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The Paradigm Shift and Technological Applications of Visual Design Interactivity from the Perspective of Digital Media

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Abstract: In the information age, research on digital visual design interactivity is evolving from traditional single-channel visual communication to the integration of multi-sensory technologies. This paper investigates various forms of interactive communication and analyzes influencing factors such as user demand and participation. Through the application of multi-channel sensory stimulation, dynamic elements, and case studies, it illustrates how digital technology facilitates the transition of visual design from static to dynamic interaction. The study reveals that digital technology redefines interactivity in information communication by merging multi-sensory experiences with technological advancements, thereby providing both theoretical insights and practical references for innovation in visual design.

Keywords: Digital visual design; interactivity; digital technology; multi-sensory experience; interactive communication; virtual reality (VR)

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1. Analysis of the Communicative Forms of Interactivity in Visual Design

The interactivity of visual design has evolved from materialization to immaterialization in response to changing social demands. Driven by advanced technologies such as Internet technology, engineering innovations, mechanical advancements, virtual reality, and 3D technology, visual design—defined as an information exchange behavior that targets individuals as the communication object—employs vision as the communication channel and visual media as its medium. As a result, the scope of development within this field has expanded significantly (**Figure 1-1**).

Historically, most visual designers conveyed their creative ideas through traditional paper media. However, influenced by scientific and technological progress, contemporary visual designers predominantly express their creativity through electronic information technologies and mobile Internet interfaces. This transition signifies an immaterial form of creation and dissemination that provides designers with enhanced platforms for creativity and fosters greater enthusiasm for innovation while simultaneously bridging the gap between audiences and design works through mechanical means.

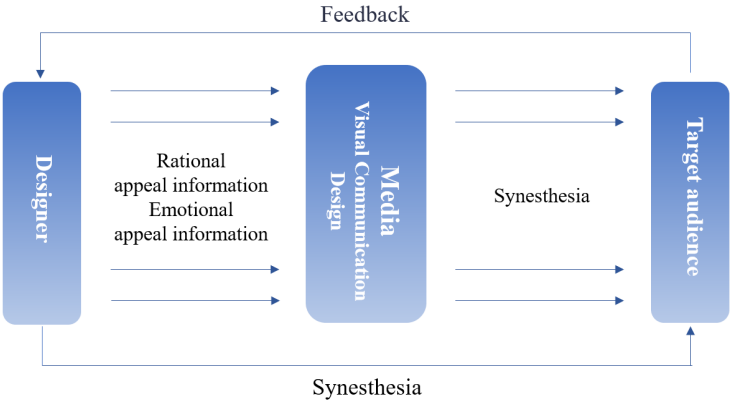

Figure 1-1. Visual Design Communication Forms (Source: Created by the author)

The interactive communication aspect of visual design is fundamentally reliant on the support provided by interactive media. Interactive media arises from the integration of various advanced technologies, including electronic technology, multimedia technology, digital technology, virtual reality technology, 3D technology, sensor technology, actuators, and control systems. The interactivity inherent in visual design underscores the experiential interaction between individuals and design works as well as the relationships among people, objects, and their environment.

The connection between individuals and works is characterized by a dynamic interplay of action and reaction alongside information output and reception. Visual design encompasses both tangible objects and intangible information. The interaction between human behavior and information serves as a crucial link that connects people with objects and their external surroundings. In his book "The Design of Everyday Things," Norman categorizes human behavior into seven distinct stages (**Figure 1-2**), which include one goal along with three execution steps followed by an evaluation step. The execution steps consist of intention to act, course of action, and action execution; whereas the evaluation step involves perceiving the state of the external world, experiencing perceptual effects, followed by evaluation and interpretation. Together with the initial goal, these seven stages establish a fundamental framework for understanding human actions while guiding interactions within the domain of visual design interactivity[1].

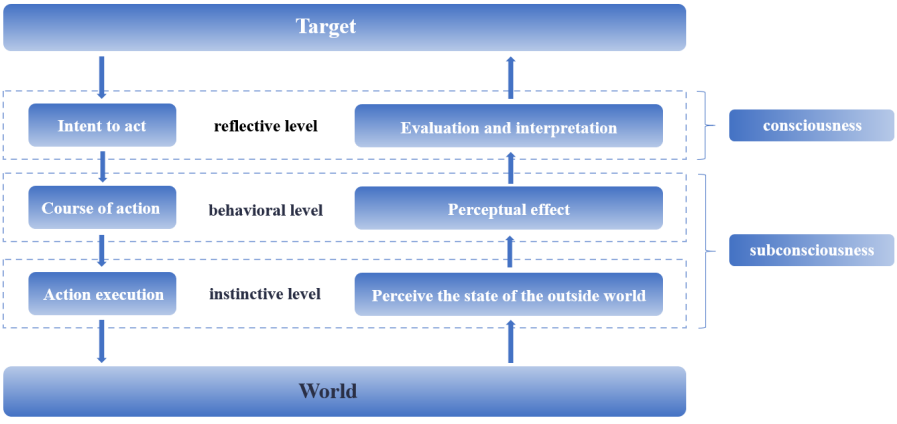

Figure 1-2. Seven Stages of Human Behavior (Source: Author's own illustration)

