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A Study on the Collaboration with Generative AI for Non-designers in the double-diamond Design Process

더블-다이아몬드 디자인 프로세스에서 비디자이너와 생성형 AI의 협력에 관한 연구

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Abstract

As the design field continues to expand, the boundaries of design have become increasingly blurred. The design field appeals to a rising population of individuals who are not design professionals with a strong passion for design. These individuals are commonly known as non-designers. Non-designers could attempt to create designs based on universal design thinking models and methods. However, the efficiency and quality of design remain a challenge for them. With the rapid development of AI and the emergence of Generative Artificial Intelligence(GAI) tools, new opportunities have arisen for this group of people. The purpose of this study is to explore the supplementary role of Generative AI in interdisciplinary design projects, to enhance design quality and efficiency. The study employed a mixed-methods research approach, combining qualitative and quantitative methods. First, we conducted a persona to gather user requirements. Then, we created a user journey map to illustrate the user's pain points. Finally, we analyzed the existing popular GAI tools that can help with design. As a result, we proposed a product design strategic framework for design collaboration with GAI, and a GAI card toolkit that can be used for product design to assist non-designers in enhancing design efficiency and quality in interdisciplinary design projects. To validate the research results, we conducted user testing. The findings of this study will assist non-designers to better accomplish their designs more effectively and encourage more designers to use GAI as an important tool for creative work.

Keyword

Generative AI(생성형 AI), Product Design Strategic Framework(전략적 프로젝트 디자인 프레임워크), Design Collaboration(디자인 협력)

요약

디자인 분야가 계속 확장되면서 디자인의 경계는 점점 더 모호해지고 있다. 이러한 현상은 디자인 전문가가 아닌 디자인에 열정있는 다른 이들을 끌어모으며 디자인 분야의 범위를 더욱 넓히고 있다. 이러한 이들을 비디자이너(Non-designers)라고 한다. 비디자이너들은 보편적인 디자인 사고 모델과 방법론을 기반으로 디자인을 시도할 수 있으나 결과물에 대한 효율성과 품질에 대해 아직까지 과제로 남아있다. 그러나 인공지능과 생성 AI(Generative AI, GAI)의 급격한 발전으로 이 집단에게 새로운 기회가 생겼다. 이에 본 연구의 목적은 생성 AI가 학제간 디자인 프로젝트에서 디자인 품질과 효율성 향상에 있어 보조 역할의 가능성을 탐구하는 것으로 질적, 양적 방법론을 결합한 혼합 연구 방법론을 활용하였다. 따라서 먼저 사용자 요구사항을 수집하기 위해 페르소나를 작성했고, 사용자 여정 맵을 만들어 페인 포인트를 도출하였으며, 디자인에 지원 가능한 기존의 인기있는 GAI 도구의 활용성을 분석했다. 그 결과를 바탕으로 GAI 협업 제품 디자인 전략 프레임워크와 비디자이너의 디자인 효율/품질 향상을 위한 GAI 카드 툴킷을 제안하였다. 이후 제시한 GAI 도구에 대해 사용자 테스트를 통해 연구 결과를 검증했다. 본 연구의 결과는 미래에 비디자이너가 디자인을 더 효과적으로 수행할 수 있도록 돕고, 디자이너들에게 GAI를 창의 작업의 중요한 도구로 활용될 수 있기를 기대한다.

목차

1. Introduction

With the rapid development of AI technology, generative artificial intelligence is flourishing. It can create interesting and useful content and improve the performance of machine learning systems. Additionally, generative AI can increase efficiency and productivity by automatically generating content, helping to save time and reduce the need for manual labor. This is useful in various applications, such as creating art, music, and chat bot-generated text. However, it is worth noting that people need to find new opportunities to collaborate with generative AI or build upon the content produced by generative artificial intelligence to improve quality and productivity. Previous studies in the design domain have demonstrated that generative AI can also aid in the design process.

