

Digital Empowerment and Speculative Design: Human-computer Interaction and Symbiosis Driven by Artificial Intelligence

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ABSTRACT

Speculative design is a design methodology that stimulates reflection on society, technology, and ethics by hypothesizing future scenarios, aiming to challenge existing concepts and propose innovative design approaches. Digital empowerment leverages artificial intelligence and data technology to enhance the capabilities of society, organizations, and individuals, promoting intelligent optimization of resource management and social services, emphasizing the coordinated development of technology and social well-being. The integration of speculative design and digital empowerment provides new insights for addressing the profound changes in social structure and lifestyles driven by technology. The former predicts potential social impacts of technological applications, while the latter uses artificial intelligence as a core technology to provide pathways and practical possibilities for these predictions. Together, they construct an innovative design framework with a sense of social responsibility and cultural value. On this basis, design concepts extend to Human-computer interaction and symbiosis, specifically manifested in areas such as public art, landscape architecture, and urban renewal, showcasing diverse scenarios of future society under technological drive. Through this approach, not only does it offer new pathways for sustainable development, but it also points the way for deploying technology solutions with long-term social impact.

Keywords: artificial intelligence; speculative design; digital empowerment; human-computer symbiosis; public art; sustainable development

1. Introduction

With the rapid development of artificial intelligence (AI) technology, society is gradually entering a new era driven by digital intelligence. Digital empowerment has become a key approach to improving the efficiency of social resource management, optimizing public services, and promoting sustainable social development. The design field is also exploring the potential impact of technological advancements on future societal forms. Speculative design, as an innovative method that stimulates social, technological, and ethical reflection through hypothetical future scenarios, when combined with digital intelligence practices, not only promotes the in-depth development of technological applications but also constructs an innovative design framework

with a sense of social responsibility and cultural value. The integration of these two approaches provides new pathways for addressing the complex challenges posed by the profound changes in social structure and lifestyle brought about by technology, thus offering theoretical support and practical solutions for shaping future societal forms.

In the context of human-computer interaction and symbiosis, artificial intelligence technology is redefining the relationship between humans and technology. This is not only reflected in changes in individual lifestyles and working methods but also leads to higher demands for technological innovation across various social sectors. Especially in the post-pandemic era, the reshaping of urban functions and the restructuring of social ecosystems

increasingly require deep collaboration between technology and design to address global challenges such as resource scarcity, environmental protection, and social equity. How to promote sustainable development in fields like public art, landscape architecture, and urban renewal through technological innovation is a question worth our consideration.

This paper aims to explore the possible models of "human-computer interaction and symbiosis" driven by artificial intelligence, combining the theoretical foundations of digital empowerment and speculative design, analyzing its application value in specific fields such as public art, landscape architecture, and urban renewal. By integrating technical practices and design thinking, it constructs an innovative design framework with a sense of social responsibility, providing theoretical support and practical pathways for shaping future social forms and promoting sustainable human settlements. "Human-computer interaction and symbiosis" as a significant issue for future social development, its significance lies not only in optimizing current technical solutions but also in empowering design to promote the deep integration of humans with technology and nature, offering inspiration for design concepts and practical approaches.

2. Theoretical framework of digital empowerment and speculative design

2.1 Definition and practice of digital empowerment

Digital Empowerment refers to the enhancement of societal, organizational, and individual capabilities through digital technologies, particularly artificial intelligence and data analysis, to promote intelligent resource management, innovative development, and the optimization of social services. In this context, digital empowerment is not only about the application of technology but also involves how to improve the overall well-being of society through technological advancements.

In practice, digital intelligence empowers the overall upgrade of society, cities, and living environments through technological means. By managing resources intelligently, artificial intelligence technology can analyze

data on transportation, energy, and water resources, optimize the allocation of public resources, and thereby enhancing the operational efficiency of smart cities. In the field of environmental protection, artificial intelligence technology is widely applied to environmental monitoring and governance, such as predicting climate change, monitoring pollution sources, and optimizing urban green space layouts, providing strong support for the sustainable development of urban ecosystems. Digital empowerment shows the potential for personalized improvements in social services by analyzing residents needs, offering precise support for the personalized design and optimization of medical, educational, and cultural services, promoting the social service system towards a more equitable and inclusive direction. Moreover, digital intelligence empowers the intelligent creation and presentation of public art through generative artificial intelligence (AIGC), not only significantly improving design efficiency but also expanding the diversity of artistic expression, infusing innovative vitality into the dissemination and experience of public art. These practices highlight the multidimensional value of digital empowerment in the deep integration of technology and society.

