Research Status and Development of Color Design for Key Information of Industrial Products in Emergency Situations

Junyan Wei[1]

[1] School of Industrial Design, Hubei Institute of Fine Arts, Wuhan, Hubei 430205, China

ABSTRACT

In modern industrial design, color has become an important component of product aesthetics and a crucial element for conveying information. Color has strong visual effects and emotional expression abilities, which can trigger different psychological, behavioral, and other reactions. In industrial design, color design aims to enhance the visual impact and recognizability of products, while also conveying information and guiding user behavior. Especially when dealing with emergencies, appropriate colors can increase information transmission, reduce misreading and false alarms. Color design is widely used in emergency products, such as indicator lights, buttons, and display interfaces for industrial equipment. Different colors such as red are used for emergency stop buttons, yellow warning, and green normal. Through standardized design, the convenience and safety of operation in emergency situations are improved, simplifying users' understanding and operation process of complex industrial systems. In this article, the author will review the role and importance of color in emergency situations, summarize the main content of current research, including the impact of color on cognition and behavior, the significance of color in different cultures, and the visibility and readability of color. Next, the author will point out the shortcomings in existing research, such as insufficient standardization, inadequate user experience research, and technological limitations. Finally, the author will discuss future development directions, including color design standardization, interdisciplinary research, and the application of new technologies. Through in-depth exploration of these issues, it is hoped to provide valuable insights and suggestions for the field of emergency color design, promote its development and application, and better serve industrial safety and emergency management.

Keywords: Emergency situations, Industrial products, Key information, Color design.

1. INTRODUCTION: OVERVIEW OF CURRENT RESEARCH STATUS IN CHINA AND FOREIGN COUNTRIES

"Color perception has extremely important significance for us humans, as it is the core of visual aesthetics and profoundly affects our emotional state."[1] Meanwhile, color, as an important component of visual information, not only carries the physical properties of object surfaces, but also plays a crucial role in human psychological activities. The relationship between color and emotion is reflected not only in the direct impact of color on human emotional states, but also in the indirect role of color as a medium of emotional expression.

Symbolic colors have common meanings in the world, as well as meanings given by different traditional customs of various ethnic groups. [2] The traditional color concept of Chinese culture emphasizes the expression of inner life imagery and pursues beauty generated by artistic conception, which is fundamentally different from the objective logic pursued by Western colors.[3]

1.1 Current Status of Chinese Research

China has issued some national standards related to emergency signs, such as "Safety Color"

(GB 2893-2008), which specify the specific usage scenarios and meanings of color such as red, yellow, blue, and green. Many large industrial enterprises have adopted these standards in practical operations, such as in chemical plants, mines, manufacturing industries, and other places. When designing the color of mechanical equipment, in addition to considering the equipment itself, the environment in which the equipment is located should also be taken into account, including the processing object, mechanical equipment, and indoor environment.

Color is an important component of design and is used to convey information about the functionality of industrial products. [5] There are significant differences in the color of products used for different purposes, which are accumulated by people's experience in daily life. Generally speaking, mechanical equipment is large and relatively bulky. To avoid color dizziness caused by large blocks of color, mechanical equipment is mostly in light color such as gray to ensure stable and efficient operation. Therefore, in terms of color design, the main materials used are matte materials without luster, and bright and soft color such as light gray, gray green, yellow green gray, etc. If it is a large mechanical equipment, in order to reduce the psychological pressure and stress of the user, a relatively bright light gray should be chosen. However, the color of the main control switches, brakes, fire prevention, power distribution, first aid, start, stop, flammable, explosive and other signs should be prominent and comply with national standards. This method not only facilitates the operator to carry out the correct operation, but also is conducive to timely and accurate troubleshooting in emergencies, ensuring the safety of the enterprise.

However, the society generally lacks due emergency knowledge and risk prevention awareness, often only pays attention to the rescue and disposal links and ignores the pre-warning and prevention links, the academic community lacks sufficient understanding of the essential connotation, classification system and industrial characteristics of the emergency industry, the development theory of the emergency industry seriously lags behind the needs of local development practice, and the departments and local governments lack systematic investigation and research on the development status of the emergency industry, and it is difficult to fully grasp the dynamic data of the development of the emergency industry.[7]

1.2 Current Status of International Research

In terms of international standards and guidelines, commonly used color cards are generally classified according to different specifications and usage purposes , such as Pantone RAL color card, NCS color card, and so on. Each color card has its own unique color code and color code to adapt to different industries and needs. ISO standards: The International Organization for Standardization (ISO) has released relevant standards, such as ISO 3864 (Graphic Symbols - Safety Color and Safety Signs), providing a unified color application guide worldwide. OSHA standards: The US Occupational Safety and Health Administration (OSHA) also has detailed color usage guidelines, particularly for safety signs in industrial environments. At the same time, there are already many interdisciplinary studies in academia, and many foreign studies combine psychology and behavior to explore in depth the impact of color on human attention, memory, and decision-making speed in emergency situations.