Design thinking is a classic human-centered innovation method. People comprehend the design thinking model and implementing it in the process of creating designs. It is more of a way of thinking that helps people better understand problems and find innovative solutions than just a design tool. The existence of design thinking models has also given non-professional design enthusiasts, with a chance to engage in design. This study explores how generative artificial intelligence can be used in the design process to assist in design projects, enabling design enthusiasts to create higher-quality designs in interdisciplinary project design. This paper adopts a hybrid approach that combines qualitative and quantitative research methods. Firstly, we summarized the existing GAI that can help with design. Then, we conducted a test and summarized the results. We interviewed participants and analyzed their pain points and needs. Based on these, we proposed a product design strategic framework that in collaboration with GAI and created a GAI toolkit to help design enthusiasts design. Additionally, this study also conducted a user test to validate the effectiveness of the framework.

2. Literature Review

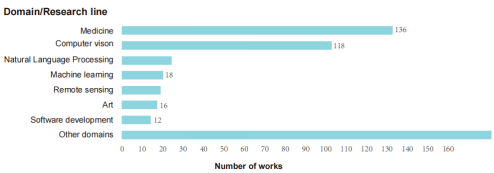
2-1. Generative AI in design fields

Artificial Intelligence(AI) has given us unlimited possibilities and has had a profound impact on various fields such as medicine[1], education[2], ar

1) A. Mashkoor, T. Menzies, A. Egyed, and R. Ramler.: Artificial intelligence and software engineering: Are we ready?, Computer, vol.55, No.3, 2022, pp.24-28.

2) J.-M. Flores-Vivar and F.-J. García-Peñalvo.: Reflections on the ethics, potential, and challenges of artificial intelligence in the framework of quality education(SDG4), Comunicar, vol.31, No.74, 2023, pp.37-47.

t[3], and software development[4], and more. With the rise of Artificial Intelligence, generative AI emerged in the field of Artificial Intelligence, sometimes referred to as “creative AI” or “synthetic media”. It can learn from existing AI and use deep learning algorithms to generate creative content(such as images and text) based on textual cues[5]. For example, when prompted to “create a realistic-looking Pomeranian at work”, various computer-generated dogs performing different jobs will be produced, with the dogs’ images being realistic and resembling real-life dogs. The emergence of generative AI has brought significant changes to many industries, especially with the appearance of Open AI’s ChatGPT in the market at the end of 2022[6]. The use of generative AI has grown significantly since then. Francisco et al.’s researc h[7] summarized the primary areas of generative AI applications from November 2022 to April 2023(Figure. 1). It can be seen that the generative AI has been used in various industries. Generative AI as a tool brings new approaches and opportunities to the design field as well.



[Figure. 1] Number of works grouped by domain of application

Generative Artificial Intelligence has brought about change and opportunities in the design field. Nowadays, designers also use GAI tools to help with design output. Previous research on the impact of generative AI on the design process can be found across various disciplines. In user experience design, Stephanie et al. analyzed how to use generative AI models to help software development teams modernize the user experience of legacy applications[8]. In architectural design, Junming Chen et al. proposed how to use generative AI tools to generate designs with specified styles and architect quality[9]. In industrial design, McClellan demonstrated how to apply AI technology to optimize the manufacturing process of lightweight aerospace instruments[10]. However, generative AI has also brought significant controversy. Can generative AI replace designers? How can we use Generative Artificial Intelligence(GAI) tools to improve design efficiency in different design processes?

3) A. Chatterjee.: Art in an age of artificial intelligence, Frontiers in Psychology, vol. 13, 2022. p. 1024449,

4) R. H. Kulkarni and P. Padmanabham.: Integration of artificial intelligence activities in software development processes and measuring effectiveness of integration, IET Software, vol.11, no.1, 2017, pp.18-26.

5) Vázquez-Ingelmo, A., and F. J. García-Peñalvo. What Do We Mean by GenAI? A Systematic Mapping of The Evolution, Trends, and Techniques Involved in Generative AI. 2023, pp.1-10.

6) OpenAI, GPT-4 Technical Report. (2023.05.27.) URL: https://cdn.openai.com/papers/gpt-4.pdf

7) García-Peñalvo, Francisco, and Andrea Vázquez-Ingelmo.: What do we mean by GenAI? A systematic mapping of the evolution, trends, and techniques involved in Generative AI. 2023.

8) Houde, Stephanie, et al.: Opportunities for Generative AI in UX Modernization. Joint International Conference on Intelligent User Interfaces Workshops: APEx-UI, HAI-GEN, HEALTHI, HUMANIZE, TExSS, SOCIALIZE. 2022.

