

The Strategy of Cultivating Graduate Students’ Innovation in Interdisciplinary Perspective*

Qin Wang

School of Design
South China University of Technology
Guangzhou, China

Abstract—Design is comprehensive interdisciplinary, and innovative education of high level personnel should emphasize interdisciplinary training. Combined with literature research and case study, the interdisciplinary research and teaching modes of many famous universities in the world are exemplified. Postgraduate training strategies are proposed, including the integration path of interdisciplinary collaborative innovation, the transformation of interdisciplinary knowledge production mode, and the management of interdisciplinary education activities. The interdisciplinary cooperation should be based on the characteristics of graduate education and technological development trend.

Keywords: *interdisciplinary, graduate students, innovation, education*

I. INTRODUCTION

At present, the discipline involves into a comprehensive and interdisciplinary orientation on the basis of high differentiation, which is conducive to cultivating innovative and high-caliber personnel (Liu & Lin, 2019). It is necessary to study teaching pattern, scientific research method and research management in an interdisciplinary way. As a new and comprehensive interdisciplinary subject, it is especially significant to explore the training pattern of postgraduates in design discipline, which is helpful to guide the education of postgraduates, improves the knowledge production of postgraduates, and provides references for the training of postgraduates in other disciplines.

II. REVIEW OF RESEARCH IN CHINA AND ABROAD

After 2000, China began to attach importance to interdisciplinary research. Guo Weimin (2005), a domestic scholar who had conducted interdisciplinary research by elaborating the practice of interdisciplinary cooperation in design teaching, and making a comprehensive and in-depth exploration on deepening art design education. According to foreign experiences, Tang Toumei (2014) puts forward the interdisciplinary research requirements for art and design education in universities from multiple perspectives, fields and

and compound talents. Liu Shulao (2015) combined the investigation on the implementation process and results of ASU interdisciplinary design competition, and explained the contribution of interdisciplinary cooperation to the cultivation of interdisciplinary talents. Zhang Wen (2018) studied the teaching mode of product design workshop, which integrates collaborative innovation of enterprises, industries and universities, and analyzed the teaching plan, teaching practice and teaching evaluation.

In *Horizon Report* (2018) by the American Higher Education Information Technology Association (EDUCAUSE) puts forward “the rise of new forms of interdisciplinary studies” in response to the emergence of new skills and educational strategies in “Artificial Intelligence”. In 2018, the “National Forum on AI Philosophy and Interdisciplinary Thinking” was held in China. Artificial intelligence will assume the responsibility of basic research on interdisciplinary thinking. Li and Wang (2019) studied the research progress and frontier focus of “Artificial Intelligence and Education” in the international field, and explored the development strategy of “Artificial Intelligence and Education” in China.

To sum up, there are few researches on the cultivation of graduate students’ educational innovation at home and abroad, focusing on curriculum, teaching reform and teaching mode. As for the deep exploration of interdisciplinary education in design discipline, such as interdisciplinary knowledge production mode and integration of interdisciplinary research methods, there is a lack of in-depth research. There are few valuable researches on the influence of the artificial intelligence on the cultivation of innovative talents, which plays a limited guiding role in the creative education of design talents.

III. INTERDISCIPLINARY TRAINING AND INNOVATION FOR GRADUATE STUDENTS

Interdisciplinary research means two or more disciplines cooperate with each other and carry out academic activities with the same goal. To solve or understand a subject, people from different disciplinary backgrounds study subjects that are difficult to explain in a single discipline. Because the traditional research of a single subject is limited to its own field, and each subject has its own barriers, it is difficult to achieve research breakthroughs. Interdisciplinary expands the research

*Fund: This research was supported by Guangdong Education Planning Project (2017GXJK003).

disciplines. Oriented by design thinking, the innovative design education combines design with science to cultivate innovative

vision and research method, gives a deeper and more comprehensive understanding of the subject, and makes collaborative research more inspiring, so it is easier to obtain innovative achievement. At present, many emerging studies in the world are interdisciplinary in nature.