The information processing theory in cognitive psychology posits a corresponding relationship between the internal and external worlds. It conceptualizes the human brain as an information processing system akin to a computer, wherein the internal environment represents and interprets the external environment through symbols, symbol structures, and symbol operations[2]. These symbols serve as carriers of information, encapsulating data from the external environment that is stored within the human mind. Continuous exchange of information occurs between the internal and external

environments, elucidating the fundamental nature of this interaction between humans and their surroundings (**Figure 1-3**).

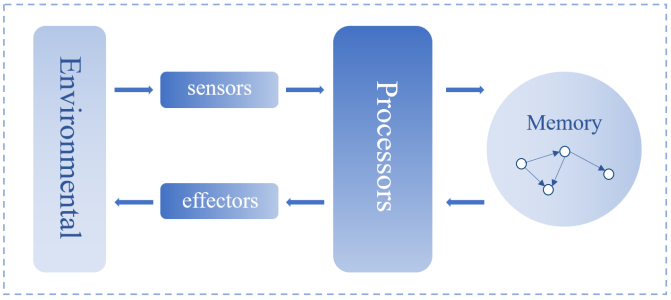

Figure 1-3. General Structure of an Information Processing System (Source: Author's own illustration)

Everyone can be conceptualized as an open internal system, comprising a complex interplay of knowledge, memory, and consciousness. In everyday life, the external system consists of a myriad of elements including individuals, objects, events, languages, activities, and more within the world. The "internal world" within the human body and the "external world" in the environment are in a continuous process of exchange—reorganizing and mixing information. At every moment, individuals engage in choices, decisions, and actions.

Through analysis, it becomes evident that behavior and information serve as the connections linking people to one another as well as to their external environments. The internal world of an individual can influence the external world through behavioral expressions; conversely, information from the external environment can penetrate into an individual's internal realm (see **Figure 1-4**). Consequently, individuals forge unique relationships with both their surroundings and other people through mechanisms of "information exchange" and "behavioral interaction[3]."

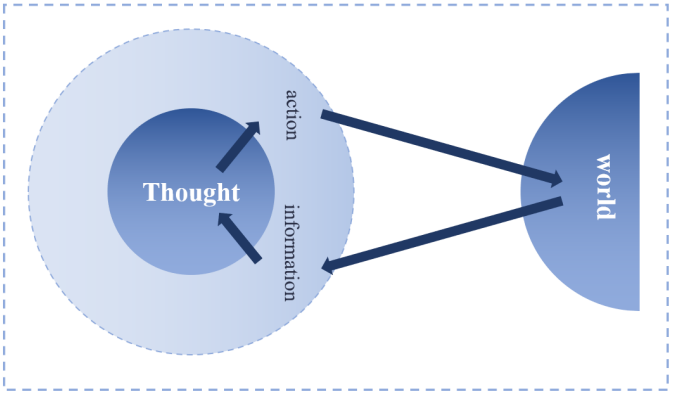

Figure 1-4. Behavior and information serve as the connections between humans and the external world. (Source: Author's own illustration)

In the field of visual design interactivity research, a human-centered approach is essential, as it actively involves the audience in the design process. Designers develop interactive content grounded in human behavior and psychology to engage the audience as co-creators. This interaction constitutes a reciprocal exchange that shapes the final design outcome. Designers must investigate various factors influencing interactivity, uncover users' latent psychological and behavioral needs, and explore multiple sensory channels—including vision, hearing, touch, smell, and taste. Such an approach facilitates audience immersion, promotes active exploration, and effectively communicates visual information.

2. The Mechanism of Influence and Theoretical Framework of Interactivity in Visual Design

2.1. Necessity

Karl Heinrich Marx, in his theoretical framework, emphasized that the formation and evolution of human needs are

fundamentally rooted in practical activities and the processes involved in transforming the natural world. These needs exist in a dialectical unity with the advancement of social civilization. Marx categorized human needs into three distinct levels: the first level encompasses survival or physiological needs; the second level includes livelihood and possession needs; while the third level pertains to self-actualization or comprehensive development needs.

B.J. Fogg's Behavior Model (FBM) elucidates the mechanisms underlying human behavior. This model comprises three core components: motivation, ability, and prompts[4]. It posits that for any behavior to be triggered, all three elements must be simultaneously satisfied, establishing a product relationship among them (**Figure 2-1**).

