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Modern Design Thinking and AIGC Intervention

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Abstract. Modern Design Thinking is a series of constantly developing heuristic methodologies that advocate for human-centered, collaborative, interdisciplinary, and iterative design research. This article traces the development of modern Design Thinking through literature research. Designers should understand the current Design Thinking mode and its limitations and speculate and develop Design Thinking based on continuous design practice and philosophical abstraction. Designers should actively face the intervention of AIGC, regard it as their tool and assistant, work together with it, and jointly promote design innovation development. Designers must maintain their advantages in creativity and personalization, constantly learn and update their skills and knowledge, establish emotional connections with users, and provide better design services.

Keywords. Modern Design Thinking, traceability, design process, AIGC

1. Introduction

The extension of design in modern society is constantly expanding, with the fields of design ranging from visual design, product design, and environmental design to service design, experience design, organizational design, and system design. As an exclusive term, Design Thinking is not exclusive to design studies. It has permeated the development of various industries, such as sociology, management, and engineering. From the perspective of keyword search popularity on the Google platform, the global search of "Design Thinking" shows a growth trend. The search volume was low from 2004 to 2010, and then the popularity rose. The increase was not significant during the COVID-19 epidemic. Then, the search popularity remained high (see Figure 1; "Remarks" in the figure is the Google data system update node).

Figure 1. "Design Thinking" search popularity (Google Trends)

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Richard Buchanan (1992), a professor at Carnegie Mellon School of Design, proposed that Design Thinking is a new synthesis of symbols, things, behaviors, and environments, emphasizing humans' specific needs and values in diverse environments (see Figure 2):

- Symbol and visual communication design includes both traditional graphic design and the communication field of film and television media.
- It is the design of objects, including the shape and appearance of objects, and the new construction of multiple physical, psychological, social, and cultural relationships between products and people.
- Organized service and event planning and design include traditional logistics management content, physical resource integration, decision-making, strategic planning, and how Design Thinking can achieve satisfactory and meaningful smooth experiences in specific contexts.
- It is the design of complex systems or environments of living, working, entertainment, and learning and exploring the role of design in continuously developing ecological and cultural systems, meeting people's needs, and meeting expected environments.

Symbols, things, behaviors, and ideas are interconnected and permeated and are integrated into contemporary Design Thinking, playing a significant role in innovation. The effectiveness of design depends on the designer's ability to integrate the three rational thinking of product ingenuity, product functional logic, and personal and social value realization [1].

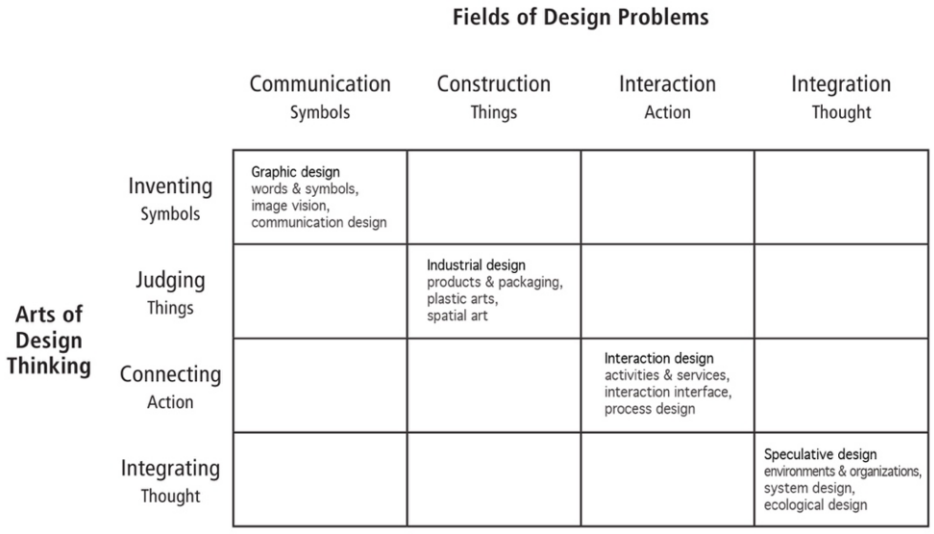

Figure 2. The four orders of design. (Richard Buchanan)

