

## Implementation of complex systems in fashion design creation using artificial intelligence

Yoon Kyung Lee  
Seoul National University, Seoul, South Korea

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**Introduction** Artificial intelligence (AI)-powered computer programs as fashion consultants can help consumers decide the implementation of their fashion choices. AI fashion systems can process large amounts of data faster, learn the styles of specific users, and remember user feedback (Dopico et al., 2016; Lee, 2021). In addition, the introduction of advanced technologies, especially AI, is expected to provide a pathway for sustainable solutions that can increase the productivity of fashion products and reduce unnecessary energy consumption, such as handling of stock items and environmental problems due to overproduction (Lee, 2021). Consumers in the fashion industry are expected to have different characteristics than the existing consumers owing to changes in the information and communications technology environment. In the digital age, consumers actively present their opinions and exchange information with others through digital environments. In addition, fashion system design is a complex and creative domain. Therefore, in this study, we explore ways to actively use AI in design work so that designers can focus on more creative work, provide opportunities to improve the simple work of fashion designers, and use AI in creative design related to complex systems.

**Literature Review** *AI technology: Machine learning, deep learning, and generative adversarial networks:* The AI technology currently used in fashion uses machine learning. It is a method of providing recommendation services by applying a natural language processing method based on big data analysis. In addition, the development of deep learning technology has enabled image analysis for various fashion products; moreover, the analysis of image (product) information, text, and voice language information, consumer tastes and preferences can be more accurately investigated. For example, a recommendation service that recommends products that meet the requirements of consumers or the coordination of products that satisfy the tastes and trends of consumers (Kotouza et al., 2020). Convolutional networks are a specialized type of neural network that use convolution instead of general matrix multiplication in at least one of their layers. Deep learning methods are growing faster with the recent development of generative adversarial networks (GANs), such as *CycleGAN*, *DCGAN*, and *StarGANv2*. The technology of GANs is challenging new creative works using AI by combining images with low correlation and finding patterns to create new images based on existing image information (Liu et al., 2019).

*Upcoming Fashion Industry and Complex System:* The use of AI in fashion could be an opportunity to provide more active consumer engagement and a virtuous cyclical economic system

to a sustainable society (Lee, 2021; Sutherland et al., 2010). In particular, the fashion industry, based on the manufacturing industry, is a production field that creates various jobs and has grown into a high value-added industry based on new creative ideas. Complex systems are becoming increasingly important in both natural and social studies. The existence of complex systems is commonly implied and their various examples can be studied across disciplines. Complex systems have several characteristics, such as nonlinearity, feedback, spontaneous order, and emergence. Nonlinearity is often considered essential for complexity (Ladyman et al., 2013).

**Methodology** In this study, we first attempted to understand the techniques for applying AI to fashion design. Accordingly, we compared creations between GANs and human design work in same conditions. A new textile design was created using GAN. A total of 100 traditional Korean graphic temple patterns and 100 real coral images. Fifty design students who participated were provided with the same graphic patterns and coral images. Then, we analyzed whether the elements of a complex system involved in the creation of AI design were defined. Finally, an AI design model with a complex system was established.

**Results and Discussion** In this study, we analyzed the innovations of fashion design in design thinking. Revolutionary changes were observed; for example, implementing the creative approach of designers. The design results of participating design students demonstrated the final esthetic and played a pivotal role in addressing the innate desire for novelty and enjoyment compared to the outcomes of GANs. These results show how design work can harmonize individual, social, economic, and environmental requirements. It involves a complex system that demonstrates a spontaneous order. In this respect, the creative process of design and basic concept of the study of complex systems can be said to be the order of systems that arise from the set of interactions between elements. Regarding the nature of complex systems, creative design work has emerged from concrete concepts in the form of symmetry, organization, periodicity, determinism, and patterns. When discussing complexity science, researchers often associate it with the limitations of reductionism. A strong, perhaps the strongest, notion of creation is that emergent objects, properties, or processes exhibit “downward causation.”

**Conclusion** In this study, we analyzed the utilization of AI technology compared with human design work. The AI design of a complex system can be effectively used in the development of the fashion industry by predicting fashion systems that will change through recommendation and co-creating services. The use of AI technology in fashion can also support a sustainable alternative that can reduce inventory problems caused by the inefficient use of resources of the existing fashion system, energy waste in production and distribution, and labor waste in simple and repetitive work. Therefore, the role of designers in the AI design environment will involve setting goals, variables, and constraints; accordingly, their work will no longer be limited to the visual part; it will expand to various domains, including the voice, sensory, and multi-sensor parts.

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