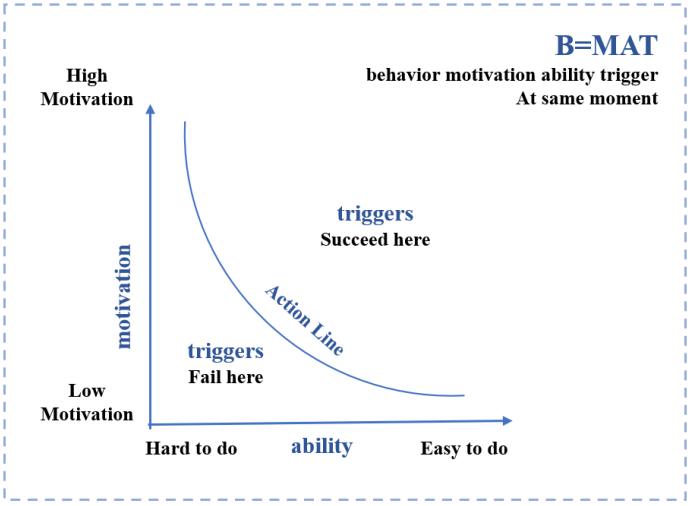

Figure 2-1. Behavioral Model (Source: Internet)

In Abraham H. Maslow's seminal work, "A Theory of Human Motivation," he introduces the concept of the "Hierarchy of Needs," which categorizes fundamental human needs into five essential levels: physiological needs, safety needs, social needs, esteem needs, and self-actualization needs. Subsequent theoretical advancements have led to the inclusion of cognitive needs, aesthetic needs, and self-transcendence needs, thereby establishing a comprehensive eight-level framework for understanding human motivation (**Figure 2-2**)[5].

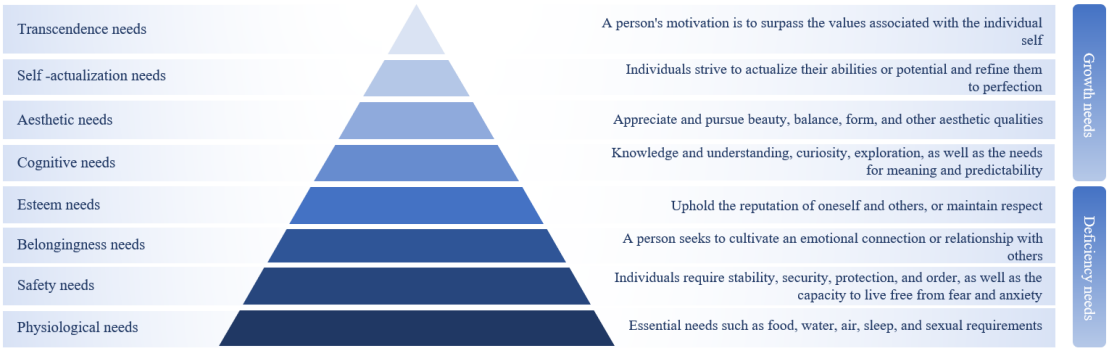

Figure 2-2. Maslow's Hierarchy of Needs (Source: Author's own illustration)

From the perspective of the logical relationship inherent in the hierarchy of needs, an individual will only develop the motivation to engage in artistic activities or other social and cultural practices aimed at fulfilling their self-esteem and self-actualization needs once their basic physiological and safety needs have been adequately met.

2.2. Participation

The traditional visual design paradigm often centers on the designer, characterized by a sacred, solemn, and grand aesthetic tone that unidirectionally imposes design intentions or information dissemination goals upon the audience. This design logic, which fails to consider the needs of the audience, not only results in low efficiency in information dissemination and

insufficient rates of audience participation but also tends to provoke psychological resistance among viewers. In contrast, modern visual design has transitioned towards an audience-centered philosophy that prioritizes the psychological and physiological needs of its viewers. This approach abandons the deliberate pursuit of ideal types and typicality in favor of a lifelike creative style and experience-oriented design concepts aimed at fostering an emotional connection between audiences and visual works. Such strategies significantly enhance audience participation; when individuals derive psychological satisfaction and enjoyable experiences during interactions with these designs, their enthusiasm for engagement is continually reinforced.

2.3. Entertainment Value

In the context of fragmented communication in the information age, there is an urgent need for the interactive narrative strategy of visual design to pivot towards entertainment in order to establish a mechanism that generates mental pleasure for the audience. Contemporary visual art fosters a new paradigm of visual communication through the entertaining transformation of linguistic symbols, the visual reconstruction of informational structures, and the symbolic encoding of meaning systems. This creative mechanism not only underscores the designer's innovative thinking and artistic expression but also encourages audiences to transcend traditional linear modes of text reception. Consequently, it facilitates a multi-dimensional interweaving of cognitive thought and emotional experience throughout the interactive viewing process.

