further improve the design strategy. The teacher and the students respectively carried out 4 rounds of design exchanges, completed the design of environmentally friendly interactive products.

Referring to the design strategy, students designed 10 environmentally friendly intelligent interactive products. The typical work "Frog Frell" (Fig.6) uses a decisive behavior influential strategy. It is a device design for recycling used batteries. When the user puts the battery for the first time, the light of the recycling box changed, and the electronic display showed that the user was rewarded with a small frog. As users put in more batteries, frogs grow up. Another typical design work, "Wall-E Robot" (Fig.6) uses seductive behavior influential strategy. It is a garbage collection robot. After the robot is powered on, the small arms on both sides are swinging up and down, attracting users to throw garbage.

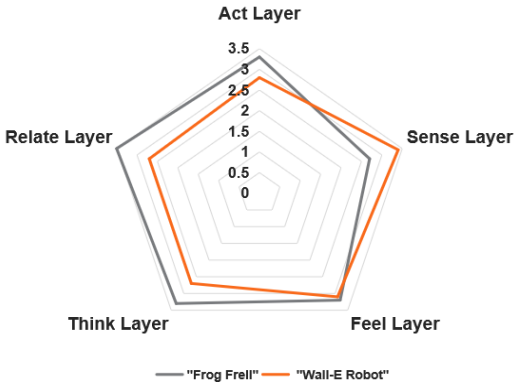
	Relate Layer	Think Layer	Feel Layer	Sense Layer	Act Layer
 "Frog Frell"	To cultivate battery recycling behavior habits	With rewards, encourage continuity	HappyExcitement	 With light signal, color change	Throw
 "Wall-E Robot"	To cultivate the behavior habit of garbage recycling	Attract attention, inform trash bin location	Curious	 Visual Interaction - Position Change (Arm Swing)	Throw

[Figure 6] Design work analysis

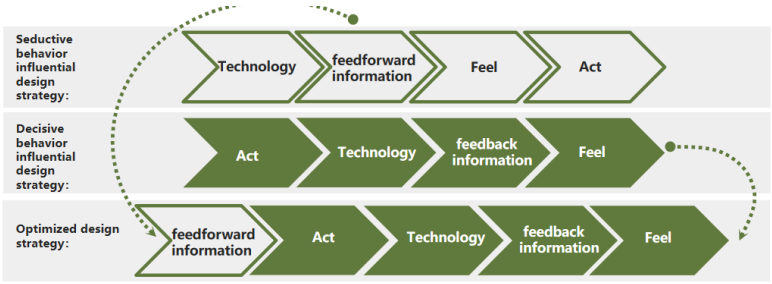
4.2Design Verification

In order to test the effectiveness of the products designed by the design strategy to guide the behavior change, the design works were displayed on-site, and the short-term persuasion effect of the interactive products was evaluated according to the experience of the audience using environmentally friendly interactive products. Taking “Frog Frell” and “Wall-E Robot” as examples, a total of 20 users (9 males and 11 females) were invited to rate the five experiences of a product from 5 to 1. Finally, the scores of 20 tested users are counted, and the average of the experience level scores from the design cases is obtained. The radar chart is shown in Fig. 7. The area covered by light grey is larger,the integrated user experience for the design work “Frog Frell” is better. The integrated user experience score of the design work “Wall-E Robot” is lower than that of the work “Frog Frell”, but the user experience score at the act layer is higher, the act experience is better.

Based on user interviews and evaluation of interactive devices, the research further compares the use of relevant elements from the seductive and decisive design strategy, and hopes to optimize the design strategy to create a better experience for the user. The sense characteristics of a product with good experience should be attractive in the first place. Then, the operation of the product needs to be intuitive and simple. At the same time, the sensor can monitor the interaction behavior in time. In the process of operation, through sense feedback to give users a pleasant act experience, so that users can emotionally resonate with the product, and finally encourage users to stick to use it.



[Figure 7] Design case scores for each level of experience



[Figure 8] Strategy optimization

Based on the summary of the above characteristics, this study further defines and analyses the design strategy in the time dimension. The information received before user interaction is defined as feedforward information. The information received by the user after completing the interactive action is defined as feedback information. By decomposing the seductive and decisive behavior influential design strategy factors into time dimensions, it is found that the two design strategies differ in the order of using process, and ultimately optimize the interaction behavior influential design strategy, as shown in Figure 8. Optimized design strategy is a relatively standardized and effective interactive product design process based on the change of sustainable behavior, which is modified according to the actual user experience.

In order to investigate the effectiveness of the teaching mode, after the end of the course, a follow-up interview was conducted with the students. 79.63% of the students have improved their environmental awareness. Most of the students expressed that the process of case collection and analysis can effectively guide them to think about environmental issues from personal behavior to social level, and understand the design concept of environmental friendly interaction to promote environmental sustainable development. The experience map is helpful to analyze the user experience of environment-friendly interactive products from the perspective of users and designers, and make the design ideas perfect and concrete.This proves that the feasibility of integrating sustainable education model into intelligent interactive design based on design process and the use of Aduino tools.

5.CONCLUSION

Under the theme of sustainable environmental protection, environment-friendly intelligent product design by using Arduino and other intelligent hardware technologies is an organic integration of behavior change theory and design expertise, which has high teaching significance. Through case analysis, the design strategies of different behavior influential types are summarized. Students refer to the design strategy to complete the prototype production of interactive devices. Through the exhibition, the effectiveness of the design strategy to guide the user’s environmental behavior is verified by comparison, avoiding the traditional theoretical concept design. At the same time, the design strategy is optimized, the feasibility of carrying out sustainable education training mode in intelligent interactive design is verified .

The experience of site design works has a transient effect on the behavior and consciousness of potential users. The formation of behavior habits is a long-term process of behavior change, Through the design work, we will continue to track and compare the changes of user awareness and behavior, and optimize the design strategy, which will be a further research direction in the future.

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