9) Chen, Junming, et al.: Using Artificial Intelligence to Generate Master-Quality Architectural Designs from Text Descriptions. Buildings, Vol.13, No.9, 2023, p.2285.

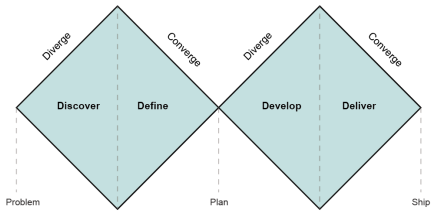
10) McClelland R. Generative design and digital manufacturing: using AI and robots to build lightweight instrument structures[C]//Current Developments in Lens Design and Optical Engineering XXIII. SPIE, 12217, 2022, pp.141-148.

Given the proliferation of AI tools for designers and the rapid progress of Generative Artificial Intelligence(GAI), it is prudent to contemplate the optimal utilization of GAI as a design tool and actively participate in the design process. This will enable a greater number of design enthusiasts to partake in the field of design.

2-2. Design thinking process

Design thinking is a specific approach to problem solving. It incorporates human-centered design principles throughout the entire design process and generates innovative solutions with interdisciplinary teams. Design thinking was initially referenced and shaped by the design consultancy firm IDEO[11] and is a design methodology that cultivates human creativity. Design thinking is defined as using the sensitivities of designers and tools to discover human needs, combining technology and business to think about solutions, and ultimately proposing solutions[12].

The Double Diamond model was proposed by the UK Design Council[13]. The double diamond model is a visually intuitive design process model. Non-design professionals have a greater capacity to comprehend the complete design process in comparison to IDEO[14]. The Double Diamond model divides the design process into four stages: discover, define, develop, and deliver(Figure. 2). Diverge thinking is in the discover and develop phases, and convergent thinking is in the define and deliver phases.



[Figure. 2] Double diamond process model

The Double Diamond Design model provides a standard design thinking process and working method for discovering and solving various types of problems in design. Based on the general Double Diamond model, more detailed design thinking models have been created. People can choose to utilize the advantages of different models' characteristics to meet their specific needs. Therefore, it is worth considering integrating AI into the design thinking model.

2-3. The Interplay of designers and GAI

Design thinking is a method of human-centered innovation. With the help of design thinking, designers accomplish their design concepts with expertise and capabilities, and generative artificial intelligence(GAI) utilizes computer algorithms to gather and produce innovative material. It is critical to consider the relationship between GAI and designers. This paper combines the concept of evolutionary creativity[15] with artificial intelligence to illustrate.

11) Kelley, Tom.: The art of innovation: Lessons in creativity from IDEO, America's leading design firm, Vol.10, Currency, 2001.

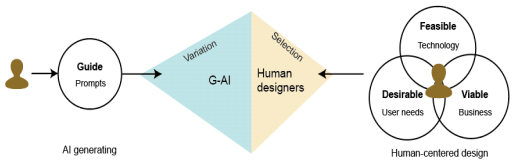
12) Brown T.: Design thinking. Harvard business review, Vol.86, No.6, 2008, pp.84.

13) Rugman, Alan M., and Joseph R. D'cruz.: The "double diamond" model of international competitiveness: The Canadian experience, MIR: Management International Review, Vol.33, 1993, pp.17-39.

14) Liu J, Nah K.: Design Collaboration Mode of Man-Computer Symbiosis in the Age of Intelligence. InIntelligent Human Systems Integration 2020: Proceedings of the 3rd International Conference on Intelligent Human Systems Integration(IHSI 2020): Integrating People and Intelligent Systems, February 19-21, 2020, Modena, Italy 2020 pp.640-645, Springer International Publishing.

