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Designing the Future: A Case Study on Human-AI Co-Innovation

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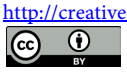

Abstract

Artificial intelligence (AI) has sparked widespread discussion across various sectors globally while triggering a transformation in the design industry. In recent years, the evolution of AI has started to reshape how people work and live. As such, the human-robot collaboration model is gradually emerging as a pivotal force driving innovation and boosting efficiency. As it rapidly advances, AI technology can process a vast amount of data while performing complex tasks and assisting designers with intricate and creative work. By automating repetitive, low-value tasks using AI technology, designers can focus on activities that require intensive creativity, critical thinking, and emotional intelligence. The present case study examines how human-robot collaboration elicits advantages in creative design. An analysis of the AI-assisted visual design project "ZhuoluFantasie" indicates that complementary human-AI collaboration can enhance design efficiency and assist designers in transcending creative boundaries. Through the process of content planning, text generation, graphics generation, graphics selection, confirmation, and finalization, the 7000 images were ultimately condensed into 27 AI-assisted visual designs. This provides opportunities for cross-field collaboration while introducing new possibilities into the creative design field.

Keywords

Human-Robot Collaboration, AI-Assisted Visual Design, Design Efficiency, Cross-Field Collaboration

1. Introduction

AI has emerged as a force to be reckoned with today, with its influence spanning worldwide as driving innovation and development in various technological do-

mains. The widespread application of AI is contingent upon the wealth of available data, the development of advanced algorithms, and the substantial enhancement in computing power (Xie, 2020). These advancements deepen the theoretical significance of AI and exhibit its tremendous potential for practical applications, which enables AI technology to help solve problems and generate economic value (Zhang & Lu, 2021). Regarding application, industries with a robust data foundation, such as healthcare, automobile, finance, manufacturing, and retail, have embraced well-established AI application processes (Bughin et al., 2017). Biomedical and healthcare systems have emerged as pivotal areas for AI applications within these fields (Castiglioni et al., 2021). For example, the Watson system developed by IBM plays a significant role in advancing oncology and leukemia treatment. Through continuous learning, this system's intelligence level has experienced ongoing elevation (Dlamini et al., 2020). Additionally, Google's deep learning algorithm enables the detection of diabetic retinopathy through images, demonstrating AI's potential in the field of ophthalmic diagnosis (Hassabis et al., 2018).

Furthermore, AI's rapid evolution has substantially advanced driverless technology, such as autonomous vehicles and drones (Duarte, 2019; Shakhatreh et al., 2019). Specifically, using machine learning, computer vision, sensor technology, and advanced data analysis, self-driving technologies enable vehicles to navigate and function with minimal human intervention. Investments from industry giants, including Google, Tesla, and Apple, have fueled growth in the industry of autonomous vehicles (Birdsall, 2014; Clements & Kockelman, 2017; Greenblatt, 2016). In the financial sector, AI applications have focused on areas such as risk assessment, algorithmic trading, credit scoring, and customer service (Xie, 2019). For instance, machine learning and big data analysis technologies enable financial institutes to assess customer risks more accurately and offer personalized financial products and services in a customer-centric manner (Indriasari et al., 2019). With the arrival of Industry 4.0, AI's role in smart manufacturing, predictive maintenance, and quality control in the manufacturing industry has become increasingly significant (Ghahramani et al., 2020; Yao et al., 2017). By monitoring production processes and analyzing data, AI aids businesses in increasing production efficiency, lowering costs, and improving product quality (Phuyal et al., 2020). Concurrently, AI is also reshaping the retail landscape in various domains, from personalized recommendations to inventory management, customer interactions, and shopping experiences (Guha et al., 2021; Weber & Schütte, 2019). For example, retail giants such as Amazon and Walmart employ AI to analyze consumer behavior and sales data, thereby achieving personalized product recommendations and inventory management optimization. Fashion brands, including H&M and Zara, have introduced chatbots to provide 24/7 real-time customer query and shopping assistance services (Jin et al., 2019). This move has streamlined customer interactions. Additionally, cashierless stores represented by Amazon Go use AI and machine vision technologies for cashierless checkout services, illustrating the future trajectory of the

retail industry (Ives et al., 2019). These AI-driven innovations have increased customer satisfaction and improved the efficiency and sales of the retail industry substantially (Dash et al., 2019; Duong, 2022).