2.2 Core ideas of dialectical design

Speculative Design is a design approach that stimulates reflection on society, technology, and ethics by hypothesizing future scenarios. It focuses on how technology might be used in future societies, thus raising questions about the relationship between social development, individuals, and technology. This design approach not only addresses current practical issues but also emphasizes challenging existing concepts and providing space for innovative thinking.

The core concept of speculative design is embodied in its orientation towards future technological applications, deep attention to social and ethical reflections, and its methodological foundation of creative experimentation. By predicting the potential applications of future technologies, speculative design explores their potential impacts on social structures and cultural ecosystems, not only providing development pathways from a technical

perspective but also guiding the public to reconsider the relationship between technology and human life. At the same time, it centers on social and ethical reflections, stimulating public attention to ethical issues such as privacy protection and creative ownership through the design process, thereby promoting further discussions on social values. More importantly, speculative design is characterized by its creative experimentation, constructing hypothetical future scenarios such as future cities where humans and nature coexist or collaborative art spaces between humans and machines, providing innovative thinking frameworks and experimental grounds for future technological applications.

In public art and urban renewal, speculative design has gradually demonstrated its value. For example, the combination of virtual reality (VR) technology with speculative design concepts can simulate future scenarios in urban renewal projects, providing intuitive references for decision-makers; in public art creation, speculative design guides the public to reassess the relationship between technology and art by hypothesizing the possibilities of future technological and cultural integration.

2.3 Combination of intelligent empowerment and speculative design

By combining digital empowerment with speculative design, design is no longer limited to solving current problems but provides a new multidimensional thinking framework for future social forms, technological advancements, and human well-being. This integration not only helps predict the potential social impacts of technological applications but also provides implementation pathways through digital empowerment, promoting the transformation of design from instrumental applications to deep integration with social culture and ethical structures. Under this framework, design can facilitate the co-development and symbiosis of technology and humanity, forming a positive interactive relationship. This combination provides innovative thinking pathways for urban sustainability, public art, and landscape architecture, while offering specific guidance on how to design and deploy technologies with long-

term social impact. For example, in the construction of future social scenarios, speculative design predicts future social forms and guides the innovative application of digital empowerment technologies in areas such as urban renewal, public art, and landscape architecture. Through AI-driven urban ecosystems, a future community where humans and nature coexist harmoniously can be constructed. In practical applications, this combination has already shown initial signs. For instance, public art exhibitions based on AI technology optimize artistic layouts through data analysis and stimulate deep thinking about the relationship between art and technology through speculative design. In urban renewal projects, AI simulates future urban layouts while combining speculative design concepts of future society to form a comprehensive solution that is both scientific and forward-looking. This framework values both the efficiency of technical practices and the deeper values of social culture, providing both theoretical and practical support for the future society of human-computer symbiosis.

3. Practice of AI-driven human-computer interaction and symbiosis

3.1 Case analysis of Machine Man

"Machine·Human" is an innovative work that unfolds across three levels: weak AI, general AI and strong (super) AI (see Figure 1. "Machine·Human" Work Case). By evaluating the application potential of AI technologies at different levels, the work envisions their possible practices in areas such as smart agriculture, education, autonomous driving, scientific research, medicine, manufacturing, and cultural heritage preservation, and delves into how these technologies can promote human-computer symbiosis and drive profound transformations in future society. At the same time, the work also reflects on the complex relationship between technological development and ethics, culture.

3.1.1 Three levels of artificial intelligence

Weak AI: The concept of weak AI was implicitly proposed by John McCarthy at the Dartmouth Conference in 1956, describing an AI system that can perform specific tasks but does not have true understanding or



Figure 1. Case study of Machine Man

consciousness (Amisha et al., 2019).

Research history: 1950s to 1970s, the pioneering stage, the main goal was to develop intelligent systems for single tasks such as chess and speech recognition. For example, the ELIZA system in 1965 was used for language interaction.

From the 1980s to the 2000s, the application development of weak AI gradually matured, and it was applied to medical diagnosis (such as MYCIN systems) and search algorithms.

Since the 2000s, deep learning has driven the expansion of weak AI applications with the rise of deep learning, such as breakthroughs in recommendation systems (Netflix, Amazon) and image recognition (medical imaging) (Shakshi, 2019).

Features: limited to a single task, unable to perform cross-domain learning.