2. RESEARCH PURPOSE AND SIGNIFICANCE

2.1 Research Purpose

Baumgarten believes that color research should encompass both the science of "chromatology" and the humanities of "aesthetics". The research is to utilize technology to develop practical functions of color beyond artistic aesthetics, connect sensory cognition through rationality, combine science and art, practical beauty and visual beauty, and open up new research ideas.[1] Baumgarten's well-developed sensory cognition has epistemological and psychological colors. [3] In visual perception, people are highly sensitive to color, and their visual functions are deeply influenced by color. Differences in regional culture and life experience can lead to cognitive biases.

In World War I, because most soldiers did not recognize words, they began to use colors instead of text to indicate information. Since then, research on the design of colors in the field of security has been pioneered. This project focuses on the research of color design methods for industrial products in emergency situations, aiming to improve the efficiency of information transmission in emergency situations, achieve rapid and accurate identification of important information of industrial

products in emergency situations, reduce personnel response time, and improve the visibility and readability of information, ensuring efficient transmission of information in complex environments. Secondly, by establishing unified standards and specifications for industrial product color design, it can promote the international community's response and cooperation to emergencies. Ultimately, by using colors reasonably, the safety performance of the product can be improved and the occurrence of emergencies can be reduced. By scientifically designing color, users can enhance their experience in emergency situations, reduce their cognitive load, and increase their trust and reliance on the product.

2.2 Research Significance

The perception of color is related to the physiological system, especially the activity of the visual and autonomic nervous systems. Different colors can elicit different emotional responses.

Marking key information or important content with specific colors can help individuals pay more attention and focus. Using different colors to represent different themes and categories can help improve the correlation between information. The color-coding system can help people more easily recognize and remember relevant information, thereby improving the efficiency of the entire information processing.

Research has found that color differences can be detected within an instant of 200 milliseconds, and may even be detected before individuals become aware of color changes (known as preconscious attention), so the role of color is significant. Kevin Mullet pointed out in "Designing Visual Interfaces" that "design focuses on discovering the most appropriate way of presenting certain information. Therefore, the reasonable use of color coding in design is of great significance. Clear hierarchy and rich and diverse color expression can transform originally complex and large datasets into carefully designed visual designs, enabling them to be efficiently processed by users. [8]

Delving into the role and effects of color in diverse psychological contexts, people are able to accurately capture users' behavioral characteristics and evolving needs in emergency situations.

3. OVERVIEW OF KEY INFORMATION

With the increasing demand of the government and the public for emergency services, more and more emergency products and services are being designed around the needs of public safety and people's livelihood in China. The provision of various emergency supplies, emergency facilities, emergency engineering, emergency equipment, emergency technology, emergency platforms, and emergency services. [9]

Sudden events generally have the characteristics of sudden occurrence, huge damage, and widespread impact. [11] In unexpected events or incidents, critical information of industrial products can help users quickly and accurately identify, understand, and take corresponding measures. They have high priority, are easy to identify, have timeliness and accuracy.

3.1 Classification of Key Information

In emergency situations, the definition and classification of key information for industrial products mainly focus on information that is crucial for safety, production continuity, environmental protection, and emergency response. Specifically, it can be divided into safety information, equipment information, production information, environmental information, emergency plans, and communication information.

The definition and classification of this information helps to respond quickly and effectively in emergency situations, minimizing damage to personnel, the environment, and property.

3.2 Principles of Information Design

When designing primary data for industrial products in emergency situations, it is necessary to comply with:

- Significance: In complex backgrounds, it is easy to identify the desired information by using high contrast colors and bright light sources. And the design should try to choose internationally recognized safety colors, such as red representing danger, green representing safety, and so on.

- Uniformity: The design should adopt unified symbols and icons to avoid information confusion caused by design differences , and be compliant with

national and international standards, such as ISO 3864-1 and ANSI Z535 series standards.

- Simplicity: The expression of information should be concise and clear, avoiding lengthy and cumbersome descriptions. Using concise text and images can ensure quick understanding and response. By utilizing various sensory techniques such as visual and auditory cues, such as alarms and flashing, effective control of the target can be achieved , ensuring effective communication of information in different situations.

- Being easy to operate: Information design must facilitate users' quick response to emergency situations , providing clear guidance and procedures for production to reduce the likelihood of production errors.