Design Thinking is a people-oriented, problem-solving-oriented methodology emphasizing participatory and iterative design processes, aiming to collaborate across multiple disciplines and discover and solve complex problems. The complexity of design objects determines the extension and transformation of Design Thinking. However, some scholars in China currently confuse "Design Thinking" with "design creativity" or believe that designers cannot produce eye-catching and touching creative products

through rigorous deduction of Design Thinking. The reason is that they need to understand the development context of Design Thinking. Design Thinking has become a systematic methodology for people-oriented collaborative innovation (an independent concept); design creativity (Ideas/Inspiration/Creation) is not a theoretical term but can be understood as the intuitive expression of designer inspiration based on narrative, symbolism, and semantics.

In 2022, AIGC broke out, causing competition from the technology and industry sectors. AIGC (Artificial Intelligence Generated Content) is an artificial intelligence system based on machine learning, deep learning, and other technologies that can perform search, screening, summarization, reasoning, and synthesis of new data from big data. It can assist or replace humans in analysis, research and development, and decision-making. AIGC is a new production method for digital content generation and interaction, following PGC (Professionally Generated Content) and UGC (User Generated Content), such as AI graphics, audio and video, AI code, and virtual human, object, and field content.

Generative AI (GAI) is an artificial intelligence technology that can generate new, deceptive content by learning and simulating data distribution characteristics. Generative AI can generate various types of content, including images, audio, videos, text, and more. AIGC refers to content automatically generated by artificial intelligence systems. This type of content can be generated using GAI technology or other artificial intelligence technologies such as natural language processing or image recognition. AIGC can include articles, news reports, works of art, music, and more. Therefore, GAI is a technology used to generate content, while AIGC refers to content generated by artificial intelligence systems. GAI is one of the methods or technologies for implementing AIGC.

AIGC can intervene in various aspects of human Design Thinking, and its impact at this stage depends to some extent on human ambition and level of control.

2. Traceability of Modern Design Thinking

The essence of discovery and creation is different [2]. The design process involves solving and discovering problems, thus enabling the joint development of problem-solving and solution development [3]. Design Thinking follows an iterative process of discovering and defining problems and exploring, developing, and evaluating possible solutions simultaneously.

The founder of Bauhaus, German architect Walter Gropius, believes that design can integrate others. In 1937, he reflected on the development process of Bauhaus and believed that many issues similar to human nature belonged to the content of Bauhaus' design education (see Figure 3). The design was neither pure theory nor simple practice but an inseparable part of daily life and was necessary for everyone in a civilized society [4]. Propose a new unity of art and technology in design theory. The design purpose is people rather than products. The design follows natural and objective laws for curriculum reform and teaching practice.

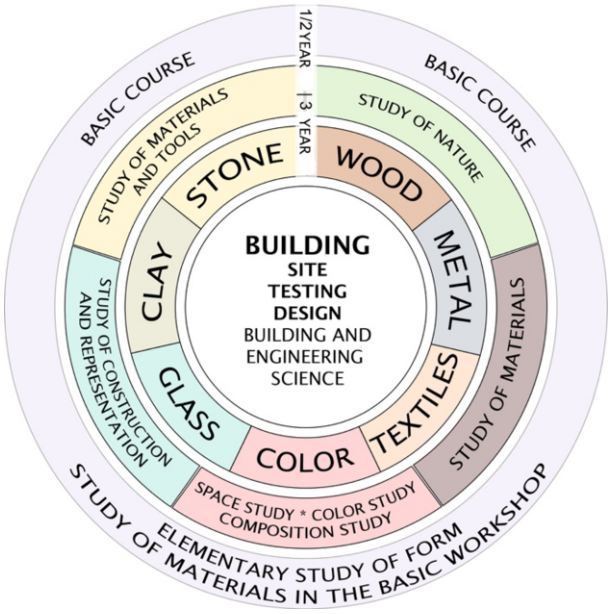

Figure 3. Bauhaus curriculum wheel.