15) Simonton, Dean Keith.: Creativity as blind variation and selective retention: Is the creative process Darwinian?, Psychological Inquiry, Vol.10, No.4, 1999, pp.309-328.
Campbell D T.: Blind variation and selective

Evolutionary creativity distinguishes between "variation" and "selection"[16]. In variation, new ideas are generated through the mutation and recombination of ideas during the creative process[17]. Generative AI can be thought of as an algorithm that comes up with new design variations through "mutation" and "recombination," which are terms used in the theory of evolutionary creativity[18]. Generative AI can recombine and transform content based on prompts provided by human designers. The prompts provided by human designers can serve as constraints to prevent generative AI from generating content beyond its scope. In selection, human designers are needed to complete the process. Although AI can generate thousands of design variations, it is important to decide which variant to choose. This step requires human designers to select and judge the generated designs based on human-centered design, which includes user needs, business goals, and other factors. During the process of variation and selection, new ideas and contents are constantly updated and iterated, which promotes and enhances user-centered design. Therefore, GAI and designers are collaborative rather than substitutes. AI mainly participates in the process of variation, while human designers are responsible for limiting variation and selecting designs that meet the design objectives(Figure. 3).



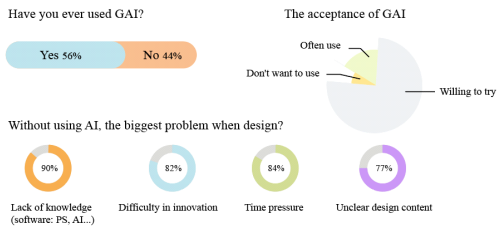
[Figure. 3] Interplay of designers and GAI related to human-centered design

Therefore, during the design process, designers need to consider how GAI can be used as an effective design tool to assist them in creating great projects and improving design efficiency

3. Methods

3-1. User needs analysis

Various design disciplines employ distinct methodologies and expertise. This research specifically focuses on the domain of product design. We conducted user interviews with a sample size of 100 individuals who are not professionals in product design. Subsequently, we designed data visualization to show the findings (Figure. 4). The interview content mainly includes the following three aspects: 1. Has GAI been utilized? 2. Acceptance of GAI 3. Challenges faced throughout the design process without using AI tools. We obtained the perspectives and challenges faced by the target users of GAI through user interviews.



[Figure. 4] User interview analysis

retentions in creative thought as in other knowledge processes. Psychological review, vol.67, no.6, 1960, p.380.

16) Thoring K, Huettemann S, Mueller R M.: THE AUGMENTED DESIGNER: A RESEARCH AGENDA FOR GENERATIVE AI-ENABLED DESIGN[J], Proceedings of the Design Society, No.3, 2023, pp.3345-3354.

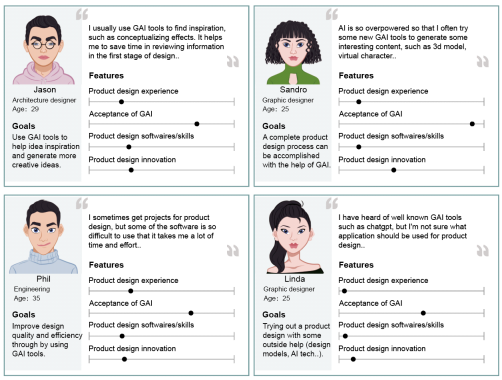
17) Thoring K, Müller R M.: Understanding the creative mechanisms of design thinking: an evolutionary approach[C], Procedings of the Second Conference on Creativity and Innovation in Design. 2011, pp.137-147.

18) Thoring K, Huettemann S, Mueller R M.: THE AUGMENTED DESIGNER: A RESEARCH AGENDA FOR GENERATIVE AI-ENABLED DESIGN[J], Proceedings of the Design Society, 2023, No.3, pp.3345-3354.

A fictional character persona was developed based on user interviews to gain a deeper understanding of the target users' requirements and preferences(Figure. 5). This persona encompasses two distinct user groups: Interdisciplinary designers within the design industry and non-designers.

P1 and P2, who are interdisciplinary users in the design field, lack expertise in product design. P3 and P4, on the other hand, are enthusiasts users who do not belong to the design domain. None of them possess a high level of professionalism in product design. Interdisciplinary individuals with design experience can find commonalities in the design process. They use GAI technologies to assist in their specific disciplinary designs, but they have not used GAI tools specifically for product design. Non-design users have not undergone a structured education in design and have not used AI tools for design. By referring to renowned design thinking frameworks and processes, certain stages of product design can be executed, while achieving a fully autonomous design is challenging. At the same time, they have a high recognition for GAI.

From the persona, it can be inferred that interdisciplinary users in the design area desire to use GAI tools to enhance the quality and efficiency of their designs. On the other hand, non-designers require a comprehensive product design guide to provide them with clear instructions to be performed at each stage of the design process. Additionally, they are also willing to use AI capabilities to help them present their designs. This indicates the research direction.



