Journal of Research in Vocational Education ISSN: 2408-5170
DOI: 10.53469/jrve.2024.06(09).07

Modern Design Methods and Industry-Academia Collaboration

Xiaoyan Teng[1,*], Hongyang Wang[2], Dongyan Shi[3], Xudong Jiang[4], Xuan Xue[5]

[1,2,3,5]Harbin Engineering University, Mechanical and Electrical Engineering, Harbin, Heilongjiang, China
[4]Harbin University of Science and Technology, College of Mechanical and Power Engineering, Harbin, Heilongjiang, China
[1]tengxiaoyan@hrbeu.edu.cn, [2]m15683118637@163.com, [3]shidongyan@hrbeu.edu.cn
[4]jxd_2023@163.com, [5]why010405@163.com
**Correspondence Author*

Abstract: ***In the field of modern design, the continuous evolution and innovation of design methods are of significant importance to the competitiveness and innovative capacity of enterprises. At the same time, industry-academia collaboration, as a bridge connecting academia and industry, can effectively promote the development of design education and industrial progress. This paper explores the concepts and applications of modern design methods, analyzes the current status, challenges, and successful cases of industry-academia collaboration, and proposes practical applications and future development directions for modern design methods in such collaborations. The study shows that effective industry-academia collaboration can further enhance the application of modern design methods, foster the cultivation of innovative talents, and promote sustainable industrial development.***

Keywords: Modern Design Methods, Industry-Academia Collaboration, Innovation, Design Education, Industrial Cooperation.

1. Introduction

The rapid development of modern design methods, especially driven by digitalization and information technology, has made design methods more diverse and complex. These methods not only affect the design industry itself but also permeate various other industries, becoming important tools for enterprise innovation and development. Meanwhile, industry-academia collaboration, as an effective cooperation model, can integrate the scientific research capabilities of universities and the practical experience of enterprises, injecting new momentum into design education and industrial development. Therefore, studying the combination of modern design methods and industry-academia collaboration has significant theoretical and practical implications.

The evolution history of modern design methods demonstrates the integration of technology and design thinking. Since the Industrial Revolution, design has gone beyond the pursuit of aesthetics to become a means of solving practical problems. With the development of computer technology, design methods have transitioned from manual drawing to computer-aided design, greatly improving design efficiency and precision. In recent years, modern design methods such as design thinking, user-centered design, and agile design have been widely applied, driving innovation and development across various industries.

This paper aims to explore the concepts and classifications of modern design methods, their applications in industry-academia collaboration, analyze the current status and challenges of such collaborations, and summarize best practices through case studies. The research methods include literature analysis, case studies, and field interviews to ensure comprehensive and scientific research.

First, this paper conducts a literature review to outline the definitions, classifications, and development history of modern design methods. Then, it analyzes the current status, modes, and challenges of industry-academia collaboration. Following this, several typical cases are explored in-depth to investigate the specific applications of modern design methods in industry-academia collaboration. Finally, based on current research findings, future development directions and recommendations are proposed.

2. Overview of Modern Design Methods

Modern design methods refer to a series of systematic and scientific methods and tools applied in the design process, aiming to improve design efficiency and quality. The main design methods include:

User-Centered Design (UCD): Focuses on user needs, continuously optimizing design solutions through user research and testing. UCD emphasizes user involvement and feedback, ensuring that design products meet users' real needs through iterative improvements.

Design Thinking: Solves complex problems through understanding users, defining problems, generating ideas, prototyping, and testing. Design thinking emphasizes interdisciplinary team collaboration, stimulating innovative thinking and solutions through co-creation.

Agile Design: Adopts the principles of agile development, enhancing design flexibility and responsiveness through iteration and rapid prototyping. Agile design emphasizes quick responses to changes, continuously improving design products through frequent user feedback and testing.

The development of modern design methods can be traced back to the early 20th century. With the rise of the Industrial Revolution and scientific management, design methods gradually shifted from experiential and artistic to scientific and systematic. Since the 1960s, the development of computer technology has further driven the digitalization and informatization of design methods, resulting in the emergence of new design methods and tools, such as computer-aided design (CAD) and virtual reality technology.