Interdisciplinary is conducive to cultivating innovative researchers in higher education. Innovation refers to new things, new methods and new thinking, which emphasizes originality and creativity. In both undergraduate and graduate studies, interdisciplinary talents are cultivated. However, in undergraduate study, students mainly focus on understanding the basic multidisciplinary academic knowledge and improving their comprehensive quality, and few can conduct integration of interdisciplinary research. Graduate students have a deep knowledge of the subject, and can improve the ability to solve research problems creatively through the interdisciplinary vision and skill training. (Xu et al. 2018)

Taking the discipline of design as an example, it is a new and comprehensive discipline. The innovation education of top research talents in design needs interdisciplinary training. First, design science should not only consider the use function of design objects, but also consider the needs of people. It has an extensive connection with production and technology, and is directly related to social culture, artistic aesthetics and humanistic emotion. Secondly, the purpose of design is to creatively solve problems in life. Creativity is a complicated process, and the solution of design problems usually requires the cooperation of multiple professionals. Design in the medical field, for example, requires expertise and interdisciplinary collaboration from a wide range of experts, including designers, engineers, contractors, administrators, healthcare practitioners and patient representatives. (Kasali & Nersessian, 2015) Thirdly, interdisciplinary research methods can bring new ideas to design. For example, the deep learning methods of artificial intelligence can automatically generate novel design schemes. Gestalt psychology provides a new perspective for pattern design. Finally, new types of crossover continue to emerge in the field of design, for example, interaction design is the crossover between visual art and computer technology, and new media design is the crossover between media art and technology, which requires designers to have interdisciplinary knowledge. Therefore, from the perspective of discipline nature, design purpose, design method and design trend, it is necessary to increase interdisciplinary training and cultivate innovative talents in design discipline in universities.

IV. EXAMPLES OF INTERDISCIPLINARY TRAINING FOR GRADUATE STUDENTS

Interdisciplinary education has received the attention of top universities. After years of development and exploration, many universities have formed a distinctive mode of interdisciplinary research.

The Institute of Continuing Education, the University of Cambridge, carries out The Master of Studies (MSt) in Interdisciplinary Design for the Built Environment (IDBE). The research includes Leadership and Interdisciplinary Practice,

Sustainability and Resilience, Innovation and Technology, Design Thinking and Practice. The program is focused on the following emerging trends: sustainability and resilience; health and well-being; energy efficiency and conservation and heritage. The course appeal to students from a wide range of professional architects, engineers, surveyors, planners, landscape architects, project managers, facility managers, surveyors, urban designers, property developers and contractors. The teachers, who are experts in different disciplines, encourage extensive participation and sharing. And scholars from different backgrounds are encouraged to collaborate and develop projects.

The Institute of Architecture and the Built Environment, the Delft University, carries out a great deal of high-quality scientific research. Among the scientific research on educational innovation, one of the themes is the study of the multi-disciplinary subjects. There is extensive interdisciplinary cooperation among scientists in the field of architectural design. Due to the changes in technology, population and transportation, the challenges in the field of design go beyond the original disciplinary field, and the design requires the integration of knowledge and methods in multiple fields. Cooperation between different fields is becoming more and more common in architectural design. So education needs to be updated to meet the new changes. There are programs as follows: Community–University Engagement via Student Research and Education, Assessing Interdisciplinary Engineering Education, and Metropolitan Analysis, etc.

At Carnegie Mellon University, several types of interdisciplinary projects are carried out, including undergraduate students, graduate students and doctoral students. CMU provides interdisciplinary undergraduate degree courses. Students can study the courses of humanities and computer science combined with fine arts. The Master' Degree includes Arts Management (MAM), Entertainment Industry Management (MEIM), and Integrated Innovation for Products & Services (MIIPS), etc. As for training innovators, engineers, designers, and business professionals work together to learn to solve complex problems and create breakthrough products and services in the MIIPS program. The Courses include Engineering, Design, Business, and Sustainable Design.

Politecnico di Milano in Milan, Italy, set up interdisciplinary research scholarship, for theme-assigned doctoral research. According to the characteristics of the material, 3DKnit-Performative 3D Knitted Space Fabric, posted on the university web site, is to study a computational design and digital knitted fabrication methodology that generate design shapes based on material characteristics. And the generation of functional surface and the development of spatial textile geometries is allowed in the proposed process. Meanwhile, the acoustic performances of this kind textiles for interior applications is explored to develop an industrial customized process for specific market products. Interdisciplinary knowledge in such as Material Science, Mechanical Engineering, Acoustic, and Information Technology is needed.