The application of AI in creative industries has significantly impacted various domains, such as games, immersive applications, advertising, and marketing. Specifically, AI has streamlined traditional creative processes and leveraged big data analysis to predict customer preferences, thereby guiding advertisement design and improving its effects (Anantrasirichai & Bull, 2022). Regarding art creation, the piece "Edmond de Belamy", constructed by the arts-collective Obvious, which uses the generative adversarial network (GAN) technology, fetched a high price at a Sotheby's auction. At a 2022 Colorado art exhibition, the piece "Théâtre D'opéra Spatial" won the championship in the digital art category (Roose, 2022), highlighting the potential of AI in art creation. Meanwhile, the scope of applying AI in the design field is expanding, with AI tools leveraged to accelerate creative processes and optimize designs. For example, AI-driven image generation tools such as DALL-E 3, Midjourney, and Stable Diffusion can create high-quality visual works based on textual descriptions (Hoşer & Köymen, 2023; Steinfeld, 2023). Applications like Canva and Adobe Spark can effectively generate professional designs and automatically present diverse design options using AI (Doehling, 2019). AI tools, including VIZCOM, offer innovative solutions to rapidly convert sketches into realistic renderings, boosting design process efficiency. In fashion design, AI is used to analyze trends and consumer preferences while supporting designers during their creative processes (Dubey et al., 2020; Jeon et al., 2021). In product and architectural design, AI contributes to each process, ranging from concept generation to structural feasibility analysis and energy efficiency optimization; this ultimately enhances the overall quality and sustainability of designs (Castro Pena et al., 2021). These instances showcase the new ways AI is employed in the creative design field to boost efficiency while driving creative expression and art creation.

Research Objective

Despite the increased use of AI in creative design, there is a lack of in-depth study regarding how AI can effectively collaborate with designers to drive creation. In 2023, researchers were invited to the Anxi Rattan Iron Crafts Innovation Development Institute to conduct a conceptual design of the local traditional rattan iron crafts using AI. Based on the theme of "Journey of Iron's Life", the design unfolded through five story chapters of birth, eruption, tempering, reconstruction, and survival. Through AI-assisted creation, the concept was translated into a design project featuring a new style and further extended into five home products. This seamless creative process underscores four advantages of AI-assisted craft design: 1) With AI's assistance, artisans can swiftly concretize their concepts, thereby gaining more creative ideas and saving time. 2) AI can help designers unshackle the constraints of traditional styles and create new value. 3) AI helps businesses examine the preferences of different customer seg-

ments while expanding into new markets. 4) Works created with AI assistance can convey the creator's emotional demands, helping to attract consumers.

This research focuses on analyzing "ZhuoluFantasie", a performance by the National Chinese Orchestra Taiwan at the "Cross-field Artistic Imagery 4.0" concert held by the National Taiwan University of Arts on 14th and 15th October, 2023. Therefore, this study had the following two research objectives:

1) To explore the collaboration between AI and designers and establishes a process model for incorporating AI into creative design.

2) To increase design efficiency and provide opportunities for cross-field cooperation in design.

2. Literature Review

2.1. Overview of AI Technology

The development of generative AI dates back to the late 20th century. The first models, such as the Hopfield network and Boltzmann machine, were primarily used for basic pattern recognition and data generation (Ackley et al., 1985). A pivotal leap occurred in 2014 with the emergence of GANs, which enhanced the quality of the data generated through the competition between a generator and a discriminator. As deep learning technology progressed, generative AI was integrated with convolutional neural networks (CNNs) and recurrent neural networks (RNNs), further increasing the complexity and authenticity of the data generated. A defining characteristic of generative AI lies in its capacity to create new, lifelike data samples while playing a pivotal role in such domains as art creation and data augmentation (Goodfellow et al., 2014).

As a fundamental branch of generative AI, text-to-image AI focuses on translating textual descriptions into images. Early models in this domain were primarily used to generate basic images and graphics. With advancing technology, particularly the evolution of deep learning and neural networks, modern systems are now capable of processing more complex instructions and generating high-quality images (Gupta et al., 2021; Naveen et al., 2021).

The introduction of OpenAI's DALL-E and GPT-3 significantly reshaped this domain. These models can generate rich, intricate images based on detailed textual descriptions, increasing the realism of images and the diversity of creative expression substantially. This technology enables people to communicate with computers using solely natural language, thereby prompting AI to generate high-quality, lifelike images (French et al., 2023; Frosio, 2023). In 2021, OpenAI's CLIP model significantly improved the connection between language and visual images through multimodal pretraining. This advancement has made text-to-image systems sought-after tools for performing computer vision tasks. It allows creators to convey concepts, attributes, and styles to computers through text, generating creative images. This progress signifies a technological leap and a new creative avenue for artists and designers, contributing to the diversity and personalization of image creation (Ko et al., 2023).

