Study on a Human-AI Collaborative Framework for Designing Culturally Creative Products Based on Artistic Paintings

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Abstract: To address the limitations of traditional design methods, such as long cycle times and high costs, this paper proposes a novel framework for human-AI collaborative design. Through analysis of ten successful human-AI collaborative creative design case studies, the experimental results demonstrate that the framework enhances the potential of AI-assisted tools, mitigates current challenges in human-AI collaboration, and promotes further advancements in collaborative design.

Keywords Modeling; I Human-AI collaboration; Creative Design; Product design; Design frameworks

INTRODUCTION

With the rapid development of artificial intelligence technology, the technology represented by Artificial Generated Content (AIGC) has been widely and deeply applied in the design industry, and the role of AIGC in the design field has gone beyond the role of traditional design aids to become a co-participant in the design process. The impact of artificial intelligence on the design process is not only limited to improving efficiency, but also helps to greatly expand the thinking and creativity of designers. With the development of cultural and creative industries, consumers are paying more and more attention to originality and quality, and the traditional design mode is gradually difficult to meet the market's requirements for innovation and differentiation due to the long development cycle, high cost, and outstanding homogenization. In this context, Artificial Intelligence (AI), especially generative AI technology, provides new possibilities for cultural and creative product design, but the existing research mostly focuses on the efficiency enhancement of AI, and pays insufficient attention to its potential in the qualitative change of creativity.

THEORETICAL CONSIDERATIONS

AI overview

Artificial intelligence (AI) was first proposed by McCarthy and Minsky in 1955, and has been defined and developed by various schools of thought, including symbolic, connectionist, and behavioral. The evolution from early rule-based systems to deep learning and probabilistic inference has established modern AI techniques, particularly deep learning and generative adversarial neural networks (GANs), which have revolutionized the performance of image colorization and style transformation in graphic design, accelerating diversity and innovation in the cultural and creative industries.

Human-AI collaboration overview

Modern design has evolved in tandem with technological innovation, from steam power to artificial intelligence (AI), which is working with designers to accelerate the development of creative design. Chinese scholars have proposed 'fusion intelligence', which combines AI's data processing with human creative thinking and emphasizes the innovations it can produce. The concept of collaborative creative design between humans and AI is at the intersection of multiple disciplines, including artificial intelligence, human-computer interaction, creativity research, design research and collaborative research. The understanding of this concept varies across disciplines, but this paper focuses on the generation of ideas in the design process, and therefore explores human-computer collaboration primarily from a creative design perspective. The essence of creativity lies in creating outcomes that are both novel and practical. Creative thinking is a central feature of idea generation, revealing the nature and intrinsic connections of things through unique thinking activities that lead to a new understanding of a problem and innovative thinking paths (Wikipedia). Generally, creative thinking consists of two stages, divergent thinking and convergent thinking, which is a model proposed by Guilford to apply different operations in problem solving, and 'emergent thinking' proposed by George Henry Lewes in The Problems of Life and Mind as a transition between divergent and convergent thinking, which is the key area of creative generation. George Henry Lewes proposed 'emergent thinking' in 'Problems of Life and Mind' as a transition between divergent and convergent thinking, which is a key area for idea generation, and put forward the 'emergent effect' and 'resultant effect' (Lewes, 1875). In creative design, emergent thinking is an indispensable key link (Zeng Zhen, 2020). Analyzed from the perspective of creative thinking, divergent, emergent and convergent thinking are constantly intertwined and advanced in the process of idea generation. George Henry Lewes, in his

book The Life and Affairs of the Mind (1875), describes the interplay of divergent, emergent and convergent thinking as the key to generating creativity, a process illustrated in Figure 1.
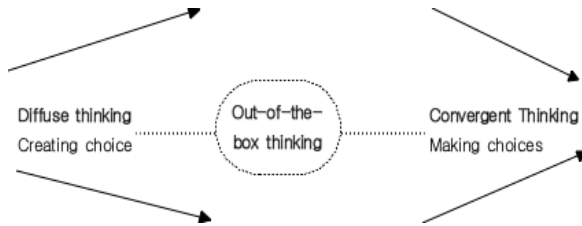
Cultural creative products and artistic paintings

Figure 1.Creative thinking

Cultural and creative products are the core of the cultural and creative industries, combining cultural content and creative ideas to create goods or services with practical and aesthetic value. UNESCO identifies them as a core category of cultural and creative industries, emphasising that they meet the needs of contemporary society with high value-added products through the convergence of art and technology.Cultural and creative products connect markets and cultures by transforming cultural resources into modern products, and function as a medium for conveying culture and spirit beyond mere commodities (Table 1).