2.4. Technicality

In the context of technology-driven social development, the integration of design and technology is exhibiting an increasingly profound trend. Technological innovation, coupled with the widespread application of Internet technologies, has fundamentally transformed both the interaction paradigms and practical approaches within traditional visual design. The developmental trajectory of this field has progressed from handcrafted methods to mechanical mass production, ultimately culminating in a data-centric communication model characteristic of the information age. Technology now serves as a foundational support for the evolution of visual design. Empowered by technological advancements, interactive visual design has established a multi-dimensional information dissemination system capable of transforming social issues and life experiences—often overlooked by audiences—into compelling visual expressions. This design practice not only broadens cognitive dimensions and enriches spiritual spaces through diverse perspectives but also reflects social realities while guiding individuals toward profound transformations in their behavioral patterns and ideological frameworks.

3. Multi-channel Sensory Interaction: Technical Implementation and Innovative Applications

3.1. Physiological Basis and Design Logic of Multi-channel Sensory Interaction

The sensory system serves as a crucial medium through which humans comprehend the world, encompassing five primary channels of perception: vision, hearing, smell, touch, and taste (refer to **Figure 3-1**). These perceptual channels form the fundamental pathways for individuals to acquire superficial information about external stimuli and construct their cognitive representation of reality[6].

Sensation	Optimal stimulus	Sensory organs	Receptors	The acquired information includes
Vision	Light wave	Eye	Cones and rods located in the retina	Color, structure, movement, pattern, and spatial depth
Audition	Sound wave	Ear	Hair cells situated on the basilar membrane within the cochlea	Tone and noise
Olfaction	Volatile gas molecule	Nose	Olfactory epithelial hair cells	Olfactory perception (the scent emitted by an object itself)
Gustation	Soluble substance	Tongue	Taste buds present on the tongue	Gustatory perception (sour, sweet, bitter, salty)
Tactile sensation	External contact	Skin	Nerve endings in the skin	Tactile sensations such as touch, pain, warmth, and cold

Figure 3-1. The Five Primary Human Sensory Modalities (Source: Author's own illustration)

The visual system, as the primary channel through which humans perceive their external environment and acquire information, occupies a central role in the interaction mechanisms of visual design. The interactivity inherent in visual design extends beyond mere surface-level presentation; it encompasses the encoding and reconstruction of information displayed on screens through various design techniques. By introducing visual stimuli, this approach facilitates effective information dissemination during interactive processes.

The tactile sense, as an active sensory system that integrates perception and emotional feedback, has the potential to enhance audience engagement in interaction design. In an era characterized by media-induced information overload, traditional visual-auditory one-way communication often leads to perceptual fatigue. In contrast, tactile stimulation can evoke emotional resonance[7]. For instance, Tsinghua University's Future Laboratory has developed a large-area tactile graphic display terminal (see **Figure 3-2**) that transforms flat images into touchable three-dimensional graphics through computer-controlled dot matrix surface protrusion. This innovation enables visually impaired individuals to access image information via skin perception. Such a natural method of interaction significantly enhances their learning experiences, text comprehension, and image cognition.