In the early stages of World War II, Brehon B. Somervell, the General of the US Army Supply Services, attempted to unify the dispersed procurement activities of the Army and Navy, establishing an integrated Army Supply Plan (ASP), which controlled the entire procurement process from contracts and production schedules to delivery and distribution to the battlefield. In order to manage the complex procurement process, ASP introduced a military supply management system in early 1944, which consisted of a carefully designed set of tables and records. All necessary procurement information for each project was gathered for the first time to collect and record the latest information at various stages of ASP operation. Although people did not consider this system to be a product of Design Thinking at the time, it was considered a pioneer in later system design in the design community (such as systems used to handle large-scale projects similar to the Apollo program in the 1960s and early 1970s) [5].

John Dewey (1964) believes that inquiry is a controlled transformation that transforms uncertain states into states with relatively certain classifications and relationships, transforming the various constituent elements of the original state into a unified whole [6]. Under this definition, the exploration strategy is to find theoretical, practical, or productive solutions to problems, guiding people's knowledge progress in cognitive and behavioral aspects [7]. Dewey described the five stages of thinking logic in "How We Think": First, identifying difficulties and difficulties; Second, Positioning and defining the problem; Third, Possible answers and solutions; Fourth, Reasoning associations; Fifth, Further observation and experimentation to validate beliefs [8]. It can be seen that the exploration process is consistent with the logical thinking. These five stages are closely related, and reciprocating iterations will occur during the process. When people gather information to answer a question and solve a problem, it is called conducting research work [9]. Design research has a certain degree of complexity and resistance to solution, and each stage of the research process may repeatedly verify and solve problems, ultimately solving problems in a spiral ascending form as a whole. Dewey's "inquiry theory" also applies to the design field.

Thomas Edison created the electric lightbulb in 1879, often considered his signature invention, and then wrapped an entire industry around it. However, Edison understood that the bulb was little more than a parlor trick without a system of electric power generation and transmission to make it truly useful. Thus, Edison's genius lay in his ability to conceive of a fully developed marketplace, not simply a discrete device. He invariably gave significant consideration to users' needs and preferences and was able to envision how people would want to use what he made. Edison's approach was an early example of what is now called "Design Thinking"—a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos. He surrounded himself with gifted tinkers, improvisers, and experimenters by creating a team-based approach to innovation, which helped experimenters learn something new from each iterative stab in his Menlo Park laboratory.

The term "Design Thinking" has been part of the collective consciousness of design researchers since Peter Rowe used it as the title of his 1987 book. According to Rowe, Design is the fundamental means of inquiry by which architects and planners realize and give shape to ideas of buildings and public spaces. His book "Design Thinking" provides a general portrait of design that characterizes its inherent qualities and sets it apart from other inquiry forms. Rowe defines the intellectual activity of designing as rational inquiry governed by guiding principles and constraints and as a matter of the conviction and impulse by which design principles are invented and applied [10].

Jonathan Cagan, Craig M. Vogel (2002) emphasized that development teams should collaborate and collaborate across disciplines on the basis of balancing the needs and desires of target users and other stakeholders, and proposed the Design Thinking process of Integrated New Product Development (iNPD), which includes four stages: opportunity identification stage, explicit and ambiguous early stage, insight into user needs and product development requirements; In the opportunity understanding stage, understand the relationships between stakeholders and the opportunity points throughout the entire process of accessing products/services, and translate them into overall design specifications; In the conceptualization stage of opportunities, value opportunities are transformed into functional, user-friendly, and attractive product/service conceptual models, and iterative optimization is repeatedly tested; In the opportunity realization stage, clarify the product brand identification and promotion marketing plan, and comprehensively carry out production, processing, and marketing (see Figure 4). INPD is a process that can guide specific practical operations and help development teams clarify the "fuzzy early stage." It is a systematic method that combines strategic planning, design, development, and brand management and integrates physical product and service design [11], which has been widely applied in the industry.

