Research on Design of Environmental Monitoring Equipment Based on Product System Design Method

Min Song [1]
003240@jcu.edu.cn[1]

Jingchu University of Technology, Jingmen, Hubei, China[1]

Abstract. Firstly, this paper analyzes the concept of environmental monitoring equipment, then deeply analyzes the research on product system design method, and then expounds the design method of environmental monitoring equipment in product system design method. Including the detailed discussion and planning of the morphological factors in the design of environmental monitoring equipment, the improvement of equipment, machines and surrounding environment in the design of environmental monitoring equipment, and the material structure factors in the design of environmental monitoring equipment. Finally, it is pointed out that the product system design method is of great significance to the design and research of environmental monitoring equipment. Through the design and research of environmental monitoring equipment, this paper provides the theoretical and scientific basis for the design of environmental monitoring equipment, and improves the working efficiency of the machine.

Keywords: product system, design methods, environmental monitoring, equipment design, micro-exploration research

1 Introduction

In recent years, China's industrial structure has undergone great adjustments and changes, and with the continuous upgrading and development of China's industrial technology, social and environmental issues have become one of the more important issues in social development. Therefore, some environmental monitoring equipment will have a greater social demand, especially for some environmental monitoring equipment facing "high pollution, high material consumption and high energy consumption". In order to improve the design level of environmental monitoring equipment, Therefore, the design concept and design ideas of environmental monitoring equipment are discussed in detail. Through the application of product system design methods, the development and progress of environmental monitoring equipment design level are promoted.

2 Discussion and explanation of environmental monitoring equipment

With the continuous progress and development of China's industrial structure, the demand for environmental monitoring equipment in China is also increasing. So far, there are 4,800 professional monitoring stations in China, including 2,200 environmental protection systems, 2,600 industry monitoring stations and 103 air quality monitoring stations. The process of

MSIEID 2022, December 09-11, Chongqing, People's Republic of China

DOI 10.4108/eai.9-12-2022.2327600

receiving the demand instruction, then analyzing and processing the data information, then designing the monitoring plan, collecting, transmitting and storing the samples, finally analyzing and testing the stored sample data, and then obtaining a comprehensive evaluation is the working process of environmental monitoring, and its monitoring objects are generally pollution components, thought factors and natural factors, etc. Therefore, it is particularly important to choose sensors suitable for application. Industrial sensors cover almost all types of sensors, including proximity, position, speed, pressure, etc. Industrial process control design chemistry, pharmacy, energy, oil and natural gas, etc. At present, the industrial processing and manufacturing system has a high degree of automation, which can ensure the effective consumption of raw materials and energy, monitor and control pressure, temperature, flow rate, humidity, dust, etc., especially in environmental monitoring.

As shown in Figure 1, it is an environmental monitoring instrument. Environmental monitoring personnel may monitor some chemical components in the process of environmental monitoring, so they will inevitably come into contact with some chemical components. Through the design and research of environmental monitoring instruments, the working efficiency of the machine is improved, and the man-machine safety in the working process is also ensured. Environmental safety index is the sum total of various standards related to pollution control and environmental protection, and it is a mandatory regulation formulated by the government. The basic principles and methods of formulating environmental safety index are to protect people's health, social finance and promote a virtuous circle of ecology, and limit values or technical specifications should be set for the level of pollutants in the environment and their emission sources.

In recent years, China has paid more and more attention to the development prospect of environmental protection. Based on the above problems, China has made great progress and breakthrough in environmental monitoring technology, and a certain production chain and scale have been formed in the production of environmental monitoring instruments. Radioactive electromagnetic wave monitoring instruments, water pollution and air pollution monitoring instruments and noise and vibration monitoring instruments are the main components of environmental monitoring instruments. In addition, according to the survey, the design and development level of environmental monitoring instruments produced in China, such as sewage flow meter, smoke sampler and oil analyzer, can be compared with some international design levels, which is of great significance in the Chinese market. [1]

However, at present, there are still some small and medium-sized enterprises in the production of environmental monitoring equipment in China. These small and medium-sized enterprises generally have small production scale, low efficiency, and their technical level can't reach the average of domestic technical level. Moreover, their research and development capabilities are limited, and the designed environmental monitoring equipment generally has a short life and unstable performance. These small and medium-sized enterprises are far from meeting the needs of China's environmental monitoring development. In contrast, the development trend of China's monitoring equipment will be towards technology-intensive direction, automation and intelligence. Convenient environmental monitoring equipment and linear environmental monitoring equipment are two categories of environmental monitoring equipment in China at present. The main instruments cover pollution sources and environmental water quality monitoring instruments, such as flowmeter, pollution source online monitoring instrument and automatic sampler. And air waste gas monitor instruments, such as online monitor of flue gas

SO2 and NOx, and automatic acid rain sampler. Portable on-site emergency monitoring instruments, such as small toxic and harmful gas monitors and portable spectrophotometers.

