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Research on Interactive Display Design of Popular Science Public Space Based on Information Dissemination Theory

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ABSTRACT

This study aims to optimize the design of interactive displays for popular science content in public spaces by integrating information dissemination theory, focusing on public interaction patterns and content acceptance characteristics. Through case studies, the research first analyzes the evolution and usage challenges of public spaces, identifying user 'pain points' to propose innovative design strategies tailored to public behavior and psychology. These strategies were implemented in practical design projects, with post-deployment feedback collected via interviews to evaluate effectiveness. The results demonstrate that applying communication theory to interactive science displays not only addresses existing spatial design limitations but also enhances public engagement, emotional experience, and knowledge dissemination. The findings offer a validated approach to improving science education in public environments, underscoring their social responsibility in fostering scientific literacy.

At a time when science education and information dissemination are deeply intertwined, how to use effective design to make public space a powerful position for knowledge dissemination has become an important issue that needs to be explored urgently. The progress of science and technology has led to the growth of public demand for popularisation of science, and traditional static displays can hardly meet the modern demand. Based on the theory of information dissemination, the interactive display design of public space for popularisation of science and technology makes the information of popularisation of science and technology vivid, intuitive and interactive, and enhances the breadth and depth of dissemination. 28 December 2021, the Ministry of Industry and Information Technology and other eight departments pushed forward the "14th Five-Year Plan for Intelligent Manufacturing Development", which builds the blueprint of high-end intelligent manufacturing from multi-dimensional aspects, and promotes the prosperity of the high-tech industries such as human-computer interaction and so on. The high-tech industry is booming. The era of Internet of Everything opens up new possibilities for human-computer interaction, and cutting-edge innovations such as biometric identification, context-awareness, and full-sensory interaction stimulate the potential of global market demand, as evidenced by the growth of popular science interactive devices in recent years. However, there are problems with the current interactive devices for children's popularisation of science, and it is necessary to clarify the

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current situation and optimise the design in order to improve the user experience and play an educational role.

OVERVIEW OF INTERACTIVE DISPLAY DESIGN FOR SCIENCE-BASED PUBLIC SPACES

Under the wave of information technology, the application of interactive technology increases the vitality of public space and builds the foundation of hardware, while the rich development platform and digital application drive the change of software. The synergistic upgrading of hardware and software makes the interactive devices of popular science public space integrate multimedia elements, and the interactive experience is more fluent and natural, which makes the dissemination of public science knowledge in public places an effective way to enhance the public's scientific literacy. The fusion of interactivity of new media art leads to the diversification and innovation of visual language in display design, which is inevitable and has strong dissemination and feasibility [1]. With the leap of touch technology, interactive design and visual art, science popularisation interactive device is gradually becoming a powerful tool for science popularisation display in digital public space. Popularisation of science is a path of scientific education and enlightenment, which contains knowledge in many fields and aims to expand the knowledge boundary and shape the scientific view. As the language and forms of expression of digital display design become richer and richer, a variety of media connect the audience, the display work and the display space, allowing the audience to understand the work more deeply in limited time and space, mobilising multisensory experience and triggering emotional resonance [2]. Because science education is abstract and complex, science popularisation interactive devices use multimedia display and interactive means to make knowledge interesting and easy to accept. For example, the game "Double Carbon Road" and the related identification table of Yue Pai Technology integrate knowledge in entertainment, and increase the effectiveness of fun with the help of technology. Education itself is regarded as a process of information transfer [3]. However, there are challenges in the interactive devices in public space for popularisation of science, such as lack of relevance in content design, mismatch between the environment and the crowd, and single interaction. Therefore, it is necessary to focus on the harmony between the device and the environment, the interface and the interaction of personalised adaptation, and to reach the audience accurately to mention the experience. Its potential as a vehicle for popularisation of science remains to be perfected, and in the future it should be designed optimally based on research and analysis, deeply integrating content, environment and technology to promote the dissemination of knowledge and the enhancement of literacy.