Diffusion Model-based AI models, such as OpenAI's DALL-E 2, Stability AI's Stable Diffusion, and the Midjourney company's Midjourney, have recently drawn significant attention in image generation. Research indicates that AI can help creators unshackle creative constraints, ignite their imagination, experiment with various styles, and boost efficiency. Creators can input a text "Prompt", which guides AI generators to swiftly produce high-quality images and images of any style and content, thereby facilitating more varied and iterative creations (Borji, 2022; Chen et al., 2023; Lee et al., 2023).

Midjourney is an AI art-generation tool that offers services through Discord. It enables users to input natural language prompts to generate images in various styles, ranging from realistic to abstract styles. Stability AI's Stable Diffusion is an open-source text-to-image AI model. It generates images using an advanced text encoder and deep learning technology and can create realistic or artistic images based on brief text prompts (Stability AI, 2023). Stable Diffusion is equipped with features such as image enlargement and image-to-image conversion and serves as a robust image editor for users. Its open-source nature has become a popular platform for community-driven development and innovation. OpenAI's DALL-E is an advanced text-to-image AI model that can generate high-quality images based on the textual descriptions input by users through an application programming interface (API). A significant feature of this model is its ability to comprehend complex, detailed textual prompts while creating corresponding images. DALL-E also incorporates ethical and safety considerations. For example, it avoids generating works that mimic the styles of existing artists or misleading and harmful images (Horsey, 2023).

With continual technological advancement and innovation, text-to-image AI has become a key tool for digital art and creative expression. From the basic image generation in its early days to today's generation of highly complex, realistic images, this technology has demonstrated AI's enormous potential in art and creative fields.

2.2. The Advantages and Importance of Human-AI Collaboration

The rapid advancement of AI in today's digital age has rendered this technology adept at tasks traditionally performed by humans. This has raised concerns about the possibility that AI will ultimately replace human jobs. However, there is a growing realization that people are, in fact, working with machines (Nardi, 2017). In this context, it is necessary to understand how people can work with AI to enhance their intelligence and overall well-being (Dafoe et al., 2021). James Wilson suggested that corporate performance experiences the most significant improvement when humans work with machines (Wilson & Daugherty, 2019). As AI advances, how we work and the subjects who engage in this work will be fundamentally transformed. Thus, a more probable and crucial trend emerges, which underscores the potential of AI in assisting and augmenting human capabilities (Wu et al., 2021). The book Human + Machine: Reimagining Work in

the Age of AI suggested that collaboration between AI and people can lead to a more efficient, innovative way of working. According to the book, it is essential for businesses and individuals to understand how AI reshapes the way people work and think to stay competitive in the AI era (Daugherty & Wilson, 2018).

Through human-AI collaboration in the design field, designers can maximize the role of technology to improve work efficiency and design quality while ultimately sustaining their competitive edge in an increasingly competitive design market. Such collaboration is advantageous in multiple dimensions, as specified below:

1) Boosting efficiency: AI can effectively generate design drafts and prototypes, saving designers time. For example, software such as AutoCAD and Revit leverages AI to streamline design processes. These AI-driven approaches can reshape conventional workflow. By automating repetitive tasks, they not only minimize errors but also contribute to substantial time savings for designers. Revit's Building Information Modeling (BIM) technology has further boosted design efficiency and refined architectural design by providing more precise building information. Such generative design AI proves instrumental in refining designs, enhancing structural integrity, and improving energy efficiency and has been employed in various industries, including automobiles and aerospace (Autodesk, 2024; Ferrandiz et al., 2018; Ibukun et al., 2022).

2) Innovation and creative ideas: As a wellspring of novel design suggestions and ideas, AI can inspire designers to think creatively, free them from the constraints of conventional designs, and help them explore new design directions. For example, Adobe Sensei leverages creative suggestions from AI in Photoshop and Illustrator to assist designers with such tasks as content-aware filling, image editing, and color matching. This has substantially boosted design efficiency and creativity (Karataa, 2018).

3) Data-driven decision-making: AI's ability to analyze extensive data and provide insight into market trends and user preferences helps designers make more informed decisions based on the data. For example, Stitch Fix employs AI to analyze consumer profiles, predict fashion trends, and guide design decisions (Kim et al., 2021).

4) Real-time feedback and optimization: By offering real-time feedback on designs, AI helps designers rapidly evaluate and optimize their designs to achieve improved user experience and market response. For example, web design tools such as Wix's AI platform provide real-time design feedback to assist users in refining web layouts and user experiences. Design tools such as Figma and Adobe XD have integrated AI to deliver real-time design feedback and suggestions, thereby aiding designers in optimizing user interfaces and experiences (Amri, 2023; Feng et al., 2023).