In "Machine·Human", weak AI is mainly used for technical applications in specific fields, such as smart agriculture and intelligent driving. AI systems optimize agricultural production processes through data analysis and pattern recognition, improving crop yields and quality while achieving efficient resource utilization; in the field

of intelligent driving, AI optimizes traffic management through autonomous driving technology, reducing traffic accidents and enhancing road usage efficiency.

General artificial intelligence: Alan Turing proposed in his 1950 paper "Computing Machines and Intelligence" that machines could exhibit human-like intelligence through learning and reasoning, but the term "general artificial intelligence" was not formally used until the early 21st century (Pennachin & Goertzel, 2007).

Research process: 1950s-1980s, concept exploration, AGI was seen as the ultimate goal of artificial intelligence, but lacked practical technical support, researchers focused on weak AI tasks.

In the 1990s and 2000s, an initial framework emerged in which early AGI theoretical frameworks appeared, but implementation remained difficult.

Since the 2000s, with clear goals, Ben Goertzel and other researchers have begun to systematically discuss the implementation pathways of AGI, including research based on cognitive architecture. The success of deep learning has reignited enthusiasm, leading to the flourishing development of AGI (Fjelland, 2020).

Features: The ability to demonstrate general

intelligence across multiple tasks requires complex learning and reasoning skills.

The application of general artificial intelligence in "Machine·Human" is more extensive, covering multiple fields such as education, scientific research, and medicine. AI in the field of education provides personalized learning paths and real-time feedback for each student; in the medical field, general AI can assist doctors in diagnosing diseases and even offer treatment plans that surpass conventional medical techniques in certain situations, thereby significantly improving medical efficiency and accuracy.

Super (strong) AI: The concept of strong AI was introduced by philosopher John Searle in 1980 to describe an artificial intelligence system that can truly "understand" or have "consciousness" (Searle, 1980).

Research Process: From the 1980s to the 2000s, philosophical debates centered on strong artificial intelligence as a philosophical proposition, primarily focusing on its feasibility and ethical implications. Searle's "Chinese Room" experiment posits that even if a computer can simulate cognition, it does not necessarily mean that it truly "understands" information.

Since the 2000s, there has been a possibility of breakthroughs in technological discussions. With advances in neuroscience and machine learning, the possibility of strong artificial intelligence has begun to be incorporated into technological discussions. However, it is generally believed that strong artificial intelligence has not yet been realized, and current research remains at the philosophical and theoretical stage (Jeste et al., 2020).

Features: Emphasizes "consciousness" or "self-awareness", transcending current technical and theoretical frameworks.

Strong AI represents the most advanced form of AI technology, possessing the ability for self-learning and reasoning. In the concept of "Machine·Human," strong AI not only can handle complex social issues but also achieve independent innovation in fields such as scientific research and mechanical manufacturing. For example, the "Hibernation Plan" aims to address physiological issues for humans in extreme environments or during

long-duration space missions. This concept not only expands the domain of human-computer symbiosis but also raises significant questions about how technology can ensure human survival in extreme environments. Super AI can not only address global issues such as climate change, poverty, and energy crises but also provide strategic guidance in various decision-making areas of human society, promoting social progress. (On December 12, Google released the quantum chip Willow, which can perform calculations in 5 minutes that would take a supercomputer 10 to the power of 25 years to complete, providing a solid technical foundation for the development of super AI.)

3.1.2 Practice of human-computer symbiosis: cross-domain intelligent applications

Through the portrayal of human-computer symbiosis in different fields, Machine Man depicts how technology drives innovation and sustainable development at all levels of society.

Intelligent agriculture: use artificial intelligence to optimize agricultural resource allocation, improve the precise monitoring of crop growth environment, reduce the burden of agricultural production on the environment, and realize green agriculture and sustainable development.

Education field: General artificial intelligence provides students with personalized learning experience. Through real-time assessment of learning progress and behavior data, AI helps teachers to develop personalized teaching plans and ensure the fair and efficient distribution of educational resources.

Intelligent Driving and Traffic Management: In the field of intelligent driving, AI technology not only changes the operation mode of transportation vehicles but also optimizes urban traffic management through intelligent transportation systems. The intelligent traffic control system can adjust traffic lights and routes based on traffic flow and environmental data, thereby improving traffic efficiency and reducing congestion.

Medical Field: The application of AI in the medical field is transforming traditional medical practices from disease diagnosis to optimization of treatment plans. AI not only enhances the accuracy of diagnoses but also

makes personalized medicine possible. By analyzing patients genetic data, AI can tailor treatment plans for each patient, thereby improving treatment outcomes.