V. STRATEGIES AND TRAINING FOR INTERDISCIPLINARY GRADUATE STUDENTS

Interdisciplinary training can improve graduate students' innovation ability. Graduate students creatively propose, analyze and solve problems with their internal knowledge. Interdisciplinary education can complement and improve graduate students' former knowledge and enhance their ability to acquire knowledge. Nowadays, the boundaries between disciplines are becoming more and more blurred. The space where different disciplines intersect is usually neglected but has research prospects, and new scientific research objects are often discovered in this intersection area. Interdisciplinary collaboration can expand the research perspective of graduate students. What's more, the interdisciplinary research method can provide new research means and ideas for graduate students, stimulate researchers' internal research motivation, and help researchers produce innovative achievement. As to the cross-disciplinary postgraduate training strategies, the following points need to attract our attention.

A. *The integration approach of interdisciplinary collaborative innovation*

According to graduate student interdisciplinary training in the international famous universities, interdisciplinary cooperation is usually through curriculum teaching and scientific research. The graduate students are required to complete the prescribed courses, which include the selected courses as well as courses concerning other disciplines. And researchers from different disciplines work together to complete a certain project and obtain corresponding achievement, such as scientific research papers and patents. For design, interdisciplinary research cooperation also appears in workshops, design patents and design competitions.

In short-term workshops or design projects, teachers guide students to find solutions to practical business programs. Creativity is the highlight of the design discipline, and design competition is an important platform for students majoring in design to improve and demonstrate their design ability. While undergraduate students in design are encouraged to participate in design competitions, graduate students of different majors will spontaneously form teams to participate for a particular interest. In annual international design competitions, such as the Red Dot Award and IF Design Award, interdisciplinary graduate teams often win design awards. Students from The Royal College of Art won several design awards in the 2017 Biodesign Challenge, an interdisciplinary competition for innovative design which combines biology, art and design, informatics and medicine to explore biologically-inspired design.

Interdisciplinary research attaches importance to the transfer and integration of knowledge and conducts knowledge innovation by referring to the theories and methods of other disciplines. Intelligent software and hardware are used, and big data information is collected by Internet. Statistics and mathematical analysis such as machine learning is of vital value. A certain amount of data is needed to generate customized product schemes that meet users' preferences.

B. *Interdisciplinary knowledge production mode*

The learning of graduate students is mainly made up of course learning and paper writing. With the transformation of knowledge production, learning is increasingly connected with universities, society and enterprises, which is characterized by interdisciplinary, applied, collaborative and diversified participation (Du & Yu, 2019).

Firstly, the university teachers were responsible for the traditional postgraduate training in the past. Now it has become interdisciplinary and multi-party, with diversified knowledge producers. Besides graduate students, tutors, stakeholders such as industry experts, product sellers and suppliers can also participate in knowledge production. Secondly, collaborative scientific research innovation, conducted by many researchers, is adopted in knowledge production. The researchers have more interaction and cooperative exchanges. So achievements, experiences and methods of different disciplines and fields are used for reference to conduct collaborative scientific research. Thirdly, with the richer means of knowledge production, artificial intelligence and internet play more roles in knowledge production. Finally, the content of knowledge production is more diversified, new research fields are opened up across disciplines, and new ideas are provided for the topic selection and research of graduate thesis.

C. *Organization and management of interdisciplinary training*

The graduate students differ in age distribution, personnel category and ideology, so a series of strategies are needed to effectively manage the interdisciplinary education in order to create a suitable interdisciplinary scientific research atmosphere for innovation. MIT's interdisciplinary research shows that a suitable academic environment for interdisciplinary communication contributes to scientific achievement. MIT has many MIT-based papers and patents of interdisciplinary research. The proximity of physical space is conducive to increasing the collaboration between scholars, especially the face-to-face communication in the shared space and near the workplace. The distance between workspaces affects the frequency of cooperation between researchers. MIT's architectural traditions encourage collaboration and communication, such as "Infinite Corridors" that connect researchers, and also provide malleable workspaces. In addition, graduate students have rich life experience and stronger independence, so the management should be more flexible. At the same time, they also need rules and norms to formulate interdisciplinary research, promote and complete scientific research projects, and carry out evaluation of interdisciplinary research work.