5) Cross-field collaboration: AI proves instrumental in contributing to the collaboration between designers and experts from other fields, such as engineering and marketing. Such collaboration aims to deliver more comprehensive, well-coordinated design solutions. For example, in fashion design, IBM Watson

has partnered with Marchesa to analyze social media trends using AI to guide garment design (Kim & Yim, 2022).

3. Methodology: Practice Case Analysis

With the rapid development of generative AI, the design field and designers' traditional way of working are being transformed. Many designers have begun using AI in their product design processes. This AI-assisted visual creation combined visual and auditory elements. Using impressive visual imagery, this piece immersed the audience in the backstory of the Battle of Zhuolu in ancient China. It also fostered a deep connection between the audience and the music.

3.1. AI-Assisted Visual Creation Process of ZhuoluFantasie

3.1.1. Story Background

Professor Yun-Song Chu's composition, "ZhuoluFantasie", transports the audience back to the battlefield in Zhuolu by depicting the epic clash between Huangdi and Chiyou. In this legendary battle, Huangdi directed his mythical creature Yinglong to flood the battlefield and submerge enemy troops. Chiyou summoned Fengbo and Yushi to fight back, who unleashed fierce winds and thunderstorms to entrap Huangdi. However, with the assistance of Fenghou and the south-pointing chariot, Huangdi was eventually victorious. Accompanied by the resounding beat of the drum covered with Kuiniu's skin, JiutianXuannv's intervention provided decisive support for Huangdi. This battle not only solidified Huangdi's legendary status but also paved the way for the ascent of Chinese civilization.

3.1.2. AI-Assisted Visual Design

This AI-assisted visual design project aimed to immerse the audience in the epic narrative as the music began and they experienced the historical context and mythical allure. The visual creation processes are content planning, text generation, graphics generation, graphics selection, graphics confirmation, and graphics finalization.

1) Content planning: the designer turned to the conversational AI search engine Perplexity Ask before beginning the formal composition to gain insight regarding the main characters' traits. Perplexity Ask generates answers through conversations, specifically it summarizes search results and provides pertinent answers with citations so that the information can be verified. Such a conversation-based approach allowed the designer to quickly understand and characterize roles. After evaluating the desired final effect, the designer began to compose stories for the characters.

2) Text generation: In the early phase, the stories were imported into ChatGPT to gain descriptions suitable for generating images based on the text with AI's assistance. Through multiple rounds of conversations with ChatGPT, the designer finalized the description of each character's image and integrated them into the story scenes for coherence. Conversations with AI are akin to brains-

torming sessions that typically occur within teams. This allowed the designer to effectively focus on the creative direction while producing appropriate text.

3) Graphics generation: This step is crucial in collaborating with AI. It focuses on whether the visual images meet the predefined goals and whether the visual presentation of each character is adequate and harmonizes with the musical ambiance. This step pushes the designer's aesthetic sense, judgment ability, and proficiency in generative AI to the test. The designer of the present case study project used Midjourney to complete the tasks, which involved setting up the text, style descriptions, and the scale of the drawings generated in previous steps to create images for each character. It could be obtained four images in one minute by entering "prompt", for suitable images, the designer could enter "variation" for further development or "upscale" to enlarge the images and check the details. The designer used the "pan" feature to extend graphics in all directions, which ensured that the images presented were majestic, detailed, and suitable for projecting onto a large backdrop for the audience's enjoyment (Figure 1).

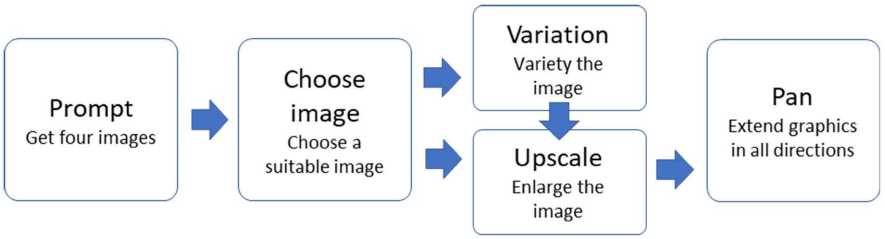

Figure 1. AI-Assisted visual creation processes (compiled by this study).