CHARACTERISTICS OF INFORMATION DISSEMINATION IN PUBLIC SPACE

Information dissemination is fast and immediate. The intervention of interactive experience design has changed the traditional display form and presentation, and brought new changes to the design of display space [4]. In the age of information technology, especially the rapid development of Internet technology, makes the dissemination of information can reach almost real-time updates. Once a news or event occurs, the relevant information can be quickly spread around the world through the Internet, social media and other channels. And the dissemination of information is no longer subject to geographical and time constraints, no matter where you are, as long as there is an Internet connection, you can get the latest information in a timely manner. Information dissemination is characterised by a wide range. The Internet connects the world as a whole, and information can flow freely around the world. A piece of information can be spread to every corner of the world in a short time. The object of information dissemination is no longer limited to a specific group of people or region, but to the global Internet users and the public. And information dissemination in a variety of forms, and multimedia support for information dissemination is no longer limited to text form, but also includes pictures, audio, video and other forms of media. These multimedia forms make the information more vivid, intuitive, easy to be accepted and understood by the audience.

Information is characterised by high interactivity and two-way interaction. It breaks through the limitations of traditional display space design methods based on physical media, and applies the concept of interactive experience in the design of display space to disseminate information to the public in a diversified way, thus improving the public's sense of participation [5]. The new media platform can carry out personalised recommendations and customised services according to users' interests and needs, enabling users to obtain information that better meets their needs. Information dissemination also presents the characteristics of fragmentation, that is, information is presented to the audience in a short and concise form. At the same time, in order to meet the audience's demand for in-depth information, information dissemination also focuses on integration. By integrating relevant information resources, a complete information chain and knowledge system is formed to help audiences better understand and master knowledge.

Information needs to take into account the characteristics of public reception. Since the public has limited attention span and selects information according to their interests, needs and environment, digital visual media have changed the communication and media ecology, information attracts the public by novelty, interest or relevance, its presentation affects sensory reception, the public understands the information according to their a priori knowledge, etc., and the expression needs to match the cognitive level. The development of digital visual media has changed the traditional communication and media ecology [6]. For example, the

Figure 1 | "Yuanmingyuan" public interactive installation display effect

"Yuanmingyuan" public art interactive installation at the North Bund Art Museum breaks through the traditional narrative. While enjoying the ancient treasures, the interactive links to study the history and culture of the Qing Dynasty, understanding the charm of Chinese civilisation, creating a unique visiting experience. The surrounding 3D screen presents a 360-degree panoramic view of the Yuanmingyuan, like being in an outdoor garden. There are three interactive points on the ground map of the Yuanmingyuan, and you can step on any one of them to enjoy the classic landscape of water and wood and nine continents of tranquillity restored by 3D Chinese paintings, which is amazing. The public's memory is selective, only key information is retained, and is subject to repetition, relevance, emotional intensity and other elements. Long-term immersion in the same information can strengthen memory and generate a sense of identity, and then change beliefs and attitudes, so this installation allows the public to experience the beauty of the Yuanmingyuan, and the public can carry out two-way interactive communication, making a greater sense of identity and participation.

INTERACTIVE DISPLAY DESIGN STRATEGIES FOR SCIENCE-BASED PUBLIC SPACES

Donald Norman, as a well-known cognitive psychologist and designer, his concept of "user-centred design" and his idea of "user experience" have profoundly changed the design field and have wide influence. As public interactive devices are aimed at a diverse public, the interface and interaction design should have a popular perspective, and while maintaining the rigour of the scientific content, it should also facilitate the users' quick adaptation and enjoyment of using the device, so as to make the experience smooth. In the design, the visual and interactive logic should be centred on the accuracy of the communication content and the emotional resonance of the public. Designers need to analyse the public's cognition and acceptance habits, analyse the design in detail, make the information conveyed logical and moving, and enhance the emotional connection between the user and the device on the basis of accuracy, so as to promote the dissemination of knowledge and public participation.

