Construction of New Engineering Cultivation Teaching System for Industrial Design Talents in Local Colleges

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Abstract. With the continuous upgrading and development of China's industry, the importance of industrial design in the manufacturing industry is becoming increasingly prominent. In order to promote the development of exceptional talent in industrial design and leverage regional characteristics and comparative advantages, this study focuses on the industrial design program at Guilin University of Electronic and Technology Beihai Campus. By analyzing the challenges in training industrial design talent in the southwest coastal areas, this paper focuses on the specific strategies for teaching reform. These strategies are based on the demands of the industrial design industry in the Beibu Gulf urban cluster, as well as the discipline attributes and future career direction of the industrial design major. The construction of a teaching evaluation system for the industrial design major, as well as the innovation of teaching design and organizational management has been analyzed. Under the context of new engineering, the concepts of talent training in local colleges and universities has been explored. It focuses on four aspects: talent training mode, professional teaching system, cell-based course module, and educational teaching evaluation system.

Keywords: Cellular Course Modules, Industrial Design, New Engineering, Talent Development.

1 Introduction

China's technology and industry are currently in the "transition period of traditional industrialization and new industrialization interwoven and alternating", and the "transition period of industrialization and information interwoven and deeply integrated" [1]. Despite the remarkable development of strategic emerging industries, China's industrial development still faces challenges in the complex international environment. These challenges include the lack of differentiated division of labor in the regional layout of industries, the absence of regional characteristics and comparative advantages, and the evident phenomenon of industrial convergence.

In 2017, the Ministry of Education proposed to "deepen the reform of engineering education and promote the construction and development of new engineering" [2]. In 2018, the Teaching Guidance Subcommittee of the Ministry of Education's Industrial Design Major in Higher Education held its inaugural meeting and the first plenary meeting at Northeastern University. During these meetings, the subcommittee clarified the teaching reform task of "new engine

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and new design" [3]. The proposal for new engineering provides a talent guarantee for industrial upgrading and offers universities an opportunity to establish a new platform for training design talents and cultivating high-quality comprehensive talents with "new abilities". In this context, this study takes serving the local area as the starting point and develops a teaching curriculum system that incorporates the local characteristics for the industrial design major. This is done by considering the regional industry, regional strategy, and technology trends. The study aims to explore a new approach to enhance the teaching quality of the industrial design major in local colleges and universities.

2 The reform of new engineering education and the current situation of the training of industrial design talents

2.1 The development status of new engineering education

Compared to traditional engineering, new engineering places greater emphasis on practicality, comprehensiveness, and intersectionality. Its main characteristics are forward-looking, driven by industrial demand, comprehensive in terms of practical innovation, and integrated across disciplines [4]. The reform of the professional talent training mode, with the background of new engineering, has been carried out globally. Among these reforms, one of the more successful examples is the Dyson Institute in the UK [5]. This institute does not charge tuition fees and provides annual salaries for students. It offers four-year engineering courses to cultivate engineering design talents that can directly meet the needs of enterprises. In 2017, the Massachusetts Institute of Technology (MIT) launched a new round of engineering education reform called the "New Engineering Education Transformation" plan [6]. Olin College in the United States [7] embodies the concept of interdisciplinary education through its project-based teaching approach. It aims to break down disciplinary barriers and offers only three undergraduate majors: engineering, mechanical engineering, and electronics and computer engineering. Students can freely choose fields such as engineering and bioengineering, engineering and robotics, engineering and design, etc. In the "Global Frontier Engineering Education" report released by MIT in 2018, the school was ranked first in the world for undergraduate engineering education. In 2018, Technische Universiteit Delft (abbreviated TU Delft) was referred to as "the Massachusetts Institute of Technology in Europe"[8]. The university focuses on integrating engineering education with the needs of society and human well-being. It emphasizes that engineering is no longer the center of society, but rather society itself has become the center of engineering.

The concept of "new engineering" proposed by China is new strategy for the development of existing engineering specialties in response the global in of industry and technology. It is necessary to reconstruct the engineering professional talent training system and mechanism that are tailored to the needs of China's modern industry from a systematic perspective. In 2017, the Ministry of Education's Higher Education Department organized discussions in universities and developed three programmatic documents: the "Fudan Consensus" [9], the "Tian Da Action" [10], and the "Beijing Guide" [11]. The strategic deployment of the paradigm shift in engineering education, rather than partial reform, was formulated. This approach emphasizes the return to practice as a guiding principle and focuses on "building specialties based on industrial demand" and "adapting content to technological development"

(Tian Da Action). Additionally, the principles of providing classified guidance for universities with strengths in engineering, comprehensive universities, and local universities were clarified (Fudan Consensus) [12].

In the traditional education system, students are prone to problems such as fragmented knowledge, narrow thinking habits, and limited abilities. These issues are challenging to address through conventional teaching methods. The aforementioned educational reforms in global universities demonstrate that the world is actively exploring new educational models and reconstructing educational and teaching methods from a systemic perspective in order to cultivate engineering design talents that can adapt to the needs of modern industry.

2.2 Current situation of talent training in local colleges

China's industrial design education is still in the developmental stage, and most local colleges and universities are facing a series of challenges and problems in their educational work, primarily in the following aspects[13]:

1.Course System level. "Teachers set courses, but students' ability to solve problems comprehensively is lacking." The current curriculum system of industrial design is sufficient for students to acquire the knowledge and skills necessary for the profession. However, when it comes to the complex situations encountered in production practice, students often lack the ability to comprehensively solve problems by applying multidisciplinary knowledge. The curriculum is designed based on the teachers' specialties, which results in each course being independent. This makes it challenging for students to integrate their learning.