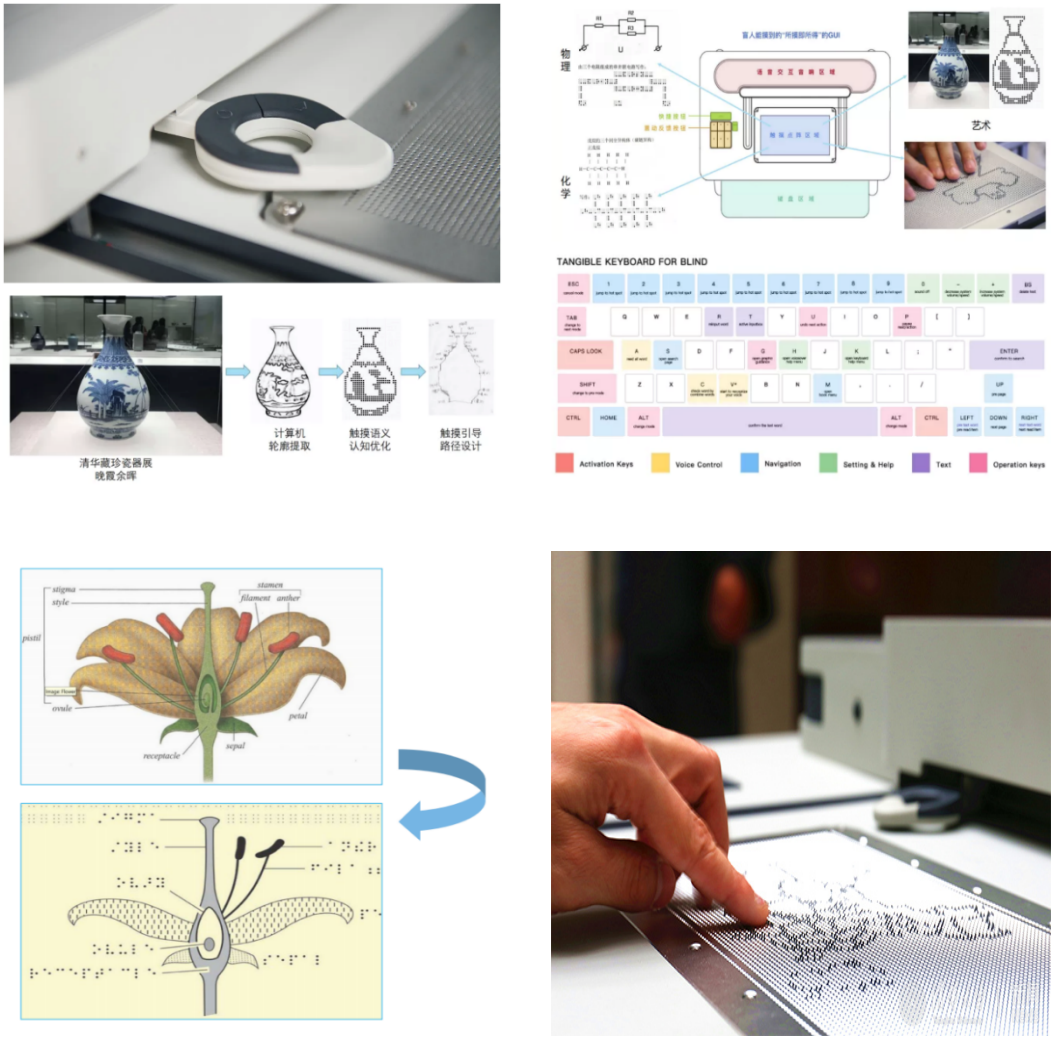

Figure 3-2. The tactile graphic reality terminal product developed by the Future Laboratory at Tsinghua University (Source: Internet)

Although olfaction is often referred to as the "hidden sense" of humans, it possesses the strongest and most enduring capacity for memory retrieval[8]. When external odor molecules enter the nasal cavity, they stimulate both the olfactory nervous system and the nasal trigeminal nervous system, which in turn triggers individual emotional responses and

awakens odor-related experiences stored deep within memory.

The exhibition titled "Smell the Art: Fleeting Scents in Colour," held at the Mauritshuis Museum in the Netherlands from February 11 to August 29, 2021 (**Figure 3-3**), employs a COVID-safe odor distribution system that enables visitors to experience scent symbols associated with 17th-century scenes. This includes a variety of fragrances ranging from pleasant to pungent while viewing artworks. Through its multi-sensory interaction design, this exhibition activates perceptual engagement among visitors, fosters a sensory connection between artworks and audiences, and encourages attendees to explore historical contexts and narrative information behind the art through an innovative olfactory dimension.

Figure 3-3. The exhibition titled "Smell the Art: Fleeting Scents in Colour" at the Mauritshuis Museum in the Netherlands (Source: Internet)

The human gustatory system is capable of perceiving five fundamental tastes: sour, sweet, bitter, salty, and umami. As a method for short-distance chemical stimulus perception, taste relies on the receptors located within the oral cavity. The interaction process associated with taste exhibits physiological invasiveness and must adhere strictly to food hygiene and safety regulations. These two factors impose significant limitations on the application of taste channels in interaction design.

3.2. Interactive Innovation Practices Driven by Emerging Technologies

3.2.1. Construction of Immersive Interactions and Cultural Translation in Virtual Reality (VR) Technology

In the media ecosystem driven by digital technology, the Internet serves as the core communication medium for visual design, facilitating its transformation towards a digital paradigm. Virtual reality (VR) technology has opened up multi-dimensional avenues for innovation in visual design[9]. Firstly, it creates immersive scenarios through multi-sensory system design, thereby expanding visual design from a singular visual experience to a comprehensive sensory interaction dimension that encompasses vision, hearing, smell, and touch. Secondly, VR transcends the limitations of two-dimensional digital spaces by embedding visual information within three-dimensional environments to achieve an enriched and vivid content display that enhances visual impact. Thirdly, it fosters a shift in visual design from static presentations to dynamic

narratives. The inherent dynamic attributes of VR—encompassing images, sounds, and scenes—facilitate the construction of panoramic interactive experiences that significantly augment the appeal of information dissemination.