Fig. 1. Environmental monitoring instrument

3 Research on product system design method

According to the results of system analysis, using the thoughts and methods of system science to design a new system process that can meet the required goals or objectives to the maximum extent is called product system design. Determining the design methods and policies and system functions is part of the system design. Performance, design concept and interaction design are the three major design schemes of product design. The design concept is to discuss and explain the designed system structure. By summarizing the design concept, the operator can easily understand the design concept of the product, which will also help the operator to skillfully operate the designed equipment or machine. Andreessen, from Technical University of Denmark, put forward "integration of product development". He believed that the three aspects of product sales, design and manufacturing should always be considered as a whole in the product system design method. [2] This requires that the manufacturing part, the design part and the sales part should work closely together, and the design department should have a broad understanding of product design. Only in this way can the research and development of product system design method be promoted. Optimization, integration and generality are several characteristics of product system. Social macro factors cover the product system (Figure 2 is the chart of social macro system factors). Each component of product system is determined by social macro factors, which drives the design and development trend of product system.

Color factors, environmental factors, structural and functional factors, and morphological factors are the enlarged components of product system design. Hue, brightness, and purity are all color factors. These factors can exert a certain influence on each other when combined,

thus causing a certain impact on people's physiology and psychology. Besides, hue, brightness, and purity are inseparable, and these three factors must be taken into account at the same time during use. Consider the after-sales work, production cycle and service life of the product and recycle the product, which is called environmental factors. Structural factors are the structural components of a product. The working ability of the designed product is called functional factor, and the initial intention and purpose of product design is to make the produced product have complete functionality. [3]

Based on the above, it is not difficult to find that product system design is of great significance in the design and research of environmental monitoring equipment. The unique feature of product design method is that it integrates valuable things in life into product design, combines modern network technology, promotes the development of social science and technology, and also promotes the research and development of environmental monitoring design.

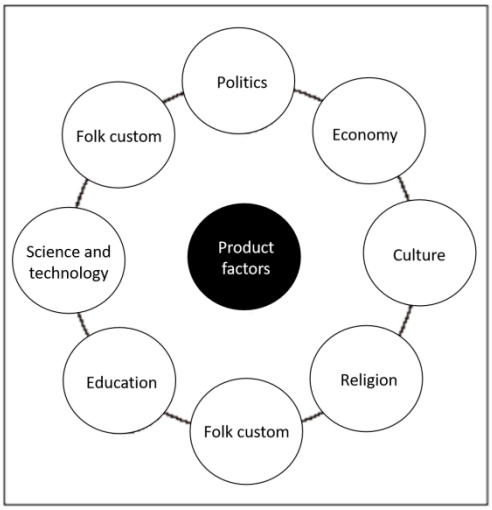

Fig. 2. Social macro-system factors (Source: Baidu Wenku)

4 Design ideas of environmental monitoring equipment in product system design method

4.1 Morphological factors in the design of environmental monitoring equipment

Based on the above, we can know the importance of positioning a brand in the design process of environmental monitoring equipment. Because environmental monitoring equipment is a kind of equipment with strong pertinence, the design process should mainly highlight the particularity of performance and take functional development as the main design research orientation. Therefore, when determining the orientation development direction, we should vent the positioning with relatively complete functionality and high technical content. Because different users may have some differences in their requirements for equipment functions, we also have some differences in the division of functions. Mental function and application

function are two major modules of equipment functions, and environmental monitoring equipment can fully investigate and study the application function and mental function. Therefore, when designing environmental monitoring equipment, we should focus on modular and intelligent design, so as to meet the different needs of users. [4]

The necessary elements that constitute the form are called the morphological elements,, which is any form phenomenon existing in the environment. As the name implies, morphological element is something that can be seen intuitively. By understanding the form, we can know or judge the internal structure and working performance of the equipment. The design and research of environmental monitoring equipment is mainly used to monitor and study the environmental index, so the environmental conditions may be relatively bad. Therefore, it is especially necessary to pay attention to the design of the appearance when designing environmental monitoring equipment, which should comply with the firmness and durability of industrial equipment. Form elements can be divided into different types in different environments, such as quantity and quality based on different ideas, and man-made and natural based on different actual situations. According to the survey, the style that is more in line with the characteristics of contemporary industrial development is tough wind. In the design process, tough wind equipment mainly pays attention to the reasonable design of lines and volumes. The design of lines shows a simple and rigorous appearance, and the rigor can be better reflected by using lines of different thicknesses for equipment with different volumes. [5] This tough wind style has been polished and innovated around technology, convenience and safety, giving people a fashion, technology, safety, reliability and tough style.