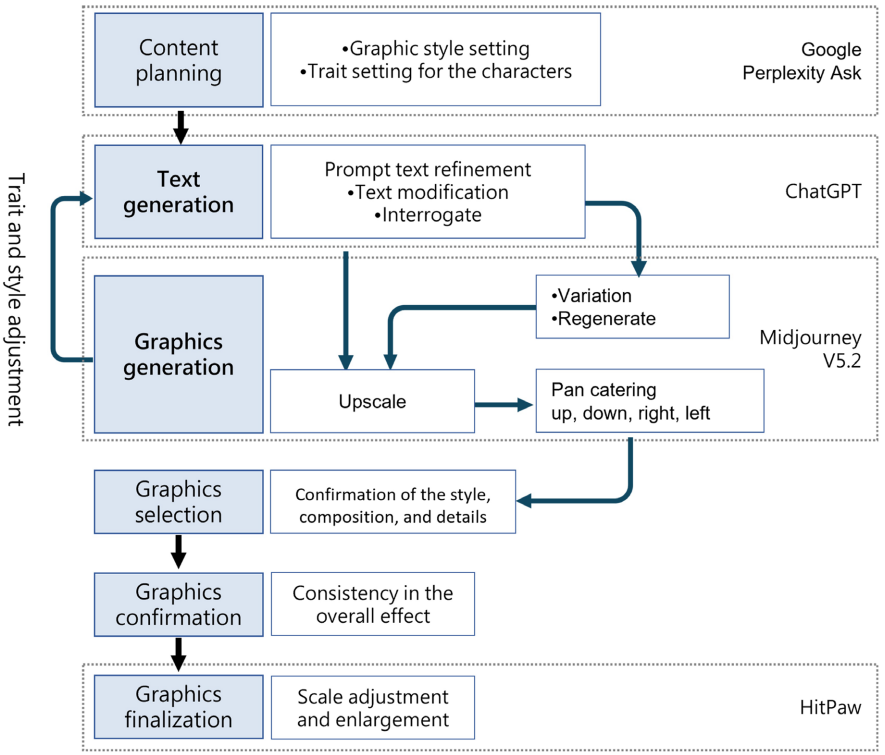

Figure 2. AI-Assisted design flowchart (compiled by this study).

4) Graphics selection, confirmation, and finalization: In the later phases of the process, the designer refined the details based on professional judgment. First, the designer selected graphics from those generated by AI that aligned with the desired overall effects, including the style, composition, and details, while ensuring the consistency of the overall impact of graphics representing the characters. Next, the designer used HitPaw AI to enlarge the graphics and checked whether these enlarged graphics had any distortions that needed to be manually modified while confirming their actual projection effects. Finally, the work was finalized.

Five AI tools, including Perplexity, Chat GPT, Midjourney, and HitPaw, were employed, which generated 7,000 images within one week, culminated in 27 AI-assisted visual designs, complemented by the 14-minute "ZhuoluFantasie". The specific process is detailed in Figure 2.

AI-assisted graphics generation process indicates a significant departure from traditional execution and production methods. In contrast, AI is the executor of human-AI collaboration while rapidly generating several aesthetically pleasing graphics. Concurrently, the designer acts as the director, defining the direction of the style. Through continual judgment and selection, the designer can generate graphics aligned with predefined goals and the requirements of collaborating musicians. This has transformed the traditional design process by shedding reliance on specialized techniques in the execution process and significantly shortening the time required. Designers collaborating with AI can focus more on creative conception, integration, and communication by reducing the amount of heavy, complex technical work. The final graphics and prompts are presented in Table 1.

3.2. Creative Outcomes and Reflections

The visual creation of "ZhuoluFantasie" highlights the impact of collaborating with AI on traditional design processes. The effects and innovative aspects of the collaboration in this case study are summarized as follows:

1) Boosting efficiency and unleashing creative potential

This case study fully illustrates the profound impact of AI within the design field. In addition to substantially boosting working efficiency, AI is a catalyst for designers, igniting their creative thinking. With Midjourney's assistance in rapidly generating design drafts and prototypes, the designer channeled more effort into creation and complicated design challenges. In the visual design project "ZhuoluFantasie", AI tools aided the designer in creating diverse scenes and characters, swiftly concretizing ideas, and sparking creativity. This enabled the designer to think from multiple perspectives about integrating music into visual arts. As a robust auxiliary tool, using AI enabled the extensive experimentation, possibilities, and rapid iteration of designs while consistently delivering high-quality outcomes during the design process.

2) Data-driven decision-making

Table 1. Final graphics and prompts.

Theme	Midjourney visual design	Feature descriptions from ChatGPT
Huangdi (Emperor)		Illustrate Huangdi standing tall amid an ancient battlefield. His bright eyes and long black hair flowing in the wind, with warriors clashing in the background, add to the drama of war.
Chiyou		Depict Chiyou, with his six arms wielding weapons, leading his army against foes on a turbulent battlefield. Emphasize his sharp eyes, revealing the intensity and spirit of an ancient war god.
Xuan Nu		Portray Xuan Nu amid a chaotic war scene. Whether depicted with a human head and bird's body or riding a phoenix, she emphasizes her role in aiding warriors with her mystical powers.
Kui Ni (Bull Deity)		Draw Kui Ni on a war-ravaged landscape, with its radiant single horn shining like a beacon. Surround him with warriors in awe of its power, as the scene captures the tension of a mythological battle.
Yinglong		Showcase Yinglong soaring above a war-torn battlefield. Below, soldiers look up in both fear and awe as the mighty winged dragon casts its shadow upon them.
Feng Bo & Yu Shi (Wind and Rain Deities)		Illustrate Feng Bo and Yu Shi manipulating the elements in a war setting. With Feng Bo's scarf creating gusty winds that disrupt enemy formations and Yu Shi's dragon pouring torrential rain.