Table 1. Product taxonomies for cultural creatives

Classifying cultural and creative products	
Classification by content	Traditional Culture , Modern Culture , Regional Culture
Classification by form	Physical products , Digital products , Service-type products
Classification by use	Decorative and functional products, educational products, gift products
Classification by market positioning	Mass consumptionHigh-end luxury
Classification by industry sector	Tourism ， Gaming ， Video ，Education

<Table 2 >shows the evolution of cultural and creative products from traditional culture to commercialisation, artisation and digitalisation.

Table 2. History of cultural and creative product development

When	Stage
Early 20th century	Protecting and preserving traditional culture
Mid-20th century - 90s	Commercialisation and marketisation trends
Late 20th century - early 21st century	Trend towards design and branding
Mid-21st century and beyond	Technological innovation and convergence

The market is increasingly demanding products with cultural connotations and innovative designs, and the use of artistic paintings is becoming increasingly important. Chinese ink paintings and Western oil paintings reflect history and culture, and when applied to design, they enhance product communication and appeal. The use of 'Tianli Kang Sando' by the Imperial Palace Cultural and Creative Products is a good example of this.

CREATIVE DESIGN FRAMEWORKS AND TYPES OF HUMAN-AI COLLABORATION IN DESIGN

The concept of collaborative creative design with AI is at the intersection of multiple disciplines such as artificial intelligence, human-computer interaction, creativity studies, design studies and collaboration studies. The concept is understood differently across disciplines, but this paper focuses on idea generation in the design process and therefore explores human-computer collaboration primarily from a creative design perspective. The essence of creativity lies in creating outcomes that are both novel and practical. Generally, creative thinking consists of two stages: divergent thinking and convergent thinking, which is a model proposed by Guilford to apply different operations in problem solving, and 'emergent thinking' proposed by George Henry Lewes in 'Problems of Life and Mind' as a transition between divergent and convergent thinking, which is the key area of idea generation. George Henry Lewes proposed 'emergent thinking' in 'Problems of Life and Mind' as a transition between divergent and convergent thinking, which is a key area for idea generation, and put forward the 'emergent effect' and 'resultant effect' (Lewes, 1875). In creative design, emergent thinking is an indispensable key link (Zeng Zhen, 2020). Analysed from the perspective of creative thinking, divergent, emergent and convergent thinking are constantly intertwined and advanced in the process of creative generation, and the relevant schematic diagram is shown in Figure 2.
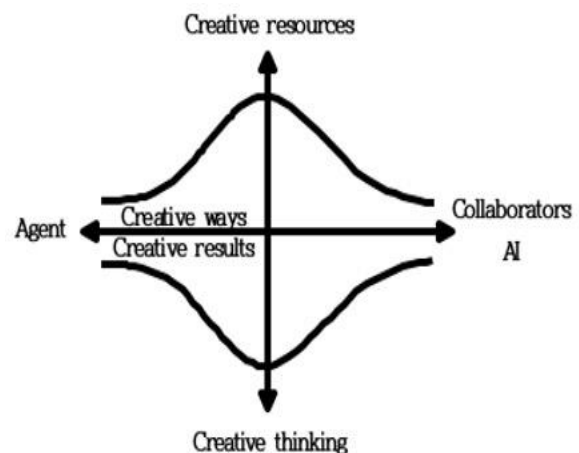

Figure 2. A creative design framework for collaboration

We analysed 10 cases of human-AI collaboration in the field of art painting to identify achievements and potential, and to derive innovative value. The results are presented in Figure 3.
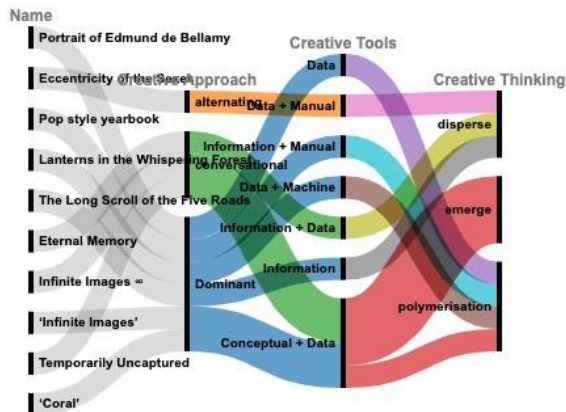

Figure 3. Case analysis charts

CONCLUSION

Based on our analysis of the cases, we draw the following key conclusions

Creative methods: The main creative method used in the creative design of human-AI collaboration is directed, followed by interactive collaboration.

Creative tools: The main creative tools in the creative design of human-AI collaboration are centred on the

thinking activities mainly occur in the creative convergence stage, which plays a key role in generating the final creative output.

Based on the above analysis, this study proposes a new framework for human-AI collaborative design. This framework can not only stimulate the development potential of AI assistive tools, but also effectively overcome the limitations of the current human-artificial intelligence collaboration process and contribute to the further development of human-artificial intelligence collaborative design.

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