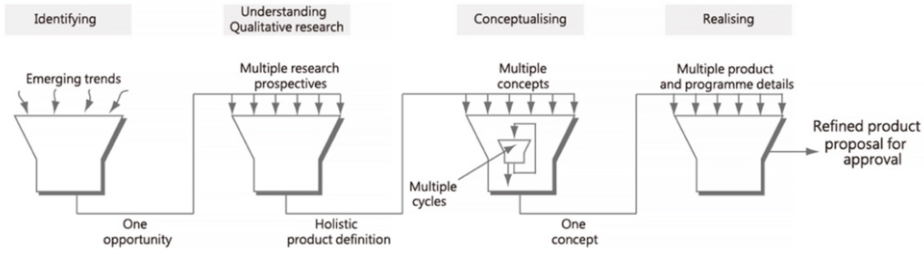

Figure 4. iNPD process (Jonathan Cagan, Craig M. Vogel, 2002)

Professor David Kelly, one of the founders of IDEO, Stanford University, founded d.school in 2004, using Design Thinking as a way of thinking and a code of conduct. He offers design courses for the entire school, dedicated to cultivating students' innovative thinking and problem-solving abilities. IDEO CEO Tim Brown (2008) proposed that Design Thinking is an innovative human-centered design approach that draws inspiration from the methods and tools adopted by many designers, integrating human needs, technological possibilities, and the conditions required to achieve business goals [12]. Design Thinking focuses on social issues, empathizes with user needs, defines problems, goals, and impacts, analyzes stakeholder relationships, envisions solutions, prototype tests, implements, and iterates products (see Figure 5). The socialized thinking advocated by Design Thinking is a method of design attitude, thinking, and communication with people. Design Thinking is just such an approach to innovation: a human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions [13].

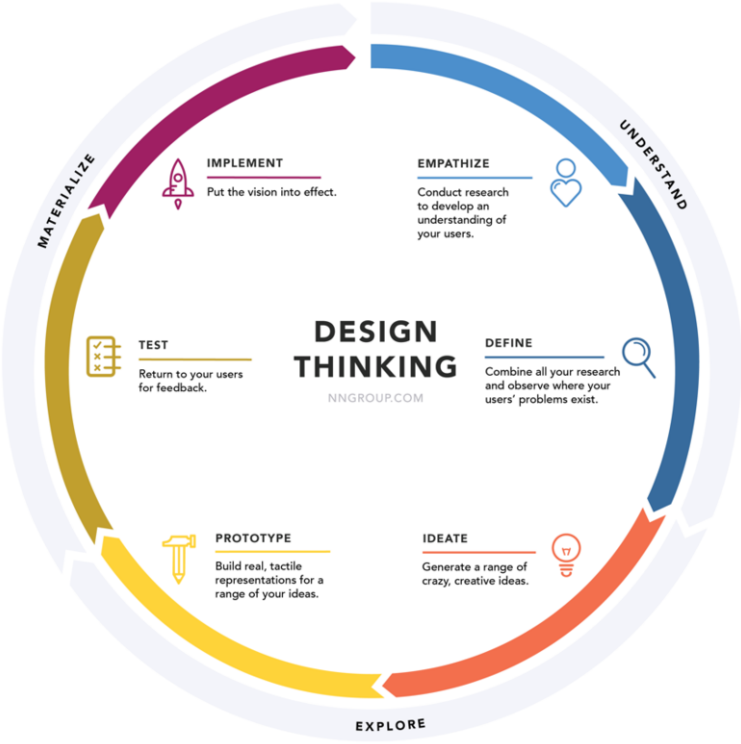

Figure 5. Design Thinking (NNGROUP.com)