Applying AI technology allowed the designer to make decisions based on data. In the "ZhuoluFantasie" visual design project, AI played a pivotal role in facilitating the audience's understanding of the backstory of the Battle of Zhuolu. Using AI technology, the designer effectively gained an in-depth understanding of this legendary event, including its cultural significance and visual representation. This data-driven insight enriched the design and ensured that the visual effects accurately conveyed the theme and emotions of the music. Such an AI application has enhanced design accuracy and strengthened the connection between music and visual arts, providing the audience with a more enriching and immersive experience.

3) Automation of tedious tasks

AI proves instrumental in automating tedious, repetitive tasks during the design process. This automation involves basic design operations and more critical creative processes of high complexity. Notably, in extracting character traits, AI can quickly and accurately identify and simulate the traits of different characters, thereby aiding designers in capturing and representing historical figures. This ensures the visual representation is artistically compelling while remaining faithful to historical events. In this process, AI is guided through simple textual descriptions to swiftly change and experiment with different design styles, offering designers a broader array of choices.

4) Learning and development

During their collaboration with AI, designers can master new skills and tools and better understand how AI can be applied in the design field. This learning journey enables designers to maintain sharp insight into future trends while enhancing working efficiency. For example, in "ZhuoluFantasie", AI facilitated the designer's interdisciplinary historical study and visual experiments. This exploration enhanced the designer's technical skills and knowledge of approaches to innovative design. AI can integrate historical elements and modern visual arts, contributing to the creation of works of both profound historical significance and artistic appeal. In this process, a designer plays a pivotal role in translating the AI-generated design program into the final piece in a unique style infused with creative ideas. Therefore, applying AI in real-world scenarios and virtual reality has rendered AI an invaluable creative partner of designers.

5) Cross-field collaboration

In the project "ZhuoluFantasie", the assistance of AI technology allowed the designer to unshackle the limitations resulting from a lack of extensive training in traditional graphic design skills. With AI's support, the designer could rapidly acquire and apply new AI-assisted design skills. This indicates that using AI has not only provided necessary technical support but has also fostered more effective collaboration between the designer and experts from other fields, thereby delivering the audience an immersive experience that seamlessly integrates visual and auditory elements.

AI application in the design field has its advantages and limitations. Specifically, AI can spark creative thinking and provide technical support. Nevertheless, high-level art expression and emotional resonance still hinge on the designer's emotional experience and comprehensive judgment. For example, when addressing the cultural elements in the project "ZhuoluFantasie", the designer was aware of AI's constraints in grasping complicated historical and cultural backgrounds. This underscores the need for designers to leverage deeper insight and creative guidance to fill this gap.

4. Application and Advantages of AI during Creative Design

4.1. Advantages of Applying AI in Visual Design

Regarding the application and effects of AI on animation production, the AI-

assisted visual design case of "ZhuoluFantasie" has demonstrated AI's strengths in swift image generation that are conducive to animation production. This process requires a significant amount of time and labor (Doxsee, 2018). Furthermore, the expert interview indicates that those entering the animation industry are typically required to master three to four suites of specialized software. Each learning period lasts one to two months or even half a year. Applying AI technology is expected to lower the threshold of these specialized tools so that designers can focus more on creative thinking and art expression.

Typically, an animation design process comprises three main phases: Pre-production, production, and post-production (see Table 2). For a 90-minute movie, the pre-production phase usually takes the longest. During this phase, AI technology acts as a converter, particularly in expediting the creative process and strengthening the communication between the designer and the director. The pre-production phase also involves a significant amount of time and effort in tasks such as character design, scene layout, and drawing and refining the overall visual style. Therefore, with their speedy, diversified style options and ability to generate visual images based on given textual descriptions, AI image generation tools are crucial to presenting an initial concept while achieving rapid iteration. For example, regarding the images generated in the AI-assisted visual design case of "ZhuoluFantasie", it takes approximately a week to produce such an image using the traditional computer-aided design method. In contrast, with AI's assistance, the process in this case was shortened to two to three hours, saving about 20 times the time taken using the traditional method. This swift visual

Table 2. Animation design process and time and labor required.