Mechanical Manufacturing: AI drives intelligence in the field of mechanical manufacturing, improving the automation level of production lines, reducing labor costs, and enhancing production efficiency. Through machine learning and deep learning AI can analyze the large amount of data generated during the production process optimizing manufacturing processes and procedures.

Combining Chinese Ancient Architecture with Cyberpunk Style: AI is not only used for innovative applications in traditional industries but also injects new momentum into cultural heritage protection. Through virtual reality (VR) and augmented reality (AR) technologies, AI assists in restoring and reconstructing ancient buildings preserving cultural heritage while integrating cyberpunk style to create unique artistic forms.

3.2 Case analysis of Interaction Symbiosis

"Interaction-Symbiosis" is an experimental art creation based on speculative design that simulates deep interactions between humans and other organisms through artificial intelligence technology. This work employs generative artificial intelligence (AIGC) technology, utilizing five-sense interaction design to extend human perception to cross-species sensory experiences, thereby achieving virtual integration of humans and nature. The piece attempts to construct a communication model that transcends linguistic and species boundaries, breaking the limitations of traditional human-nature communication methods and providing new ideas for future innovative practices in human-computer symbiosis and ecosystems. (See Figure 2. "Interaction·Symbiosis" Work Case)

In practical application, "Interaction·Symbiosis" enables humans to "be present in" the living environments of other organisms through five sensory experiences: visual, auditory, olfactory, gustatory, and tactile. For example, through visually generated content created by artificial intelligence, audiences can experience the perspectives of animals in various ecological settings; with the aid of olfactory and tactile devices, AI simulates

the ways different organisms perceive their world. This immersive experience not only broadens human understanding of natural ecology but also reshapes the relationship between humans and nature to a certain extent.

"Interaction Symbiosis" centers on generative artificial intelligence (AIGC) technology, expanding the forms of public art expression and audience experience through five-sense interaction design. The work combines human perception with other biological senses, creating an immersive art interaction method that can be widely applied to public art exhibitions and urban space art installation designs. For example, the work can set up dynamic installations in urban public spaces, guiding audiences to re-examine the relationship between humans and nature through multi-sensory interactions involving visual, auditory, and olfactory experiences, thereby enhancing the interactivity and educational value of urban art.

The work simulates changes in biological perspectives and ecological environments through AI technology providing new ideas for landscape architecture design. By generating virtual scenes through technology landscape architects can anticipate the potential impacts of different ecological environments on human-nature interactions thereby optimizing landscape layout and vegetation pairing enhancing ecological functions. At the same time this immersive experience can also serve as part of landscape education helping the public to more intuitively understand the importance of ecosystems promoting the sustainable development of urban green spaces.

4. Social impact and sustainable development of human-computer symbiosis

4.1 Human-computer interaction and symbiosis mode driven by artificial intelligence

Human-computer interaction and symbiosis mode refers to the evolution of the relationship between humans and machines beyond mere tool users and tools under the support of artificial intelligence moving towards deeper interaction and co-development. Under the



Figure 2. Case study of Interaction Symbiosis

symbiosis model of human-computer interaction, artificial intelligence not only assists humans in completing tasks as a tool but also takes the initiative to collaborate with humans to jointly address complex social and environmental challenges, and in some scenarios, the boundaries between human and artificial intelligence roles may become blurred.

Under the framework of digital empowerment, artificial intelligence provides humans with more efficient means for resource management and optimizing social services, promoting intelligent development from the individual to societal levels. Meanwhile, speculative design guides us from ethical and social value perspectives on how to ensure that the symbiosis of humans and technology does not go astray during the process of intelligence promotion, avoiding potential negative impacts of technology application (such as privacy breaches, social inequality, etc.).

4.2 Practice and application of combination

By combining digital empowerment with speculative design, a dual framework of technology application and social responsibility has been formed. For example:

In the field of public art, AI not only optimizes the efficiency of artistic creation but also expands the forms of artistic expression through generative design. Through speculative design, audiences can reflect on the ethical issues of how AI influences artistic creation and audience experience, exploring how technology can integrate with culture.

In the field of urban renewal and landscape architecture, digital empowerment enables the

optimization of urban resource allocation through AI and improves the quality of ecological environment, while speculative design guides us on how to design a more ethical urban form in the future society, ensuring that intelligent cities with human-computer symbiosis can improve efficiency while maintaining values such as social equity and environmental protection.