The Double Demand Model was created by The British Design Council (2005) and describes the mindset used by designers, mapping the divergent and convergent stages of the design process. Design Thinking starts with a trigger, which may be an idea, some insights, market changes, or macroeconomic changes [14]. Stage 1: Identify issues. Understanding phenomena and current situations, exploring new issues, and identifying opportunities for further reflection. Stage 2: Define the problem. Integrate information and knowledge into insights, define real problems, focus on opportunities, and develop plans. Stage 3: Development exploration. Through the iterative process of exploration

and verification, the design solution is evolved into an executable development solution. Stage 4: Delivery Plan. Analyze and validate potential solutions, and after the solution is determined, begin implementing the deliverable solution (see Figure 6).

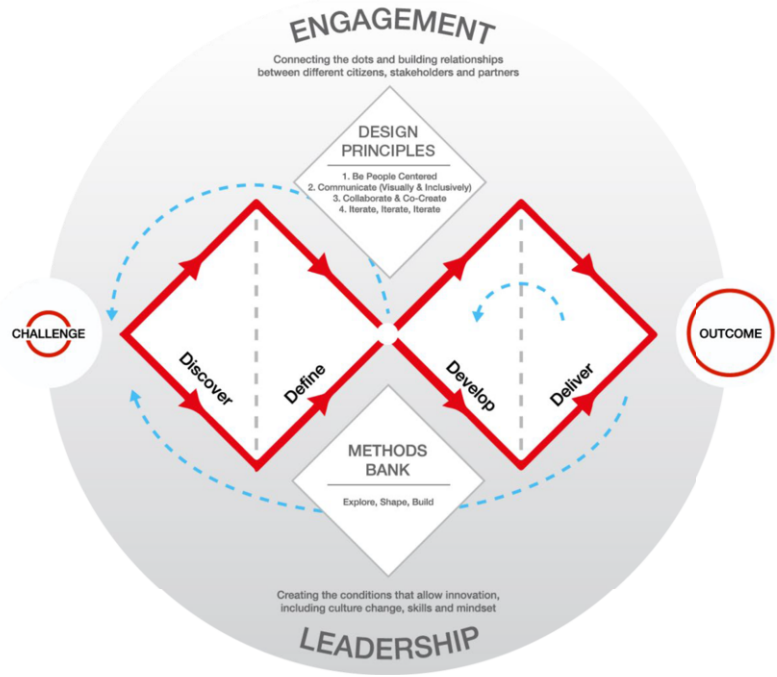

Figure 6. Double Demand Model (The British Design Council, Revised in 2019)

Through investigating how design practices could be enlisted to help organizations deal with the new open, complex problems they are facing in the modern world, Kees Dorst concentrated on frame creation as a core practice that is particular to the designing disciplines and explored how that design practice could interface with an organization. Abduction is most closely associated with design (Roozenburg & Eekels, 1995) [15]. The term "Abduction" was proposed by American pragmatist philosopher Charles Sanders Peirce, which differs from induction or deduction in reasoning. Deduction proves facts; Induction indicates the operability of things, and Abduction only indicates the possibility of things [16]. The challenge in the Abduction of open-ended problem-solving is to figure out 'what' to create, while there is no known or chosen 'working principle' that we can trust to lead to the aspired value. That means we have to create a 'working principle' and a 'thing' (object, service, system) in parallel (see Figure 7) [17].

Figure 7. Abduction of open-ended problem-solving (Kees Dorst, 2011)

We can see that from Dewey's exploration theory, Integrated New Product Development, IDEO's Design Thinking, to The British Design Council's Double Demand Model, there is a common understanding of the "Design Thinking" process, which involves drawing threads and cocoons from the chaotic and fuzzy early stages to define real problems, designing prototypes, iteratively testing and implementing solutions, and analyzing problems through agile iteration to obtain the best solution during the process.