	Steps		Number of persons	Time	
Pre-production	Story/Screenplay		One	6 months	AI assistance saves the most time.
	Script/Storyboard			1.5 to 2 months	
	Art settings	Props designed for characters		1 year	
		Animation dailies • 3D model making • Shading		6 months	
	Dubbing, sound effects, and music planning				
	Plan development				
Production	Artwork and modeling		200 to 300 persons	8 to 10 months	
	Texture mapping				
	Characters and settings				
	Lighting and rendering				
	Visual effects				
Post-production	Sound effects and music				
	Synthesis				
	Release				

design generation has substantially reduced the time required for freehand drawing and digital graphics. It also lets the creative team quickly explore and compare different design options. Furthermore, with AI's assistance, designers can create multiple versions of characters or scenes in real-time and engage in fruitful discussions with directors. This enhances communication efficiency and makes the creative decision-making process more dynamic and interactive.

Regarding story creation, AI writing tools such as ChatGPT can assist with data gathering and organization, spark innovative thinking, facilitate the refinement of script structures, imitate different writing styles, and improve text quality; this saves a substantial amount of time for writing. This technological integration boosts the efficiency of the creative process and fosters teamwork, ensuring a smoother, more efficient animation production process. Thus, applying AI technology in the pre-production of animation production can accelerate the creative process. It can also substantially enhance creative quality and teamwork efficiency. Moreover, it lowers the threshold of these specialized techniques and allows the creative ideas contained in a design to be fully leveraged.

4.2. The Complementarity of Designer-AI Collaboration

In the "ZhuoluFantasie" visual project, the collaboration between the designer and AI illustrates several key complementary aspects, as presented in **Figure 3**. These aspects indicate how the strengths of human creativity can be combined with AI to achieve impressive visual design outcomes. The complementarity and advantages of the designer-AI collaboration are detailed below.

- Human strengths:

1) Creativity: The "ZhuoluFantasie" visual design project demonstrates outstanding human creativity. Human designers can create visual art from scratch, transforming an intricate musical story into concrete visual elements. As a human strength, this distinctive creativity is embodied in visual designs and the designer's nuanced understanding and emotional expression of the story.

2) Emotional sensitivity: Emotions are essential in art; people can sense and express profound emotions. During the present case study project, the human designer successfully conveyed the emotions infused into the story through visual design, fostering an emotional connection with the audience. Based on their understanding and expression of the emotional elements of the music, the designer immersed the audience in the story.

3) Judgment and decision-making: Human designers must make complicated judgments and decisions in the face of multiple design options. They can identify the most appropriate one from miscellaneous visual elements while integrating professional aesthetic judgment and practical considerations into their designs. This judgment and decision-making ability is crucial to ensuring design quality and alignment with the intended goals.

- AI's strengths:

1) Rapid iteration: AI can swiftly generate many visual elements and design options, accelerating the exploration and iteration of design programs. In this

project, this strength contributed to the continual refinement of the visual design to meet professional standards.

2) Diversified styles: AI can present a rich array of style options, which broadens the design horizon and sources of inspiration. Furthermore, it allows for experimentation with different design styles so that designers will have more visual options, which, in turn, contributes to the creative process.

3) Graphic quality: AI-generated images boast high quality, ensuring the visual effects meet professional standards. This strength helps to ensure the final visual design is satisfactory in both technical and aesthetic terms.

- Advantages of human-AI collaboration:

1) Boosting design efficiency: The collaboration between humans and AI can significantly boost the efficiency of the design workflow. AI can quickly process data, generate visual content, and perform tedious tasks like image editing or layout design. This helps designers to conserve time and energy. With enhanced efficiency, designers can concentrate more on creative and strategic work while meeting tight project deadlines.

2) Human capability enhancement (extension): AI can serve as various design tools and enhance designers' capabilities. It can rapidly generate diverse design styles and options, which helps to broaden the design horizon while offering more inspiration and options to designers. Such capability extension enables designers to make more sensible design decisions and refine their designs.

3) Cross-field innovation: Collaboration between humans and AI drives cross-field collaboration and innovation, such as the fusion of visual art and music. This is indicated in the "ZhuoluFantasie" case, which delivered a multi-sensory experience. In the past, cross-field collaboration was exclusive to professionals in the industry. With AI's assistance, numerous design possibilities have emerged, providing designers with ample opportunities for cross-field innovation.

These complementary aspects highlight that the collaboration between humans and AI in the realm of creative design can yield superior visual design outcomes and streamline the design process. Such collaboration enhances design quality and provides more creative possibilities, unleashing potential for future design.