4. THE ROLE OF COLOR IN EMERGENCY SITUATIONS

The color of warning signs is generally a single color, and the commonly used colors in the world are red, yellow, blue, green, etc. It has been well used in safety signs on production sites, mainly for key positions of traffic signs, gas cylinders, and equipment facilities. In logo design, internationally unified colors and patterns should be adopted to enable people from different regions and countries to recognize and recognize them. The selection of object colors mainly includes three aspects: main color, color matching, and accent color. In terms of electronic instruments, if it is the main color tone, the panel is a matching color, and other components such as frames, logos, characters, character frame decorative strips, device bodies, fasteners, are all decorative colors. [12]

Vibrant and bright colors often attract attention and make information more prominent. Marking key information or important content with specific colors can help individuals pay more attention and focus. [13]

To make information communication easier and more accurate, color must be combined with social cognitive and physiological theories to make it more efficient. The process of user processing visual encoding mainly consists of three stages of pattern perception. The visual processing system quickly divides the field of view into different regions and forms, and feeds back to the brain for processing and editing of information. The color adjustment and optimization in the visual processing stage will help the audience to quickly understand and efficiently process information.[8] Color design is an important part of industrial product design, but color design is not an important part of industrial product design. However, color design is not designed arbitrarily, but has certain design rules. [16] The goal of humanized color design is to fully consider people's psychological needs and usage habits, and create a more comfortable and safer emergency environment. There is a must to consider people's psychological needs and usage habits. At the same time, it is necessary to pay attention to the differences in people's understanding and habits of colors. For example, for the elderly and people with color blindness, high contrast and easily recognizable color combinations should be chosen in color design. At the same time, it is also necessary to consider the cultural background and cognitive habits of the users to ensure accurate and effective communication.

In emergency situations, critical information about industrial products plays a crucial role. They not only help users respond quickly, but also effectively reduce casualties and property damage. Transmiting alerts through visual and auditory means can alert users to emergency situations. For example, the sound of a fire alarm and the flashing red light can quickly catch people's attention and prompt them to take safety measures. At the same time, it is necessary to guide correct emergency actions, indicate escape routes, provide instructions for the use of emergency equipment, such as the operation steps of fire extinguishers, so that users can use the equipment correctly and control or eliminate emergency situations.

By designing standardized key information through colors, symbols, and icons, users can avoid making incorrect judgments due to unclear or confusing information. The concise and clear information design enables users to quickly understand and make decisions in emergency situations, reducing cognitive burden and improving reaction speed.

In emergency situations, the main goal of color design is to quickly convey information through visual stimuli and reduce reaction time. The use of color is particularly crucial in emergency situations, as it not only attracts people's attention but also conveys specific information through the contrast and brightness of different colors.

In short, in emergency situations, by using reasonable signs (green escape signs, calm voice

prompts), users' emotions can be relieved. A unified and specialized design of critical information can enhance users' confidence in the enterprise, allowing the enterprise to make correct decisions based on this information in case of emergencies.

5. THE DEVELOPMENT TREND OF COLOR DESIGN FOR KEY INFORMATION OF INDUSTRIAL PRODUCTS IN EMERGENCY SITUATIONS

Although color design has been widely used in emergency products, there are still some issues, such as insufficient standardization. At present, China lacks relevant international standards in emergency color design, and there are different standards between different countries and industries, which has caused confusion in international cooperation and product exports. Secondly, there is insufficient research on user experience. Currently, most studies on color focus on its basic functions, lacking comprehensive and in-depth research on user experience. The impact of factors such as the user's psychological state and environmental factors on color perception during emergencies is worthy of in-depth research. For example, in highly stressful environments, users may have different reactions to color information, which requires us to pay special attention in design. Meanwhile, under extreme conditions such as strong light and smoke, the visibility of colors is limited. Therefore, how to achieve efficient transmission of color information is a challenging task. In terms of adaptability, different industrial products and usage scenarios have different needs, and should be tailored to local conditions. For example, in hazardous environments such as chemical factories and nuclear power plants, color design must give special attention to visibility and durability.

The research on color design of key information of industrial products in emergency situations has achieved certain results, but still faces many challenges. Through standardized design, user experience research, and the application of new technologies, the scientific and practical nature of color design can be further enhanced, providing more effective solutions for industrial safety and emergency management.

Future research directions should focus on improving the global adaptability and effectiveness of color design in various environments to ensure maximum impact in industrial safety and emergency response on a global scale. With the development of technology, color design is also moving towards intelligence. The core of intelligent color design lies in using sensors and intelligent algorithms to achieve adaptive color adjustment, thereby improving the efficiency and accuracy of color information transmission in emergency situations.

By installing sensors within the device or system, real-time monitoring of environmental parameters such as lighting, smoke, and temperature can be achieved. The system can automatically adjust the color of the display in different situations, ensuring good visibility and recognition ability in different environments.

On the basis of intelligent algorithms, a color display strategy based on sensor information was designed. This method not only increases the elasticity and adaptability of color design, but also greatly reduces the possibility of human error. For example, intelligent algorithms can automatically select appropriate color combinations based on the severity of emergencies, and transmit important information to users in the fastest and most intuitive way.

6. CONCLUSION

The development trend of key information color design for industrial products in emergency situations mainly focuses on three aspects: intelligence, humanization, and environmental protection and sustainability. By introducing sensor technology and intelligent algorithms, adaptive color adjustment can be achieved, which can improve the intelligence level of color design; By considering people's psychological needs and usage habits, a more comfortable and safer emergency environment can be created; By selecting environmentally friendly materials and processes, improving the recyclability and recyclability of color design can achieve sustainable development of color design. These trends not only help improve the efficiency and safety of emergency response, but also promote the overall progress and development of industrial design.

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