As shown in Figure 3, the overall design style of this environmental monitoring instrument is tough wind. From the figure, we can clearly see that the perfect conversion of lines has been completed through the opposite cutting, which makes the whole instrument and equipment present a rigorous and high-efficiency feature. The hard appearance conforms to the working characteristics of the equipment in the harsh industrial environment, so that its performance can be brought into full play.

Fig. 3. Schematic diagram of the tough geometry analyzer

4.2 Color factors and structural factors in the design of environmental monitoring equipment

Whether in the design of equipment or clothes or other items, if the colors can be flexibly used, it is usually easier to catch the eyes of users and attract their attention. Therefore, in the design of environmental monitoring equipment, the scientific and rational collocation of colors also

plays an important role. In the design of color equipment, it is not only to make the equipment have different colors to give people a visual impact, but more importantly, the overall appearance of the equipment can be divided into different modules through the use of color, so that the equipment can be divided into vertical and horizontal series, and the bold use of color can make users have a strong visual impact. Because environmental monitoring equipment is mainly put into use in industrial environment, it should choose stain-resistant colors in design, such as gray, black, silver and other stain-resistant colors. In addition, we can design warning lights or indicator lights with low color brightness on the instruments and equipment, so that workers can easily and conveniently find the equipment whether they work in the daytime or at night, thus greatly improving the working efficiency of workers and making them more comfortable in the working process. As shown in Figure 4, the overall color design of the equipment is mainly black, and adding green can make workers notice the equipment conveniently. The combination of black and green matches the working environment of the environmental monitoring equipment, and it can make workers find the equipment conveniently while resisting dirt, thus increasing workers' work efficiency. [6]

In addition to the above morphological elements and color elements, structural materials also play an important role in the design and research of environmental monitoring equipment. Structural materials are the direct materials that directly constitute the equipment. Therefore, when designing environmental monitoring equipment, the choice of materials can be some metal or the fusion of plastic and metal, which can have a strong contrast in texture and ensure the toughness and durability of the equipment. In addition, Based on the strategy of sustainable development of resources in China, the recyclability and utilizability of materials should be considered when designing environmental monitoring equipment, and ABS engineering plastic or sheet metal frame structure can be selected in the design of equipment shell, which can not only reduce the weight of equipment but also ensure the stability of equipment, and make use of the research and design of environmental monitoring equipment.

Fig. 4. Topology diagram of UPS intelligent cloud monitoring terminal

4.3 Human factors in the design of environmental monitoring equipment

Environmental factors and some human factors have certain influence on the design of on-site monitoring equipment. Different areas have different environments, so the monitoring equipment used is also quite different. Therefore, human-computer interaction design should

be reasonably applied in the design of environmental monitoring equipment, so as to create a complete environmental monitoring equipment. For example, in the design of winning monitoring equipment for optimization, it is developing in the direction of convenience and miniaturization of equipment. Such monitoring equipment works in a narrow space, which can facilitate the staff to hold it, avoid more unnecessary troubles in the running process, and make the whole monitoring process go smoothly. Generally speaking, environmental monitoring equipment can be divided into two categories, one is outdoor environmental monitoring equipment, which often works in an exposed environment during its working process. Therefore, the design of this kind of monitoring equipment should pay attention to its durability, stability and firmness, so as to ensure that the monitoring equipment can cope with the harsh outdoor environment. [7] The other kind is indoor environmental monitoring equipment, which is contrary to the working environment of outdoor monitoring equipment, and can generally be used in indoor observation rooms. For indoor monitoring equipment, we should pay attention to its convenience, compactness, low weight and other performance when designing. The design of convenient environmental monitoring equipment mainly focuses on convenient carrying and transportation and convenient on-site operation. Take the portable multi-parameter water quality tester as an example. Many on-site use environments require staff to put the instrument into the water for monitoring. Therefore, for this kind of monitoring instrument, the more portable it is in design, the smaller the volume, the better. The appearance design should pay attention to durability, dirt resistance and other performances, and it should be able to adapt to the complex and changeable on-site environment. As shown in Figure 5, this monitoring instrument uses engineering plastics, which greatly reduces the carrying weight of the instrument. The guided interface and control panel can help users to operate step by step. In addition, the instrument uses a cold light emitter, so it has strong anti-interference ability, high measurement data accuracy and high stability. Moreover, the life of the light source reaches tens of thousands of hours, so there is no need to worry about being affected by harsh environment. The most important thing is that the instrument can provide software support, can be connected to a computer to view and store monitoring data, and can print related measurement data and measurement curves. In the battery design, a large-capacity lithium battery is used, which can be digested at least twice, so it is more suitable for outdoor use. To sum up, this portable multi-parameter water quality monitor is more humanized in design, which realizes an accurate and rapid monitoring process. Besides, all the auxiliary tools that may be used during on-site monitoring can be found in the suit, which improves the working efficiency of the staff. [8]