Visual Design for Public Spaces

Streamlined and Understandable Layout

The layout of the interactive devices in the public space follows simplicity and guidance, taking advantage of simple forms to simplify complexity, avoiding complicated and obscure elements, leading the public to interact with clear expressions, and lowering the threshold by using visual means such as streamline design, colour matching, as well as instructional signs and explanatory texts to guide the public to interact with the devices in accordance with the predetermined paths. Focusing on the use of space and living, the location, size and shape of the installation are planned according to the actual situation of the site, so as not to disturb the other functions of the public space, the theme is close to life, and natural and living elements are used to increase the affinity. Emphasis on clarity of information and visual prominence, with a simple interface and tips on information and simple operating steps to help the public quickly grasp the use of the method, by virtue of the distinctive and unique shape, colour matching and reasonable layout to attract public attention, stimulate curiosity, highlight important information, and to provide the efficiency and accuracy of information transfer.

Visual Presentation of Information

The intuitive experience of information requires clear navigation and instant feedback, providing intuitive operation prompts when interacting, clarifying the current and next actions, helping users to follow the flow of operations and eliminating guesswork and trial-and-error. It also relies on effective data visualisation and clear path planning, with charts and graphs to display data so that key information can be captured quickly, and with the help of streamlines or signs to set up clear interactive paths to reduce user confusion. Common sense design principle is important to mention the intuition of information, close to the user's habitual cognition, avoiding professional and difficult to understand terminology and symbols, and increasing the user's sense of intimacy and familiarity in order to facilitate the acceptance and understanding of information. Accessibility design is the key to the universality of information intuition, taking into account the needs of special groups, such as the visually impaired, mobility-impaired people, the use of voice navigation, large fonts, excellent colour contrast, etc., to ensure that the information intuitive presentation of all users can be accessed, showing respect and care, and to promote the dissemination of information and communication.

Harmony and Unity of Style

Harmony of styles is the foundation of the charm of public interactive installation art, which comes from the consistency of design concepts and the harmony of colour matching. The design concept is the core of the spirit of the installation, so that each element is centred around the core, function, art, and value, so that the public can easily understand the intention and resonate

with it. Colour is the key to vision, and harmonious matching enhances the charm and sense of integration. The layout is planned according to the psychological principle of colour, echoing and avoiding suddenness, and is in line with the theme and the environment. Stylistic unity is also reflected in interactive synergy and natural integration. Interaction is the soul, according to the user mode and demand to set up a logical creative process, each link is smooth. The installation belongs to the urban ecology, respecting the natural elements and cleverly integrating them into the strategy. The unity of style also depends on the consistency of cultural expression and the unity of technical realisation. Culture as a pillar, digging local essence of the integration of traditional and modern, increasing the identity of the characteristics. The unity of technology ensures operation and experience, selects reliable solutions, ensures the compatibility of component standards, explores new applications, drives performance and quality improvement, and gives the public an excellent interactive experience.

Aesthetic Creative Uniqueness

Public interactive device aesthetic and creative uniqueness, the core lies in personalized interactive experience, breaking the traditional static viewing limitations, seeking dynamic communication and dialogue with the audience. According to the venue, audience, cultural background planning interactive details, appearance and even mechanism, are the pursuit of personalisation, to ensure that participants get exclusive user experience, the device as an emotional bridge, uniqueness is also tapping into the emotional resonance of the touch, the North Bund Museum of Art, opposite the interactive screen, the 9,999 different seal script "longevity" arranged in the whole body, the craftsmanship is extraordinary amazing. The craftsmanship is amazing. Passing through the round archway, the character "Shou" scrolls on the screen, and the audience can change the shape and direction of the characters through personalised interactive gestures, as the characters are gathered and dispersed like quicksand into the shape of a "banquet for a thousand old men". The design incorporates the public's emotions and values, giving the audience visual enjoyment and emotional resonance through interactive links, and stimulating concern for traditional culture. This is not a simple copy and paste, but the use of innovative thinking mode and methods, cultural symbols to reshape and interpretation, so that the traditional culture in a new form presented to the public, greatly enriching the cultural connotation, aesthetic creativity to add a more profound and diversified colours and connotations.