The "Civilization Imprint: Dunhuang Art Exhibition," hosted by the Beijing Minsheng Art Museum (**Figures 3-4**), stands as the world's largest exhibition themed around Dunhuang art and has innovatively integrated virtual reality intelligent navigation technology. By utilizing AR glasses, visitors can access digital guide services based on the prototype of the Nine-Colored Deer. This technological integration not only alleviates visitor congestion at Dunhuang grottoes and reduces reliance on traditional explanations but also optimizes museum exhibition efficiency while enhancing both cultural dissemination effects related to Dunhuang culture and public cognitive experiences.

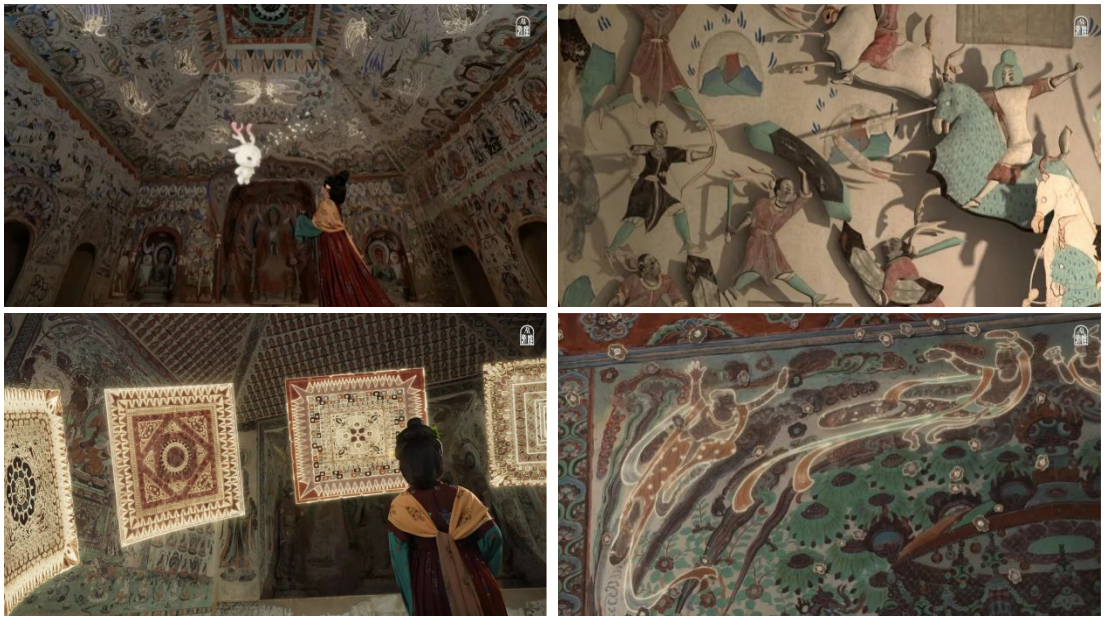

Figure 3-4. 'Civilization's Imprint: The Great Exhibition of Dunhuang Art' (Source: Internet□

3.2.2. The Mechanism of Illusion Generation in Naked-Eye 3D Technology and Its Cross-Domain Applications

Naked-eye 3D technology, also known as Autostereoscopy Technology, is an innovative display technique that facilitates the perception of three-dimensional visual effects without the need for auxiliary devices. In contrast to traditional two-dimensional designs and computer displays, this technology generates three-dimensional visual illusions through binocular parallax. It integrates principles from color science, optimizes algorithms via computer software, and modifies display hardware accordingly[10].

Mainstream implementations of naked-eye 3D technology encompass slit-type liquid crystal gratings, active backlighting systems, lenticular lenses, directional light sources, and parallax barriers. As a cross-disciplinary innovation, it has garnered widespread recognition across various fields including advertising, media production, art design, scientific research, and medical diagnostics. This technology offers unique immersive visual experiences and represents a highly regarded direction in technological innovation.

The naked-eye 3D stage visual design for the opening and closing ceremonies of the 2022 Beijing Winter Olympics (**Figure 3-5**) created an immersive three-dimensional scene using 42,208 50-centimeter square LED modules. This completely revolutionized the expressive paradigm of traditional stage art. This technological endeavor not only presented high-quality visual performance content but also, while disseminating Chinese cultural symbols, demonstrated China's comprehensive capabilities in the aspects of visual technology innovation and aesthetic expression to the international community.