Early 20th Century: The Industrial Revolution brought mechanized production, transitioning design methods from craftsmanship to industrial design, emphasizing functionality and manufacturability.

Mid-20th Century: The rise of scientific management and systems engineering promoted the standardization and systematization of design methods. Design methods based on engineering principles began to be applied in product development and manufacturing processes.

Late 20th Century: The development of computer technology revolutionized design methods. The widespread adoption of CAD technology made the design process more precise and efficient. Additionally, the application of virtual reality and simulation technology further enhanced the visualization and interactivity of the design process.

21st Century: With the development of the internet and mobile technology, design methods have become more user-centered. Emerging methods such as design thinking and agile design emphasize user participation, rapid iteration, and interdisciplinary collaboration, significantly driving design innovation.

Modern design methods have been widely applied in various industries such as manufacturing, services, and information technology. For example, user-centered design is extensively used in product development, helping companies better understand user needs and enhance product user experience through user research and testing. Design thinking also plays a crucial role in innovation management, helping companies solve complex problems and drive innovation.

Manufacturing: In the manufacturing industry, user-centered design and agile design are widely applied. For instance, automotive manufacturers conduct user research and testing to design vehicles that meet user needs and preferences. Agile design improves product development efficiency and quality through rapid iteration and prototyping.

Services: In the service industry, design thinking is used to innovate service models and enhance user experience. For example, banks and financial institutions use design thinking methods to develop more convenient and user-friendly online service platforms, improving user satisfaction and loyalty.

Information Technology: In the IT industry, modern design methods are extensively used in software and application development. Through user-centered design and agile development, software companies can quickly respond to market demands and develop high-quality products and services.

3. Current Status and Challenges of Industry-Academia Collaboration

3.1 There are Various Modes of Industry-academia Collaboration, Including:

Joint Laboratories: Universities and enterprises jointly establish laboratories for cutting-edge technology research and development. Joint laboratories can integrate the scientific research resources of universities and the practical experience of enterprises, promoting technology transfer and application.

Internship Programs: University students intern at enterprises, gaining practical work experience, while enterprises benefit from fresh blood and innovative thinking. Internship programs are the most common form of industry-academia collaboration, allowing students to apply theoretical knowledge to practical work and enabling enterprises to discover and cultivate talent.

Joint Development: Universities and enterprises jointly develop new products or technologies, integrating their resources and strengths. Joint development can improve research and development efficiency, reduce development costs, and achieve mutual benefits.

Each mode has its characteristics, advantages, and disadvantages. Joint laboratories facilitate long-term cooperation and in-depth research but require significant investment and resources; internship programs are simple to implement and yield quick results but have limited depth of cooperation; joint development achieves mutual benefits but requires clear projects and objectives.

3.2 Successful Cases of Industry-Academia Collaboration

Case 1: Huawei and Tsinghua University Joint Laboratory:

The joint laboratory between Huawei and Tsinghua University, established in 2014, aims to promote 5G technology research and development. The collaboration has achieved significant results in resource sharing and technological breakthroughs. The joint laboratory provides Huawei with cutting-edge technology support and offers practical project opportunities for Tsinghua University's graduate and doctoral students. Through collaborative development and technology transfer, the laboratory has successfully solved several 5G communication technology challenges, published numerous high-quality academic papers, and filed multiple patents. This collaboration model not only enhances the research capabilities of both parties but also promotes the industrial application of university research achievement. Additionally, Huawei has cultivated a large number of highly skilled technical talents through this collaboration, who play crucial roles in Huawei's 5G technology development and industrialization.

Case 2: Alibaba and Zhejiang University Internship Program

Alibaba annually hosts a significant number of Zhejiang University students for internships, providing them with valuable practical experience, while also discovering and nurturing many outstanding talents. This internship program began in 2012, addressing Alibaba's talent shortage and fostering technological and business innovation through interns' innovative thinking. For example, the collaboration between Zhejiang University's College of Computer Science and Technology and Alibaba has led to the development of multiple big data and artificial intelligence projects, enhancing Alibaba's data processing capabilities and offering Zhejiang University students practical engineering experience.