Interactive Device Design Based on Public Acceptance Characteristics

With the development of computational simulation technology, there has been a gradual increase in the stabilisation and immersive display of spatial scene animations in the field of life experience and in the field of visual arts [7]. The excellence of smart mobile devices lies in their powerful interaction capabilities, a feature that greatly facilitates close interaction between people and devices, thus optimising the overall user experience. Well-designed interactive interfaces not only keenly stimulate the human sensory experience, but also serve as catalysts for deepening and broadening intellectual and thinking activities, while becoming effective tools for popularising scientific knowledge. Donald Norman, a famous cognitive psychologist and designer, put forward design concepts such as "user-centred design" and "user experience", which have had a wide impact in the design industry [8].

Figure 2 | Effect of displaying Chinese character-themed public interactive installation at the North Bund Art Museum

Clearly Orientated Design

Orientation design clarity begins with the setting of references. In the early stages of planning for public interaction devices, references such as natural elements, prominent facilities, and established spatial architecture should be clearly identified and used as a baseline to ensure visual harmony between the device and its environment, and to provide intuitive orientation guidance for users. In order to seamlessly integrate public interaction devices into urban space, the orientation design should carefully consider the coordination of colour, material, light and shadow with the environment, select a main colour and mid-tone in the colour scheme, and try to choose similar colours, so as to enrich the perception of the interface without cluttering the interface, and to maintain the unity of the style [9], and the layout should conform to the spatial flow to achieve a natural integration, reduce the cognitive effort of the user, and enhance the overall sense of harmony. Orientation design relies on the creation of visual code, which is the key to identify, guide and illustrate the unique and easy to understand icons, symbols, colour schemes to build a clear information system, and to maintain consistency, so that users can quickly grasp to follow the guide. Style positioning is an important cornerstone of orientation design, which can enhance artistic expression and ensure a consistent user experience. When setting up the design, it is necessary to take into account the function of the installation, cultural significance and the aesthetic preferences of the target audience to ensure that the orientation design is in harmony and unity with the overall installation, and that it conveys a clear and unique message.

Immediate and Friendly Feedback

Instant and friendly feedback mechanism is the key to enhance the user experience, which needs to integrate visual, auditory and other elements, and intuitively and quickly respond to user operations. With the development and progress of science and technology, intelligent machine vision technology has become one of the most important directions in the field of human-computer interaction ([1) (0) (]). Visually, the effectiveness of the operation is confirmed with distinctive colour changes, flashing icons, animation effects, and instant visual feedback during operation. Audio feedback is also necessary, with beeps or specific sound effects to convey the operation. Interaction design should be extremely simple and clear to ensure that the feedback is intuitive, the operation process is simplified, avoiding complex settings, the operation interface with clear icons and necessary instructions to help users master the operation of the essentials, in case of incorrect operation or failure to present a concise error alerts and solution suggestions. Fault-tolerant design is an important part of experience enhancement, anticipate misoperation, reduce errors by setting default values and providing undo/reset functions, optimise internal processing logic and communication protocols, improve response speed, reduce waiting time and improve interaction efficiency.

Fluid Operating Experience

The interface design is based on minimalist aesthetics, holding the principle of "less is more", eliminating non-essential elements to create an intuitive and refreshing visual experience. The layout is carefully planned, with a clear hierarchical information structure, highlighting the core information to improve the efficiency of information retrieval, clear and recognisable icons, and concise text descriptions to lower the threshold of cognition. Hardware and interaction level, selected high-performance touch screen and processor, to ensure instant and accurate response to touch, in-depth optimisation of the touch feedback mechanism, reduce response delays and false touches, to give users a smooth operating experience. We provide detailed and intuitive introductory tutorials for new users, setting up clear guidelines for key operations, reducing confusion and fumbling time, keeping the interface and interaction coherent and unified, reducing the learning curve, and allowing users to navigate intuitively. The interactive device incorporates a thorough fault-tolerant design concept, with flexible countermeasures for common misoperations to ensure a continuous and stable user experience. Instant and precise feedback mechanism lets users know the operation result instantly, and gives clear error prompts to help users locate and solve problems, thus enhancing operation convenience and satisfaction.

Emotional Experience of the User

The emotional experience of the user is at the centre of the design concept. This installation aims to touch the heart of every visitor through a multi-sensory immersive experience that draws on the richness of traditional culture.