4.3 Future development of human-computer symbiosis mode

The rise of artificial intelligence technology is gradually permeating multiple fields such as human-computer symbiosis in daily life, urban development, and public art, bringing new opportunities for sustainable development. In daily life, artificial intelligence enhances quality of life through personalized services and optimized resource allocation. For example, smart home systems can automatically adjust energy consumption strategies based on user behavior habits, thereby achieving a green lifestyle. In urban development, the human-computer symbiosis model optimizes urban operational efficiency through intelligent infrastructure, such as the widespread adoption of intelligent traffic management and energy distribution systems, which provides the possibility for building green and smart future cities. Human-computer collaboration in the field of public art has become an innovative driving force for artistic creation. Through artificial intelligence-generated content (AIGC), artists can break through technical and expressive limitations in creation, while audiences can experience more personalized art forms through interactive installations and immersive experiences.

This human-computer symbiotic model not only brings about the deep integration of technology and life but also has a profound impact on social organizations, education, and working methods. For example, in the field of education, artificial intelligence provides precise auxiliary tools for teaching, making personalized education possible. In workplaces, AI-driven automation is reshaping the structure of the job market, not only boosting production efficiency but also giving rise to many new professions. Despite this, the model also poses challenges to society: how to balance efficiency and humanity, innovation and ethics as technology continues to penetrate human life, has become an issue that must be addressed.

4.4 Balance between technology and social responsibility

In the process of promoting human-computer symbiosis and technological development, maintaining a sense of social responsibility and ethics is crucial. The widespread application of artificial intelligence technology inevitably brings about some potential issues, such as the leakage of data privacy, unfairness in technology application, and the lack of ethical decision-making. To achieve a balance between technology and society, efforts need to be made from the following aspects.

First, policy-making is the foundation for ensuring the ethical application of technology. The government and relevant institutions should establish comprehensive laws and regulations to define the boundaries of technology application. For example, in matters involving data privacy, strict data protection policies should be formulated to ensure that user information is not misused. Furthermore, for content generated by artificial intelligence, legal provisions should be made to clarify the ownership of intellectual property rights and protect the legitimate rights and interests of creators.

Second, enhance technical transparency and explainability. The "black box" nature of artificial intelligence technology makes it prone to social trust crises during application. Therefore, technology developers should strive to improve the explainability

of algorithms, ensuring that the application process is transparent and open, allowing the public to understand the mechanisms and decision-making bases of technology.

Third, the cultivation of social responsibility cannot be separated from the extensive participation and supervision of the public. It should be achieved through education and publicity to make the public understand the advantages and risks of artificial intelligence technology, enhancing their acceptance and sense of participation in the technology. At the same time, through a multi-party collaboration mechanism, integrate the opinions of all sectors of society into the decision-making process of technological development, forming a diverse and open technological ecosystem.

5. Conclusions

The AI-driven Human-computer interaction and symbiosis mode actually refers to the deep integration of artificial intelligence with various fields of human society, promoting the common progress of technology and humanity. Digital intelligence empowers this process by providing specific technical means, while speculative design helps us reflect on and examine the impact of technological development on society and ethics while advancing it. The key to this model lies in balancing technology and ethics, ensuring that artificial intelligence promotes social progress while also aligning with human values and social structures.

Although this paper explores the integration of digital empowerment and speculative design through theoretical analysis and case studies, as well as their role in human-computer symbiosis, there are still certain limitations to the research. Firstly, due to the limitations in case selection, this paper only focuses on the two typical cases of "Machine·Human" and "Interaction·Symbiosis," failing to comprehensively cover the diverse practices of artificial intelligence technology across various fields, which may limit the broad applicability of the conclusions. Secondly, regarding the social and ethical issues of technology, the discussion in this paper remains at a preliminary level and fails to deeply analyze the differences and complexities of ethical challenges under

different social contexts. Lastly, since the focus of the research is concentrated on the design framework of future social forms, this paper lacks sufficient empirical research on the effectiveness of existing technology applications, making it unable to fully assess their actual social impact. These limitations provide directions for further expansion in future research.

The combination of digital empowerment and speculative design not only promotes the widespread application of artificial intelligence technology in human-computer symbiosis but also provides new innovative ideas for social, cultural, and ethical fields. Through reasonable policy guidance, interdisciplinary collaboration, and in-depth ethical reflection, artificial intelligence technology will play a more significant role in shaping future social forms, contributing to sustainable development and human well-being.

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