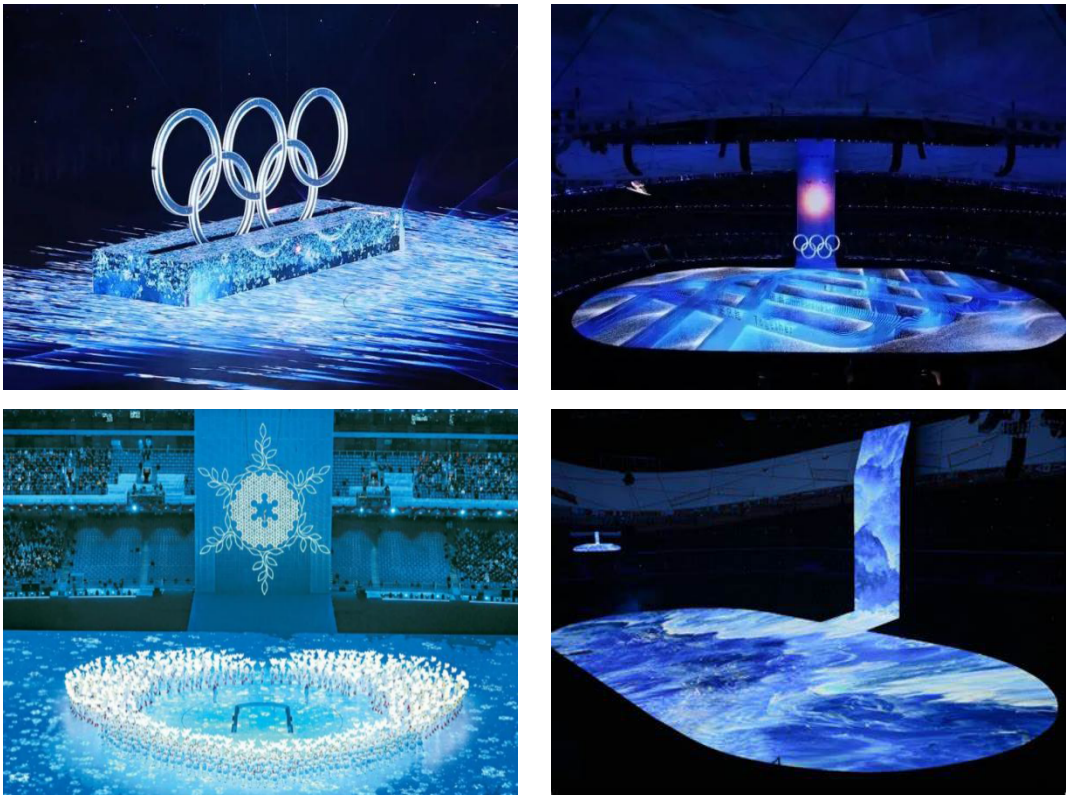

Figure 3-5. The Opening and Closing Ceremonies of the 2022 Beijing Winter Olympics (Source: Internet)

3.2.3. Visual Transliteration and Dynamic Interaction Practices in Mechanical Power Systems

In industrial production and engineering practice, motors serve as essential power devices that convert electrical energy into mechanical energy based on the principles of electromagnetic induction. They often act as the driving core for various types of mechanical equipment and find extensive applications in fields such as industrial manufacturing, transportation, and medical technology.

The innovative work of Dutch artist Jennifer Townley exemplifies the interdisciplinary integration of visual art and mechanical engineering. Her creations (**Figures 3-6**) are inspired by geometric shapes. By affixing geometric components to pivot structures and employing miniature DC gear motors (MDCGM) to generate rotational power, she constructs sensory conflicts characterized by mechanical tension and cyclical rhythm within repetitive motion. This approach enables audiences to engage in a hypnotic visual experience while exploring an expansive imaginative space.