3. AIGC Intervenes in Modern Design Processes

Design Thinking follows the principle of putting people at the center. ISO 9241-210:2010 provides requirements and recommendations for human-centered design principles and activities throughout the entire lifecycle of computer interaction systems, aimed at being used by those who manage the design process, focusing on the software and hardware of the interaction system to enhance the way people interact with the system. This type of design research has a typical architecture, an iterative research cycle typically characterized by observation, definition, rapid prototyping, and testing. Each iteration is built on the lessons learned from the previous cycle, and the process terminates when the results are appropriate or the deadline is reached [18]. AIGC has changed the speed and efficiency of the design process. Traditional design processes typically require significant time and effort to complete various stages, such as requirements analysis, creative development, design production, and review. However, AIGC can automatically generate design content, significantly shortening the time of the design process. Designers can quickly create preliminary design plans using design elements and templates generated by AIGC and make further adjustments and optimizations. This way, designers can respond to customer needs faster and provide more efficient design services.

3.1. Background Research and Requirement Insight Stage

Design Thinking starts with understanding, and the design process starts with deeply understanding the client's background, behavior, and experience. Using empathy to view the world from the perspective of others is the key to collaborating with stakeholders and utilizing different perspectives to plan better solutions. However, people inevitably have certain cognitive biases or are constrained by the information cocoon effect, which narrows our horizons and makes it difficult for us to empathize with people who are different from ourselves. However, AIGC can help designers understand market trends, user preferences, and industry dynamics by analyzing a large amount of data and information. Designers can use AIGC-produced data analysis reports and trend predictions to guide design direction and decision-making. In this way, designers can more accurately grasp market demand and provide design works that meet user expectations. AIGC can also help designers understand users' evaluations and needs for design works by analyzing user behavior and feedback data. Designers can utilize user feedback and insight reports generated by AIGC to understand user preferences, pain points, and expectations, thereby optimizing design works. This way, designers can better meet users' needs and provide design solutions with a more user experience.

3.2. Collaborative Innovation and Problem Definition Stage

The design research process requires designers, organizations, and stakeholders to engage in Participatory Design or Co-Design. In the process of open innovation, people from different fields share and integrate ideas, ideas, and knowledge to meet the needs of various stakeholders [19]. The complexity and diversity of problems are something only some can handle, and this process still requires designers to take the lead, highlighting designers' professionalism in controlling design research. AIGC can achieve a more efficient innovation process through collaborative work with designers. Designers can interact and collaborate with AIGC in real time, raise questions, seek advice, and receive timely feedback through dialogue. This interactive design process can help designers better understand user needs, utilize AIGC-produced design works as creative inspiration and reference, and quickly generate diverse design solutions. Generative AI intervenes in co-creation, analyzing stakeholders' knowledge background and practical needs more profoundly and comprehensively, thereby making designer decisions more objective, generating efficient, high-quality, low-cost solutions, and jointly promoting innovation and progress in design works. AIGC can help designers define design problems more accurately by analyzing and processing a large amount of data. Designers can provide AIGC with some essential information and parameters, and AIGC can analyze this data to help designers better understand user needs and pain points. AIGC can provide in-depth insight and understanding of design issues based on user feedback and behavioral data, assisting designers in defining and solving problems better.

3.3. Creation Developing and Concept Setting Stage

In traditional design processes, the creative and conceptual stages typically require designers to conduct extensive research and brainstorming to generate ideas and concepts. AIGC can provide rich creative inspiration and reference resources, helping designers obtain more inspiration and references during the design and research stage. Designers can broaden their design ideas and enhance the innovation and uniqueness of their designs. AIGC can also automatically generate ideas and concepts by analyzing a large amount of data and information. Designers can use the creativity and concepts generated by AIGC as a starting point for further development and optimization. In this way, designers can create ideas and concepts faster, improving the efficiency of the design process.