[Figure. 5] Persona

3-2. User journey map

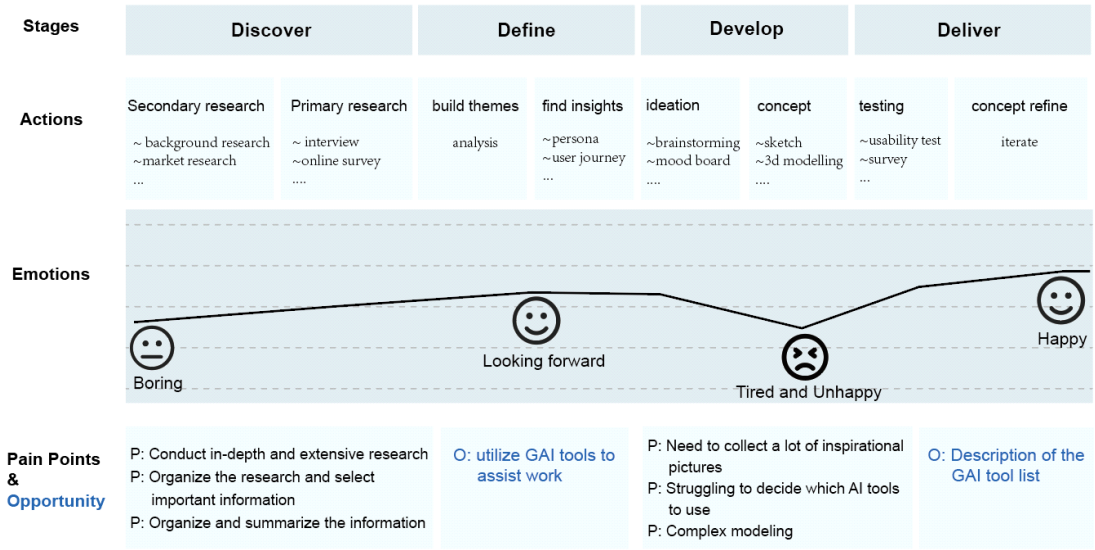
The user journey map facilitates a deeper understanding of users' behavioral, emotional, and cognitive aspects, resulting in the development of a more comprehensive strategy framework. According to the user journey map(Figure. 6), the entire process can be divided into four parts. In the discovery stage, design enthusiasts conduct research to obtain effective information, but during this step, users feel bored and dissatisfaction. Upon condensing the research findings, they identified valuable information for design purposes and established the design direction. In the design development stage, they do online research to find inspiring images and begin to conceive design concepts. In the deliver stage of the design, they need to think about the utilization of modeling software for the purpose of modeling, which is a challenge for them. Significant time was invested, although the ultimate presentation outcome may fell short of their expectations. Finally, the solution undergoes testing, and the design solution is improved and presented.

For design enthusiasts, product design can be challenging as it requires considering the functionality of the product to solve user problems, as well as the unique and aesthetic design of the product. At the same time, presenting design concepts poses a difficulty, regardless of whether they are presented in a two-dimensional or three-dimensional style.

These tasks are difficult to complete efficiently and independently by referring to a universal design thinking model, and require a lot of effort to learn and practice. However, certain tasks can be effectively resolved with the assistance of artificial intelligence. With the growing of multidisciplinary connections, more and more people with interdisciplinary backgrounds will engage with product design and develop an interest in it. Therefore, it is necessary to develop a strategic framework for product design specifically tailored to their needs.

3-3. Case study on Generate AI application space in the design industry

Currently, there are many mature generative AI tools that can provide users with thousands of solutions. To further demonstrate how these tools can be helpful in the design field, this paper selects representative generative AI tools that can provide different types of assistance in design. Table 1 lists and describes the functions of these tools, as well as their potential applications in the design field, such as text-to-image : Midjourney.