Furthermore, Alibaba can stay updated on the latest academic research results and apply these findings to real-world business scenarios, thus improving the company's competitiveness.

Case 3: BMW and Tongji University Joint Development of New Energy Vehicles:

BMW and Tongji University have jointly developed new energy vehicles, leveraging their combined technologies and resources to launch a series of innovative products. Since the collaboration began in 2015, the two parties have conducted in-depth cooperation in battery technology, drive systems, and intelligent driving. The joint development project has promoted BMW's technological advancements in the new energy vehicle sector and enhanced Tongji University's research level and international influence. For instance, the electric vehicle battery management system jointly developed by BMW and Tongji University has improved battery energy density and lifespan while significantly reducing production costs. Through this collaboration, BMW has gained technical support and enhanced its innovation capabilities by working with universities. Tongji University, in turn, has trained a large number of high-level researchers and gained valuable project experience. This collaboration has also fostered further cooperation in other fields, such as intelligent transportation and vehicle networking technology.

3.3 Challenges of Industry-Academia Collaboration

Although industry-academia collaboration has many advantages, it also faces some challenges, such as:

Resource Allocation: Universities and enterprises may experience conflicts due to unequal resource allocation in collaboration. The different resources and objectives of both parties may lead to unequal distribution of benefits, affecting the effectiveness of the collaboration.

Interest Conflicts: Universities and enterprises have different interest demands, potentially causing conflicts in collaboration. Universities focus on academic research and talent cultivation, while enterprises emphasize economic benefits and market competitiveness. This difference may lead to interest conflicts in the collaboration.

Communication Coordination: Differences in culture and management modes between universities and enterprises may result in communication issues. The diverse cultural backgrounds and management styles of both parties may cause communication barriers during the collaboration, affecting its effectiveness.

4. Application of Modern Design Methods in Industry-Academia Collaboration

4.1 Mechanisms of Modern Design Methods in Promoting Industry-Academia Collaboration

Modern design methods play a crucial bridging role in industry-academia collaboration, effectively promoting synergistic innovation between universities and enterprises through user-centered design, design thinking, and other methods. For example, through user-centered design, universities can conduct in-depth user research, and enterprises can develop products based on research results, thus improving the market adaptability and competitiveness of the products.

Application of User-Centered Design in Industry-Academia Collaboration: Universities and enterprises can jointly conduct user research through user-centered design methods, understanding user needs and preferences to develop market-oriented products. For instance, in developing a new product, universities are responsible for user research and analysis, while enterprises design and develop the product based on the research results. This collaboration model enhances product market adaptability and fosters synergistic innovation between universities and enterprises.

Application of Design Thinking in Industry-Academia Collaboration: Design thinking emphasizes interdisciplinary team collaboration and co-creation to stimulate innovative thinking and solutions. In industry-academia collaboration, universities and enterprises can form design thinking teams to develop and research innovative projects. For instance, in solving a complex problem, universities handle problem definition and analysis, while enterprises design and implement solutions based on the universities' research findings. This collaboration model improves problem-solving efficiency and promotes interdisciplinary cooperation between universities and enterprises.

Application of Agile Design in Industry-Academia Collaboration: Agile design emphasizes quick responses to changes, continuous improvement of design products through frequent user feedback and testing. In industry-academia collaboration, universities and enterprises can jointly undertake agile design projects, optimizing design solutions through rapid iteration and prototyping. For example, in developing new technology, universities conduct technical research and development, while enterprises design and test products based on the universities' research results. This collaboration model enhances technological development efficiency and fosters continuous innovation between universities and enterprises.