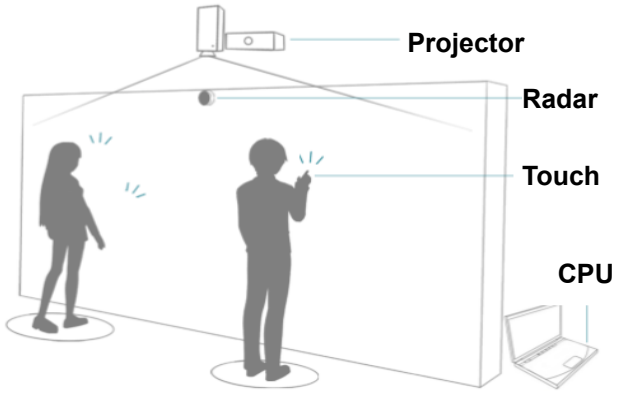

Figure 3 | Schematic diagram of the technical engineering plan for the Chinese character-themed public interactive installation at the North Bund Art Museum

From the visual dimension, the installation presents delicate and exquisite brushstroke art illustrations, each brushstroke is full of the artist's deep emotions and exquisite skills, making the viewer feel as if they were in the temple of art, so that they can feel the charm of artistic creation up close and personal. At the auditory level, the unique music melody flows slowly, like wrapping the user in the warm embrace of traditional atmosphere, and every note beat can trigger the deepest resonance of the soul, as if in dialogue with history.

In terms of haptics, the installation is bold and innovative, cleverly integrating projection and touch-sensitive radar technology. When the user gently touches the surface of the device, the related cultural animation will be slowly presented in a dynamic form. This unique feedback mechanism is not only an innovative interpretation of traditional culture, but also a vivid interpretation of the new quality productivity in the field of science popularisation. Every touch interaction is not just a simple physical contact, but a deep emotional exchange, and also an effective transfer of knowledge.

With the rapid development and continuous innovation of emerging technologies, their application in the field of teaching is becoming more and more widespread, and they have become an important reference basis for educational change. In this device, the screen displays a wealth of knowledge information in real time, allowing users to enjoy an immersive and pleasurable experience at the same time, but also to harvest valuable scientific knowledge, in a subtle way to enhance the public's awareness of heritage heritage. Digital art design education has also become an emerging research hotspot in the field of education, which fundamentally changes the external form and internal connotation of display design.

This innovative display method is suitable for public spaces with high pedestrian flow, such as nature museums, underground stations, oceanariums, shopping malls and so on. In the context of public art, the traditional "look but don't touch" display paradigm is gradually changing to a new model involving interactive display and creation by visitors. It is a unique form of educational and entertaining, warm and touching, which

pushes the public display to a whole new level, and successfully builds up an important bridge connecting human and nature, knowledge and emotion, so that the public can not only feel the charm of culture, but also draw the nourishment of knowledge in a relaxing and pleasant atmosphere.

CONCLUSION

Advances in information technology and the penetration of interactive technology have led to the wider application of science popularisation interactive devices in the public domain, and they have become a powerful assistant for digital science popularisation. However, there are problems such as unclear design semantics and complicated interactive processes, which are detrimental to user experience and knowledge dissemination. Therefore, it is urgent to optimise the design according to the theory of information development, the logic of public thinking and the characteristics of information dissemination. Interface visual design should follow the principles of streamlined layout, intuitive information, unified style, and individual aesthetics to enhance aesthetics, attract attention, and help understanding. Interaction design should be combined with public acceptance habits and memory mechanisms to ensure clear operational guidance, excellent fault tolerance, timely and friendly feedback, and a natural and smooth process, so as to facilitate the smooth dissemination of knowledge and promote the achievement of the goal of popularisation of science. Science popularisation interactive devices also need to pay attention to the public's personalised and diversified knowledge needs, and enhance the user experience by providing customised information through audio-visual feedback. As a result of the integration of information technology and science education, the design should take user needs as the core, and pay close attention to the public's psychology and memory patterns, in order to give full play to the function of science education and provide the public with a quality experience of popularisation of science.

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