VI. CONCLUSION

According to the literature review as well as the examples of interdisciplinary training of the graduate students majoring in design in many international universities, it is obvious that interdisciplinary training can improve the graduate students' innovation ability. The design major mainly carries out curriculum teaching, scientific research projects and design

competition to achieve the integration of interdisciplinary and innovation. The cross-disciplinary knowledge production is transformed into a diversified, collaborative, and intelligent knowledge production. According to the characteristics of graduate students, the organization and management of interdisciplinary education, which is suitable for exchange and cooperation, should be carried out.

REFERENCES

- [1] Liu Xiaoxuan, Lin Chenghua. Element Identification and Pattern Construction of Interdisciplinary Training Mode for Graduate Students in Research-oriented Universities: Multi-case Study Based on Content Analysis[J]. *China Higher Education Research*, 2019(01):66-71.
- [2] Guo Weimin. Moving Toward the Systematic Design — The Transdisciplinary Cooperation of Design Education[J]. *Art & Design*, 2005(07):5-6.
- [3] Tang Ruomei. Innovative design education: interdisciplinary development trend of Art Design Higher Education[J]. *Journal of Nanjing Arts Institute(Fine Arts & Design)*, 2014(05):125-128.
- [4] Liu Shulao. Exploration on the Effect of Interdisciplinary Design Competition on Interdisciplinary Talents Cultivation—Thoughts on the Interdisciplinary Design Competition Held by School of Design, ASU[J]. *Heilongjiang Researches on Higher Education*, 2015(07):145-148.
- [5] Zhang Wen. Research on the teaching mode of product design workshop based on Collaborative Innovation[J]. *Art Panorama*, 2018(07):142-143.
- [6] Li Haifeng, Wang Wei. Research Progress and Frontiers of International “AI + Education”: Along with Discuss of Development Strategy of “AI + Education” in China[J]. *Journal of Distance Education*, 2019, 37(02):63-73.
- [7] Xu Lan, Tao tao, Zhou xiaonan. Core Competence Cultivation for Postgraduates of Inter-disciplines- Analysis Based on IGERT Project in USA [J]. *Academic Degrees & Graduate Education*, 2018(05):61-68.
- [8] Kasali A, Nersessian N J. Architects in interdisciplinary contexts: Representational practices in healthcare design[J]. *Design studies*, 2015, 41: 205-223.
- [9] MSt in Interdisciplinary Design for the Built Environment. [EB/OL]. <https://www.ice.cam.ac.uk/course/mst-interdisciplinary-design-built-environment/>, 2020-02-05.
- [10] Multi-, inter- and transdisciplinary education. [EB/OL]. <https://www.tudelft.nl/en/architecture-and-the-built-environment/research/research-at-bk-bouwkunde/education-innovation/themes/multi-inter-and-transdisciplinary-education/>, 2020-02-05.
- [11] Master of Design. [EB/OL]. <https://design.cmu.edu/content/master-design/>, 2020-02-06.
- [12] Majors & Minors [EB/OL]. <https://www.cmu.edu/cfa/schools-and-academic-programs/majors-and-minors/index.html#bxa>, 2020-02-01.
- [13] Integrated Innovation Institute. [EB/OL]. <https://www.cmu.edu/iii/degrees/miips/9.html>, 2020-02-06.
- [14] Interdisciplinary Scholarships. [EB/OL]. <http://www.dottorato.polimi.it/en/looking-for-a-phd/call-for-positions-and-scholarships/places-and-scholarships/interdisciplinary-scholarships/#c1799>, 2020-02-01.
- [15] RCA Biodesign Exhibition. [EB/OL]. <http://designbio.co.uk/>, 2020-02-06.
- [16] Du yanfeng, Yu Xiaoyan. Transformation of knowledge production mode and personnel training mode in university[J]. *Higher Education Exploration*, 2019(08):21-25+31.
- [17] Proximity boosts collaboration on MIT campus. [EB/OL]. <http://news.mit.edu/2017/proximity-boosts-collaboration-mit-campus-0710>, 2017-07-09/2020-02-06.