4.2 Case Analysis

Case 1:

Apple's Design Thinking Course with Stanford University: The collaboration between Apple and Stanford University began in 2010, focusing on cultivating innovative talents through a design thinking course. This course emphasizes practical projects, allowing students to experience the entire design thinking process from problem definition and idea generation to prototyping and user testing. Apple provides real project cases, while Stanford professors and students conduct in-depth analysis and design. This collaboration model enables students to apply theoretical knowledge to practical problems and provides Apple with fresh design ideas and innovative solutions. For example, in one semester, students designed a new user interface for Apple. Through user research and prototyping, students identified some usability issues with the current interface and proposed

improvements. After evaluation by Apple, some of these suggestions were implemented in actual products. This collaboration not only enhances students' practical skills but also brings innovative design ideas to Apple.

Case 2:

Tesla and MIT Agile Design Collaboration: Tesla's collaboration with the Massachusetts Institute of Technology (MIT) began in 2016, focusing on the in-depth development of autonomous driving technology. Tesla adopts agile design methods, continuously optimizing autonomous driving technology through rapid iteration and prototyping. MIT researchers are responsible for foundational research and technological innovation, while Tesla engineers apply these research results to product development. Through frequent user testing and feedback, both parties collaboratively optimize technical solutions. For instance, during the development of the autonomous driving system, MIT researchers developed a new path planning algorithm, which Tesla engineers implemented into the system, continuously optimizing the algorithm's performance through real-world testing. This collaboration model not only improves Tesla's technology development efficiency but also provides MIT researchers with valuable practical application experience.

Case 3:

Google's User-Centered Design Project with Carnegie Mellon University: Google's collaboration with Carnegie Mellon University (CMU) began in 2017, focusing on in-depth cooperation in user experience design and human-computer interaction. Through user-centered design projects, Google and CMU jointly conduct deep user research to develop products and services that meet user needs. For example, in one project, CMU researchers conducted user research on a Google smart home device and identified some usability issues. Based on the research findings, Google's design team improved the product, adding voice recognition functionality and optimizing the user interface. This collaboration model enhances product user experience and provides CMU students and researchers with practical design project experience. Additionally, through this collaboration, Google can quickly access the latest user research findings and apply them to product development, thus enhancing market competitiveness.

5. Future Development and Prospects

5.1 Future Trends in Modern Design Methods

Modern design methods will continue to evolve towards digitalization, intelligence, and humanization. Emerging technologies such as artificial intelligence, the Internet of Things, and big data will further enrich and expand the application scenarios of design methods, driving continuous innovation and evolution.

Digitalization: With the development of digital technology, design methods will become more digitalized. Digital design tools and platforms will make the design process more efficient and convenient. For example, the application of virtual reality and augmented reality technology allows designers to conduct design and testing in a virtual environment, enhancing visualization and interactivity.

Intelligence: The development of artificial intelligence technology will make design methods more intelligent. Through AI algorithms and machine learning models, designers can more accurately predict user needs and market trends, developing products and services that better meet user demands.

Humanization: Modern design methods will increasingly focus on user experience and human-centered design. Through user-centered design and design thinking methods, designers can gain deeper insights into user needs and preferences, creating more humanized and personalized products and services.

5.2 Future Prospects of Industry-Academia Collaboration

With the deepening of globalization and informatization, industry-academia collaboration will become more extensive and in-depth. Future industry-academia collaboration will not only be limited to research and education but will also expand to social services and industrial upgrading. Through closer and more diverse cooperation, both academia and industry can jointly address complex social and economic challenges, promoting innovation and development.

Interdisciplinary Collaboration: Future industry-academia collaboration will increasingly emphasize interdisciplinary cooperation. By integrating resources and advantages from different disciplines, academia and industry can jointly solve complex social and economic problems. For example, in smart city construction, universities can provide the latest research findings and technological support, while enterprises can offer practical application and market promotion experience, promoting smart city development through interdisciplinary collaboration.

Global Collaboration: Future industry-academia collaboration will increasingly emphasize global cooperation. By collaborating with internationally renowned universities and enterprises, both academia and industry can access the latest research findings and technologies, enhancing their innovation capacity and competitiveness. For example, through collaboration with internationally renowned universities, universities can gain access to the latest research findings and technologies, improving their research level and international influence. Through collaboration with internationally renowned enterprises, enterprises can access the latest technologies and market information, enhancing their market competitiveness and international influence.