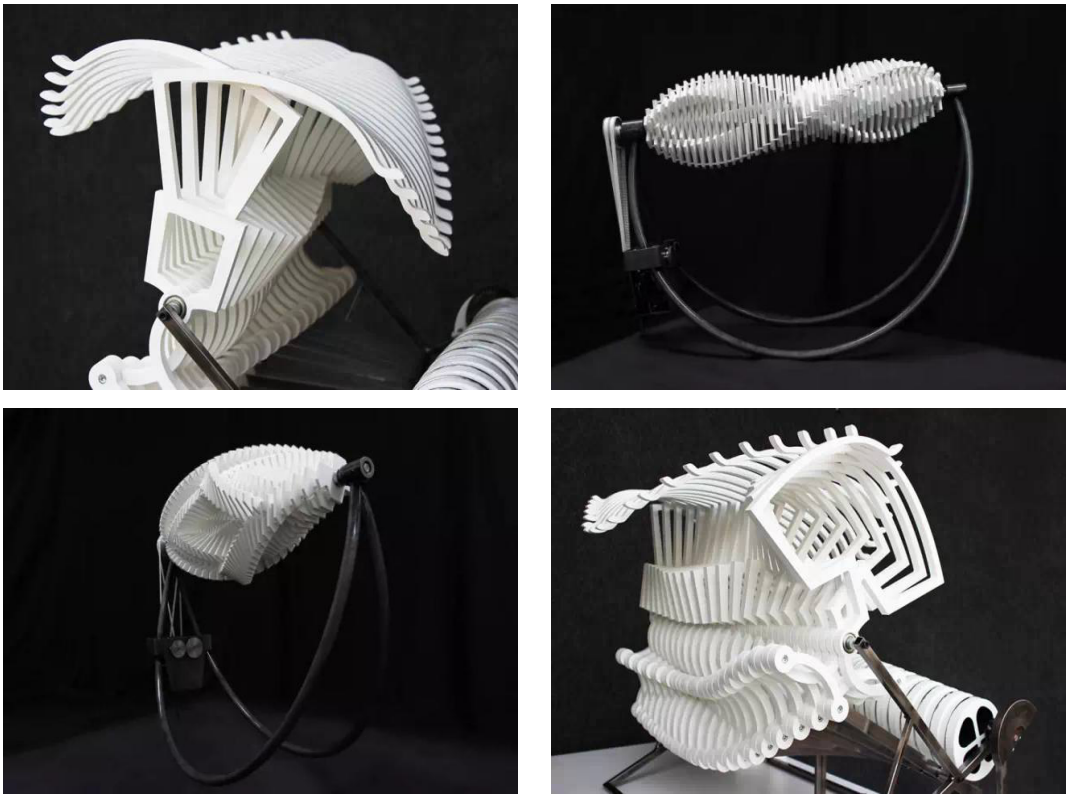

Figure 3-6. Works by Jennifer Donnelly (Source: Internet)

The dynamic landscape model design of the National Archaeological Museum in Chemnitz, Germany (**Figure 3-6**) visualizes the cultural, industrial, and archaeological information of the Free State of Saxony through interactive touch screens and projection technology integrated into a dynamic sculpture installation. This model delineates regional contours with five plush structures and facilitates the dynamic sliding of various exhibition levels via a steel cable suspension system coupled with a motorized drive mechanism.

In contrast to traditional museum information dissemination methods that rely on static exhibits, textual descriptions, or manual explanations, this innovative visual design significantly enhances the multi-dimensional value of cultural education, information dissemination, and public entertainment by fostering greater audience engagement.

4. Conclusion

Digital technology, through the integration of multi-sensory experiences and advanced technological applications, has fundamentally transformed the interactive communication paradigm within visual design. This evolution facilitates a shift from static displays to dynamic interactions. The essence of interactive design resides in harmonizing technological application, audience engagement, and sensory experience. This approach offers contemporary visual design innovative pathways such as “cross-disciplinary technology integration” and “multi-channel sensory stimulation.” Looking ahead, designers must further harness digital technology to achieve a balance between artistic expression and functional utility. This endeavor aims to enhance the immersion and participation in information dissemination processes, thereby fostering ongoing innovation in visual design during the digital media era.

Disclosure statement

The author declares no conflict of interest.

References

[1] Norman, Don.The Design of Everyday Things[M].Basic Books (AZ).2013.

[2] David Klahr, Herbert A.Simon.Exploring Science The Cognition and Development of Discovery Processes[M].The MIT Press.2000.

[3] Zhou Jun & Guo Shaokang.(2018).Exploration of Product Design Based on Behavioral Interaction and Emotional Guidance.(eds.)Proceedings of 2018 1st International Conference on Education,Art,Management and Social Sciences(EAMSS 2018)(pp.461-468).School of Design Art,Nanhua University;

[4] BJ Fogg. A Behavior Model for Persuasive Design[EB/OL]. http://www.behaviormodel.org/ind ex.html, 2019-12-23.

[5] Abraham H.Maslow.A Theory of Human Motivation[M].Martino Fine Books.2013.

[6] Daniel Roehr.(2022).Multisensory Landscape Design:A Designer's Guide for Seeing.doi:10.4324/9780429504389.

[7] SUK H J, JEONG S H, YANG T H, et al. Tactile Sensation as Emotion Elicitor[J]. KANSEI Engineering International, 2009, 8(2): 153-158.

[8] RICHARD E, TIJOU A, RICHARD P, et al. MultiModal Virtual Environments for Education with Haptic and Olfactory Feedback[J]. Virtual Reality, 2006, 10(3): 207-225.

[9] Hanshuo Zuo.(2024).Visual Design of Digital Display Based on Virtual Reality Technology with Improved SVM Algorithm.EAI Endorsed Transactions on Scalable Information Systems,11(5),

[10] Congrui Wu,Xitong Ma,Xiaojun Tang,Xin Li,Ran Duan,Xingxing Zhao & Xing Zhou.(2023).42.1: Invited Paper: Naked-Eye 3D Display System Based on Microlens Array.SID Symposium Digest of Technical Papers,54(S1),289-292.