AIGC can increasingly participate in creative digital content generation work, assisting designers in continuously generating, iterating, and validating innovative solutions through human-machine collaboration. AIGC has been involved in the production of various media forms such as text, images, music, videos, virtual humans/objects/fields, and completed the creation of specific themes under the guidance of humans. AIGC can automatically generate design prototypes and sketches. Designers only need to provide some basic design parameters and requirements. AIGC can quickly generate multiple design solutions, helping designers explore different creative directions faster and allowing them to gain more creativity and choose the best solution. AIGC can automatically complete repetitive and tedious design tasks, such as graphic generation, layout, and color selection. This way, designers can devote more time and energy to creative and strategic work, improving design efficiency.

3.4. Review and Feedback Stage

AIGC provides automated design review and optimization functions, allowing designers to use these tools to check their designs' accuracy, consistency, and compliance. Designers can quickly identify and fix problems in their designs, improving the quality of their designs. AIGC can automatically evaluate designs based on design specifications and best practices and provide suggestions for improvement. AIGC can simulate user behavior, provide feedback on design usability, usability, and satisfaction, evaluate the user experience of design solutions, and automatically generate different versions of design solutions to help designers optimize strategies to meet customer requirements and improve user experience. AIGC can use simulation and simulation techniques to predict the performance and effectiveness of designs under different conditions, validate and optimize designs, and help designers identify and solve potential problems before production, which helps to reduce errors and inconsistencies in design and improve design quality and efficiency.

Although AIGC can skip many steps in the human Design Thinking process and directly provide solutions, we still hope to use AIGC to support and assist in various stages of the Design Thinking process to control the research direction and form of results accurately (see Figure 8).

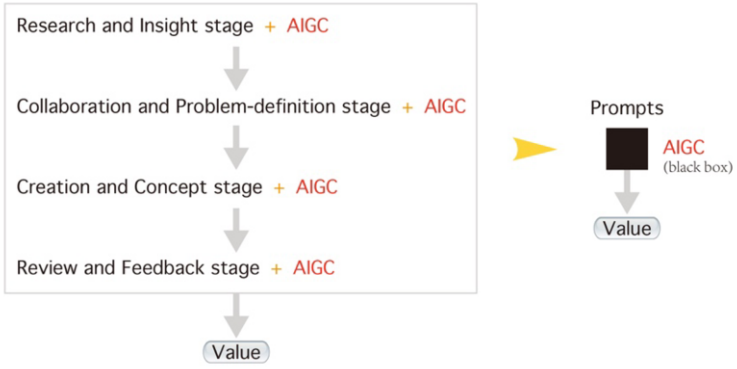

Figure 8. Design Thinking Process + AIGC.

4. AIGC Changes Modern Design Services

Here, we will discuss it from two aspects: the design object and the design subject.

4.1. Design Form and Media

AIGC has improved the design process and processes in modern design services. It can provide insight, automatically generate design solutions, automate review and optimization, and interact and collaborate with designers in real time, thereby improving design efficiency and quality and helping designers create excellent design works more efficiently. Designers can use AIGC as a starting point and reference resource to further develop and improve their design work. At the same time, AIGC can help designers

quickly identify and fix design issues, improving the quality and accuracy of design works.

The application of AIGC in design form and media provides designers with automated design generation, multimedia design and interactive experience, personalized customization, and intelligent recommendation services. AIGC can automatically generate design works through deep learning and algorithm models. By inputting essential information and parameters, designers can enable AIGC to generate design works that meet the requirements automatically. For example, AIGC can automatically generate product models and rendered images with usage scenarios. This automated design generation can significantly reduce designers' workload and time costs and improve design efficiency. AIGC can help designers provide more decadent choices and creativity in multimedia design and interactive experience. AIGC can generate diverse design forms and media presentation methods by analyzing many multimedia materials and interaction design cases. For example, AIGC can generate web page templates with different styles and layouts, helping designers quickly build website interfaces. In this way, designers can more flexibly choose and apply various design forms and media to meet the needs of different user groups. AIGC can provide intelligent design customization and recommendation services based on users' personalized needs and preferences. AIGC can generate personalized design works tailored to users by analyzing user behavior data and preference information. For example, AIGC can generate customized advertising plans based on user interests and purchase history. This personalized customization and intelligent recommendation can improve the personalization and targeting of design works and enhance user engagement and satisfaction. Designers can use AIGC to generate design works more efficiently, choose suitable design forms and media, and meet the personalized needs of users.