Sustainable Innovation: Future industry-academia collaboration will increasingly focus on sustainable innovation. Through continuous cooperation and innovation, both academia and industry can jointly address the ever-changing market and technological environment, promoting sustainable development and progress. For example, through continuous cooperation and innovation, universities can continually improve their research level and education quality, while enterprises can continuously enhance their technological innovation capacity and market

competitiveness.

6. Conclusion

This paper explores the importance and application of modern design methods and industry-academia collaboration, analyzes the current status, challenges, and successful cases of industry-academia collaboration, and proposes practical applications and future development directions for modern design methods in such collaborations. The study shows that effective industry-academia collaboration can further enhance the application of modern design methods, foster the cultivation of innovative talents, and promote sustainable industrial development. In the future, further deepening industry-academia collaboration and strengthening innovation and application of design methods are needed to cope with the continuously changing market and technological environment.

Acknowledgement

This paper is supported by Heilongjiang Province Graduate Course Ideological and Political High Quality Construction Project under Grant No. HLJYJSZLTSGC- KCSZAL- 2022-031. High quality school enterprise course "Modern Design Methods" for graduate students with school level professional degrees.

References

[1] Boland, R. J., & Collopy, F. (2018). Design Matters for Management. Oxford University Press.
[2] Brown, T. (2019). Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. Harper Business.
[3] Buchanan, R. (2019). Systems Thinking and Design Thinking: Reflections on the Connections. She Ji: The Journal of Design, Economics, and Innovation, 5(1), 37-51.
[4] Dorst, K. (2020). The core of 'design thinking' and its application. Design Studies, 32(6), 521-532.
[5] Eppinger, S. D., & Ulrich, K. T. (2021). Product Design and Development. McGraw-Hill Education.
[6] Kolko, J. (2018). The Practice of Design Strategy: Articulating, Understanding, and Pursuing Organizational Intent. Journal of Business Strategy, 39(1), 34-43.
[7] Liedtka, J., & Ogilvie, T. (2021). The Designing for Growth Field Book: A Step-by-Step Project Guide. Columbia University Press.
[8] Lockwood, T., & Papke, E. (2020). Innovation by Design: How Any Organization Can Leverage Design Thinking to Produce Change, Drive New Ideas, and Deliver Meaningful Solutions. Red Wheel/Weiser.
[9] Martin, R. L. (2020). The Design of Business: Why Design Thinking is the Next Competitive Advantage. Harvard Business Review Press.
[10] Michlewski, K. (2018). Design Attitude. Routledge.
[11] Norman, D. A. (2021). The Design of Everyday Things: Revised and Expanded Edition. Basic Books.
[12] Osterwalder, A., & Pigneur, Y. (2020). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
[13] Seidel, V. P., & Fixson, S. K. (2019). Adopting design thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. Journal of Product Innovation Management, 36(3), 90-108.
[14] Simon, H. A. (2019). The Sciences of the Artificial. MIT Press.
[15] Stickdorn, M., & Schneider, J. (2021). This is Service Design Thinking: Basics, Tools, Cases. Wiley.
[16] Teixeira, J., Patrício, L., Huang, K. H., Fisk, R. P., Nóbrega, L., & Constantine, L. (2021). The MINDS method: Integrating management and interaction design perspectives for service design. Journal of Service Research, 24(1), 37-51.
[17] Tschimmel, K. (2022). Design Thinking as an Effective Toolkit for Innovation. Digital Transformation and Industry 4.0 Applications, 25(3), 101-115.
[18] VanPatter, G. K., & Pastor, E. (2020). NextDesign Leadership: How Design Innovation Leaders Navigate Complexity. Innovation Leadership Forum.
[19] Verganti, R. (2018). Design-Driven Innovation: Changing the Rules of Competition by Radically Innovating What Things Mean. Harvard Business Review Press.
[20] Zuber, R. (2020). Designing for Growth and Scaling Innovation: Design Practices in Corporate Innovation Labs. Journal of Design Business & Society, 6(2), 45-62.