[Figure. 6] User journey map

[Table. 1] Generate AI application space in the design industry

Name	Input	Output	Function
Chat GPT	Text	Text	ChatGPT is an AI chatbot program developed by OpenAI. ChatGPT is powerful and includes the use in natural language processing tasks such as text generation, code generation and conversational AI[19].
Midjourney	Text	Image	Midjourney is an AI tool that generates beautiful images based on user's text prompts input[20].
DreamFusion	Text	3D	DreamFusion is an AI tool that creates 3D images from textual descriptions using 2D diffusion[21].
Audio2 Face	Sound	3D	Audio2Face takes a voice track as an input and renders the facial expressions of 3D characters including emotional expressions[22].
Artbreeder	Image	Image	Artbreeder can generate various types of images such as portraits, landscapes, architecture, animation, comics, and other subjects[23].
Runaway ML	Image	Video	RunawayML is an online AI creative platform that generates and edits video, audio and other subjects[24].
Shap-e	Image	3D	Shap-E introduces a diffusion process that can generate a 3D image from a text prompt[25].
Move AI	3D	3D	Move AI is a high-fidelity video generation 3D modeling tool that helps you capture motion and convert it into 3D models[26].

Upon examination of current applications of Generative Artificial Intelligence(GAI), a prevalent attribute becomes apparent: they are highly effective in tasks demanding substantial effort, such as image generation. They are capable of assisting people in resolving menial and repetitive jobs. However, they are not capable of independently executing design projects. They are not skilled in summarizing and struggle with emotionally driven creative tasks. This provides non-designers significant comfort, eliminating the need to invest substantial effort in acquiring proficiency in fundamental design tools. Hence, generative AI can serve as an effective design tool to aid designers in the process of designing. It is worth thinking about how GAI tools can be utilized to help improve design efficiency at different design stages.

4. Analysis and Results

4-1. Strategic framework for design collaboration with GAI

Design thinking plays an important role in the product design process. The Double Diamond model is commonly used by designers as a framework to facilitate the creation of exceptional solutions. The Double Diamond model is a universal model that provides a broad reference value for interdisciplinary design, making it a rough model. This makes it a challenge for design enthusiasts to independently accomplish a complete product design. Hence, taking into account the challenges faced by individuals with diverse backgrounds, this research proposes a detailed model of the product design process. It also highlights the potential assistance offered by current technologies, namely the Strategic framework for design collaboration with GAI (Figure. 7). This is helpful for non-designers to refer to when engaging in the process of product design. The framework is developed upon the Double

19) OpenAI, GPT-4 Technical Report. (2023.05.27.) URL: https://cdn.openai.com/papers/gpt-4.pdf

20) www.midjourney.com/

21) Poole B, Jain A, Barron J T, et al.: Dreamfusion: Text-to-3d using 2d diffusion[J]. arXiv preprint arXiv: 2209.14988, 2022.

22) www.nvidia.com/en-us/omniverse/apps/audio2face/

23) www.artbreeder.com/

24) runwayml.com/

25) OpenAI, GPT-4 Technical Report. (2023.05.27.) URL: https://cdn.openai.com/papers/gpt-4.pdf

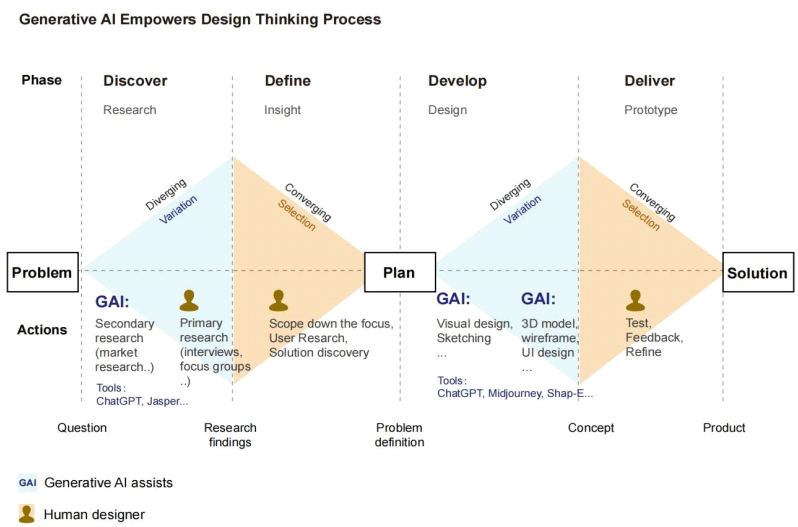
26) www.move.ai/

Diamond model, specifying the required design thinking and actions to be undertaken at each stage of the design process, and highlighting how to use GAI as a tool to assist in each stage of the design process.