Fig. 5. Portable multi-parameter water quality tester

5 The significance of product design method to the design and research of environmental monitoring equipment

With the rapid development of China's economy, people's living standards have improved significantly. It is in this fast-growing society that the material quality of life is constantly improving, and our environment is also facing great challenges. Dust is an important factor of air pollution, especially in large-scale urban construction sites, and the problems are more prominent: polluting enterprises, including construction sites, lack initiative awareness and need to monitor the atmospheric environment 24 hours a day; Insufficient manpower cost and professional knowledge and skills; No information circulation, no sharing, no discussion, many governance links, high synergy cost and repeated governance effects. Therefore, the establishment of an environmental monitoring system for construction sites and slag trucks can improve the efficiency and effectiveness of environmental protection management, which is of great practical and significant significance to effectively control dust pollution and improve air quality in large and medium-sized cities in China. In the report of the 19th National Congress of the Communist Party of China on October 18th, 2017, the challenges faced by China's ecological environment were clearly pointed out. [9] At the same time, China's impetus to the construction of ecological civilization has reached an unprecedented height. The research of environmental monitoring equipment in product system design method has improved the design level of environmental monitoring equipment, and at the same time, unified the brand image, making it stand out among many environmental monitoring equipment with unique advantages.

6 Conclusion

In recent years, the demand for environmental monitoring equipment is increasing in China. This paper mainly studies the application of product system design method in the design of environmental monitoring equipment, using scientific product system method as a guide.

Designers should consider many aspects when designing the equipment, such as color elements, structural and functional elements, and morphological elements. Only in this way can they better design the environmental monitoring equipment in line with the contemporary industrial environment, thus establishing a good brand image, promoting the research and development of environmental monitoring equipment, and guiding the future application of environmental monitoring equipment in enterprises and products.

Acknowledgements. Fund-The Second Batch of Scientific Research Teams of Jingchu University of Technology-Research on Traditional Creation Culture in Central Hubei (No. TD202005)

References

[1] Chi Fangyuan, Jiang Yong. Research on Design of Environmental Monitoring Equipment Based on Product System Design Method[J]. Industrial Design, (2):3 (2022).

[2] Geng Xiuyi. Design of laying hen breeding environment monitoring system based on Internet of Things technology[D]. Henan Normal University, (2016).

[3] Jing Qi. Research on Micro Photoelectric Detection System Applied to Environmental Monitoring[D]. Tianjin University, (2007).

[4] Yan Fahao, Zhu Chunjie, Chen Hu, et al. Design of Monitoring System for Operating Environment of Power Equipment Based on DCS[J]. Light Industry Science and Technology, (5):2 (2015).

[5] Gong Zhihong, Feng Liping, Li Maosong, et al. Design of Remote Digital Monitoring Software System for Corn Farming Situation[C]// The 28th Annual Meeting of China Meteorological Society.

[6] Jia Guoqiang. Design of Three-phase Electrical Parameter Monitoring System Based on GPRS Technology[D]. Chengdu University of Technology, (2016).

[7] Lv Ting. Design of Production Site Monitoring System Based on Esper in Pervasive Environment[D]. Dalian University of Technology, (2015).

[8] He Haixing. Application of Delta Electromechanical Products in Integrated Monitoring System of Underground Pipe Gallery[J]. Electric Power System Equipmen, (2018).

[9] Niu Chong. Design and Implementation of Embedded System of Spectrum Monitoring Equipment Based on S5PV210[D]. University of Electronic Science and Technology of China, (2016).