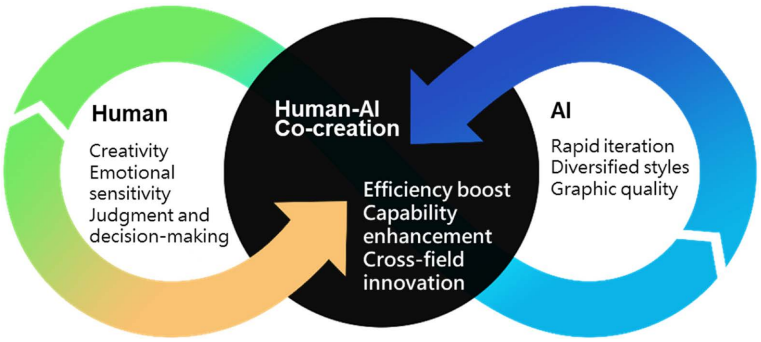

Figure 3. Advantages and complementarity of human-AI collaboration in design.

4.3. Future Outlook

As AI advances, more exciting opportunities and challenges are on the horizon in the creative design field. The following points concern outlook and recommendations on how we should respond to these changes:

1) Broaden the scope of AI applications: Although we have witnessed successful AI applications in various creative domains, the scope of potential applications of this technology is still broad. We can expect AI to be applied in more areas in the future, including architectural design, fashion design, advertising design, and film-making. This can offer designers across industries more opportunities to boost efficiency and raise their creations to a higher level.

2) Encourage designers to improve their AI skills and keep abreast of the latest developments: Designers should improve their AI skills and stay abreast of the latest developments. As the application of AI in creative design continues to expand, designers should continue to enhance their skills and acquire new technologies to stay competitive in this ever-changing industry. Meanwhile, AI-related courses should be incorporated into educational and training activities to help designers leverage AI tools and respond to industry changes more fully.

3) Strengthen education and training: Integrating AI into the educational system is crucial to ensuring that next-generation designers will fully embrace AI. Design schools and educational institutions should focus on teaching AI technologies, tools, and ethics so that students can effectively apply AI-related knowledge in their future careers.

4) Preserve human creativity: Despite AI's remarkable benefits to creative design, human creativity remains indispensable. Designers must remember that AI should serve as a tool and a partner rather than a complete substitute for human creativity. Preserving human creativity and emotional sensitivity is essential for ensuring the uniqueness and emotional connections of a design.

5) Prioritize ethical considerations: When using AI, designers should always bear in mind ethical and privacy considerations, be responsible, and observe relevant laws and regulations. The ultimate goal is to safeguard user data and privacy.

6) Continue to reflect and make improvements: Designers should continue to reflect on and improve their design workflows while seeking better ways to integrate AI technology. This will help to enhance design efficiency and quality while meeting predefined design goals.

The application of AI in creative design has already triggered significant transformations and still has huge potential to be tapped into. We can anticipate more innovations and collaborations that will deliver increasingly outstanding design outcomes while preserving the core value of human creativity. In this ever-changing context, designers should continuously learn and grow to ensure that they can fully harness AI's potential and stay competitive in the design field. In this exciting era, we are eager to witness the human-AI co-innovation model

continuing to drive cutting-edge creative design.

5. Conclusion

This study examined the application of AI in the field of creative design. Based on a detailed analysis of the AI-assisted visual design case "ZhuoluFantasie", this study explored how AI and humans should collaborate to achieve more remarkable design outcomes. This topic is essential in today's increasingly digital and technologically driven world. AI's emergence has reshaped creative design while eliciting numerous new possibilities and challenges. This study has highlighted the complementarity between humans and AI in creative design and how such collaboration delivers more remarkable design outcomes. This complementarity is manifested in multiple dimensions, including AI's rapid iteration, ability to generate diversified styles, and boost efficiency. This enables designers to bring their creative goals to fruition more effectively. However, this study has also argued that AI should be considered a partner of designers rather than a complete substitute for human creativity. Human creativity, emotional sensitivity, and cultural insight are irreplaceable because they infuse designs with depth and emotions while fostering a closer connection with the audience. Therefore, preserving the core value of human creativity is paramount. Nonetheless, this study has certain limitations. Considering the specificity of the case, it may be challenging to generalize the findings of this study to all design fields or other types of AI applications. Furthermore, as technology advances rapidly, the AI technologies and tools used in this study may soon be superseded by newer iterations. It may be necessary to adjust and update this study's specific findings for better alignment with future technological advancements.

Integrating AI into creative design has opened new possibilities and posed challenges. By maximizing the strengths of AI and maintaining the core value of human creativity, we can attain more standout design outcomes and contribute to the ongoing development of the creative design field. In this era brimming with promise and potential, we anticipate more impressive pieces created by human designers in collaboration with AI.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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