This framework outlines the whole process of using Generative Artificial Intelligence (GAI) in aiding product design, as well as the responsibilities of human designers and AI in the process of problem discovery, problem thinking, and problem solving. During the discover phase, people have to do the research before designing. At this stage, people have the option to utilize generative AI to help with conducting secondary research, such as ChatGPT, and BingAI.. Human designers have to undertake primary research, such includes conducting user interviews and observations. GAI can help designers discover more ideas that were not thought of before and get more materials. After diverging information, human designers need to converge and scope down the research findings to effectively describe problems. Then, in the develop stage, GAI can provide ideation support by providing photos, drawings, models, and other resources to aid with conceptual design.

GAI can also generate concept images or 3D models to help design enthusiasts who are not good at using design software. There are so many tools that can be used such as Midjourney. In the final deliver stage, human designers need to conduct prototype testing and user tests to obtain feedback for further refinement.

In general, GAI has the potential to aid in gathering abundant design resources and enhancing design productivity during the process of generating diverse ideas. But GAI lacks empathy which is important in design. That is the reason that people play an important role in requiring user needs finding and user-centered design. This framework enables design enthusiasts to clearly comprehend the specific tasks and design thinking processes required at each phase of product design, as well as the tasks that can be accomplished with the assistance of GAI, hence facilitating the completion of the design more optimally. At the same time, this framework can serve as a reference for the creation of design frameworks in other disciplines in the future.



[Figure. 7] Product design strategic framework for design collaboration with GAI

4-2. GAI card toolkit in use

A design toolkit is a collection of methods, techniques, and tools used to support the design process that can be applied in practice[27]. Design toolkit have emerged as a powerful tool, facilitating multidisciplinary design. During the discovery and development stages of design, GAI could provide great assistance to designers. Nevertheless, there is uncertainty among people regarding the GAI instruments suitable for various tasks, necessitating investigation and acquisition of pertinent knowledge. To convenient the utilization of GAI in product design for people with interdisciplinary backgrounds, we have developed a GAI card toolkit(Figure. 8). This card toolkit contains a selection of GAI tools that can currently be used for product design, which people can choose from. Combining the previously proposed strategic framework for product design, this card toolkit contains two components: one is GAI tools that can be used during the product design discovery stage, and the other is GAI tools that can be used during the development stage.

Considering the readability and ease of use of the toolkit, the visual design of the cards is clear and intuitive. The GAI card toolkit clearly shows the content that GAI tools can provide, such as inputting text to output images.

The GAI card toolkit proposed in this study aims to assist the product design process. The GAI card toolkit provides a clear reference for people to determine the appropriate artificial intelligence tools to employ for different tasks. It can be used for both designers and non-designers. For example, in the development stage, if a man has a product concept sketch and wants to generate a three-dimensional model, but lacks expertise in modeling techniques. In this case, He used the GAI card toolkit and discovered that the Shap-E program could create a three-dimensional model based on an image. The field of artificial intelligence is advancing at a rapid pace, and it can be expected the development of increasingly advanced AI generation tools in the future. Thus, the GAI card toolkit suggested in this study is an expanding toolkit that can be further supplemented based on this in the future.

GAI card toolkit for DISCOVER process

Name	Assist area
ChatGPT	Secondary research : Market, technology
Jasper	Secondary research : Market, technology
UserZoom	Primary research : User research
Optimal Workshop	Primary research : User experience research

GAI card toolkit for DEVELOP process

Name	Input	Output
ChatGPT	Text	Text
Midjourney	Text	Image
Dall-E	Text	Image
DreamFusion	Text	3D
Prome AI	Image	Image
Artbreeder	Image	Image
Shap-E	Image	3D
Meshy.AI	Image	3D
Runaway ML	Image	Video

[Figure. 8] GAI card toolkit for "discover"and "develop" stages in product design

27) Conole G, Fill K.: A learning design toolkit to create pedagogically effective learning activities[J]. Journal of Interactive Media in Education, 2005, No.1. pp.1-16.