4.2. Designer Responsibilities and Training

AIGC's ability to empower full-stack creative talents will result in a transformation of talent mobility and the emergence of new work mechanisms [20]. Traditionally, designers are mainly responsible for innovative ideas, design proposal development, and visual expression. However, with the development of AIGC, the role of designers has gradually shifted from creators to guides and strategists. The emergence of AIGC redefines the roles and responsibilities of designers. Designers must collaborate with AIGC technology as tools and resources to expand their creative abilities and Design Thinking. Designers need to understand and master the principles and applications of AIGC technology to communicate and collaborate with it effectively. Designers need to learn how to utilize the design content and creativity generated by AIGC to provide customers with more strategic and innovative solutions. The role of designers has gradually shifted from creators to guides and strategists. Designers must consciously guide their development direction when using AIGC to meet customer needs and goals. Designers need to possess strategic thinking and innovative abilities, be able to combine the design content generated by AIGC with their professional knowledge and experience and provide more creative and valuable design solutions. Although AIGC can automatically generate design content, it lacks human emotions and personality. Designers can customize and personalize the design content generated by AIGC through in-depth communication and understanding with customers to meet their unique needs and brand image.

Design education is an essential part of cultivating designers, and the emergence of AIGC has brought new challenges and opportunities to design education. Designers need to adapt to the skills and tools of using AIGC to better collaborate with artificial intelligence. Therefore, design education must update course content and teaching methods, strengthen training on related knowledge such as artificial intelligence and machine learning, and enable students to use AIGC technology to assist design work flexibly. At the same time, design education must cultivate students' creativity and Design Thinking. Although AIGC can automatically generate design content, it must partially replace designers' creativity and unique perspective. Therefore, design education must focus on cultivating students' creativity, critical thinking, and problem-solving abilities, enabling them to collaborate with AIGC to create more innovative and strategic design solutions. In addition, design education also needs to pay attention to ethical and moral issues. Using AIGC may raise ethical and moral issues such as intellectual property, data privacy, and social impact. Therefore, design education must teach students how to use AIGC technology correctly, follow ethical norms, and be aware of design's social responsibility and impact.

Overall, the emergence of AIGC has profoundly impacted modern design services and design education. It has changed the positioning and blame of designers, improved the efficiency of the design process, broadened the diversity of design outputs, and prompted design education to update courses and cultivate students' creativity and problem-solving abilities.

5. Problems and Challenges

AIGC's involvement in the Design Thinking process brings some problems and challenges to designers. Firstly, the design works generated by AIGC may need more uniqueness and personalization, as they are generated based on a large amount of data and algorithms. Designers must know this by conducting in-depth research on user needs and market trends, seeking unique creative inspiration, and creating more personalized and innovative design works. Secondly, designers need to adapt to the collaborative work style with AIGC. Designers can use AIGC as their tool and assistant to repeatedly interact and adjust with AIGC to generate design solutions quickly. At the same time, designers must filter and modify the designs generated by AIGC to ensure that they meet user needs and brand image. Once again, designers need to constantly learn and update their skills and knowledge, understand the latest design trends, and adapt to the development of AIGC technology. Designers can pay attention to relevant technologies and algorithms and understand their principles and application scenarios. Finally, the design works generated by AIGC may lack the emotional and human touch and cannot establish deep emotional connections with users. Designers can inject unique humanistic characteristics into their design works by incorporating personal creativity and emotional elements. Designers can also engage in in-depth communication and feedback with users, understand their needs and emotional experiences, and create more infectious design works.

Although AIGC still has much room for development in details, accuracy, and extreme event handling, its initial performance is impressive, with some achievements comparable to those of experienced creators. Generative AI is undergoing rapid innovation and will become a new life form in the digital world with unlimited potential.

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