4-3. User test

To verify the effectiveness of the framework and GAI card toolkit, user testing is necessary. The testing includes two product design projects and anonymous ratings. Ten individuals with less than one year of expertise in product design were recruited from various disciplines to take part in the testing. All participants willingly volunteered and received a notebook as a gift after the testing was completed.

The design section required all participants to complete the same design tasks. The two design tasks were "designing a balance bike for kids" and "designing a scooter for urban people". The design content includes the design of product aesthetics, functionality, and the introduction of design concepts. The two design tasks were completed within two days, with a maximum time limit of three hours for each project. Participants could terminate the design early according to their process. It is important to mention that this test does not encompass usability testing of the ultimate design concept and subsequent implementation of the solution. During the first project process, students can use computers and artificial intelligence tools. During the second project, the GAI card toolkit and the product design process framework were provided for them as a reference. Finally, participants anonymously evaluate other people's designs according to the German Red Dot Award standard[28], with a rating scale of 0-5 points. The evaluation criteria are divided into two aspects: creativity and practicality. In order to enhance the clarity of the findings, we conducted a comparative analysis of the data obtained from the two tests, as indicated in Table 2.

[Table. 2] Comparison of the results of two tests

	"Balance bike design for kids"			"Scooter design for urban people"		
ID	Innovation Score (M)	Practicality Score (M)	Design Time	Innovation Score (M)	Practicality Score (M)	Design Time
P01	2.25	2	3h	2.75	2.5	2h40 min
P02	2.5	2.25	2h40 min	3	2.5	2h30 min
P03	3.25	3.25	2h30 min	4.25	4	2h10 min
P04	2	2.5	2h40 min	2.75	3	2h10 min
P05	3.25	3.5	3h	4	4	2h30 min
P06	2.75	3	3h	3	3	2h40 min
P07	3.25	2.75	3h	3.5	3	2h45 min
P08	3.5	3.5	3h	4.25	4	3h
P09	2	2	3h	3	2.5	2h50 min
P10	2.5	3	3h	3	3	2h50 min

The findings indicated that after using the strategic framework and the GAI card toolkit, the participants' scores in terms of innovativeness and practicality of product design improved, without becoming worse. This suggests that the strategic framework and GAI card toolkit proposed in this research are helpful and effective for design enthusiasts in product creation. Furthermore, the second design time also exhibited a shorter duration compared to the first project design, suggesting that the utilization of GAI tools can enhance design effectiveness.

5. Conclusions

The advancement of artificial intelligence technology has led to the increasing potency of Generative Artificial Intelligence(GAI), resulting in significant disruptions across various industries. Within the realm of design, GAI possesses the ability to autonomously accomplish certain tasks, but it is incapable of substituting human designers. GAI is proficient in handling a large amount of repetitive work. However, they

28) Zec P.: Design on stage-The red dot design award[J], Design Management Review, Vol.18, No.1, 2007, p.60.

are not capable of independently completing design projects. They are not skilled in summarizing design content and performing some creative work that requires emotional design. The importance of human designers resides in their cognitive and emotional abilities, which is why certain traditional design thinking frameworks and methodologies have been learned and employed by people, rather than being forgotten. The GAI, being a potent and efficient tool, has created opportunities for people from other disciplines. GAI can serve as a design assistant, enabling a broader range of design enthusiasts to participate in the design process and produce their creations.

This study aims to investigate the use of Generative Artificial Intelligence(GAI) in supporting designers and non-designers during the design process for creation. This study presents a design collaboration strategic framework for the entire product design process, utilizing the Double Diamond design model and incorporating GAI into the design process. The framework shows the specific tasks that human designers should undertake at each phase of the design process, as well as the assistance that can be offered by GAI. The purpose of this framework is to help comprehension among designers and non-designers on the steps to be followed during the design process and the tasks that can be accomplished with the aid of technology. Furthermore, this study presents a GAI card toolkit that facilitates the utilization of current technologies to enhance design quality and efficiency.

The framework and toolkit have undergone user testing, and the results indicate a positive influence on product design. In the future, more detailed strategic frameworks can be developed based on the different contents of various design specialties. Meanwhile, the GAI toolkit presented in this study is an expanding toolkit that can be updated with further artificial intelligence technologies. In addition, designers and professionals in various fields can develop their own GAI toolkits to enhance the efficiency and quality of design.

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