2.Discipline system level. Discipline systems are independent of each other, making it difficult to achieve integration between the arts and industry. In order to highlight the distinctive features of the local industry, many local colleges and universities offer specialized majors. However, due to a shortage of teachers, their professional foundational education is only superficial. The concept of discipline construction follows the traditional education model and primarily emphasizes the development of mechanical or artistic specialties. However, this approach has certain limitations when it comes to promoting the comprehensive development of multidisciplinary industrial design.

3.Social demand level. The training objectives of schools do not align with the actual needs of society. Most local colleges and universities often determine the social needs based on the current trends in the domestic industry when implementing educational reforms. On one hand, this leads to the training of individuals with broad, but not refined, skills, resulting in a certain gap between their abilities and practical application. On the other hand, it can also lead to a talent exodus. The employment opportunities for trained professionals are often concentrated in urban areas, which can result in a shortage of skilled workers in rural communities. As a result, numerous skilled individuals are unable to utilize their expertise in their respective local communities due to a discrepancy between their skills and the specific requirements of the area.

2.3 The feasibility of the new engineering training reform of industrial design talents in local colleges

Industrial design is a comprehensive and practical interdisciplinary field. Its development cannot be separated from the support of modern science, technology, and industrial manufacturing. Its achievements involve the cross-integration of technology, art, humanities, and other fields [14]. Furthermore, its industry directly impacts people's daily lives. Industrial design serves as the bridge that connects advanced science and technology to human life. The integration of science, technology, and humanities drives continuous innovation in industrial design. The new approach to engineering emphasizes the practicality, interdisciplinary nature, and comprehensiveness of the discipline. It is guided by industrial demand and focuses on integrating various subjects, with practical innovation as the foundation. These characteristics are fully evident in the development of the industrial design industry [15].

In the context of the transformation and upgrading of the global industrial structure, various industries are integrating new technologies, materials, and processes through industrial design. This integration aims to promote sustainable development by embracing intelligent, green practices and fostering co-creation with the help of information technology. The training of industrial design talents in colleges and universities should align with the current industry development trend, and local colleges and universities should closely collaborate with the needs of the local industry [16]. The educational reform, based on new engineering, aims to cultivate intelligent compound talents through a cross-integration approach, while still building upon traditional education. This approach aligns with the current trend in industry development.

3 Exploration and practice of new engineering training mode for industrial design talents in local colleges

This study focuses on the industrial design major at Guilin University of Electronic and Technology Beihai Campus. It aims to explore the development of a new engineering training model for applied talents in industrial design, taking into consideration the regional characteristics of Guangxi. Centering on the geographical location, natural conditions, resource allocation, and economic industry of Guangxi, a new engineering teaching system for the industrial design major in local colleges and universities has been constructed. This system includes cellular curriculum modules, multidisciplinary and cross-school teaching and research sections, integration of excellent school resources, allocation of diverse academic background teachers, and promotion of studio teaching mode. The teaching reform experiment is carried out based on grade and curriculum, implementing task-driven, project-driven, and innovation-driven approaches at different levels. Diversified evaluation and optimization are also conducted, resulting in a circular rise.

3.1 Talent training mode

The training mode of applied talents in industrial design under the background of new engineering is guided by a focus on practical experience practice, emphasizing the principles of stresses "building a based on asking industrial demand" and "adapting the based on asking technical development" [12]. In the "14th Five-Year" development goals of Guangxi, the target output value of industries in the strategic emerging industry categories such as information technology, high-end equipment manufacturing, and green environmental protection is set to exceed 100 billion yuan by 2025. Based on the industrial demand and development trend, the teaching team has gradually adjusted the training objectives and professional segmentation direction in recent years. As a result, three major directions have been formed: characteristic cultural and creative design, intelligent equipment design, and service design. By leveraging the advantages of Guangxi's geographical location, natural conditions, resource allocation, and economic industry, an applied talent training mode has been established to align with regional strategy, industrial demand, and technology trends. This is illustrated in Figure 1.

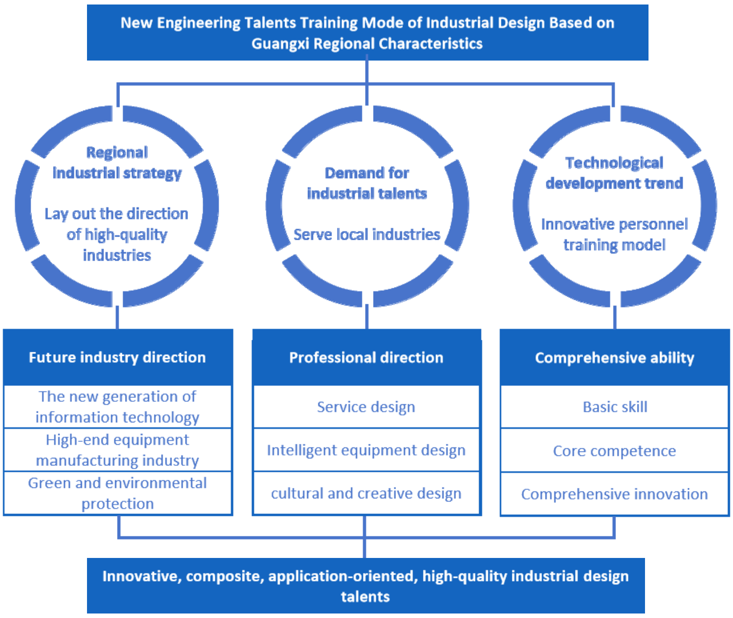

Fig.1. Application-oriented talent training mode

3.2 Professional teaching system

The teaching system of industrial design under the background of new engineering is composed of three levels: course cell, course organization, and course system. As depicted in Figure 2, the "course cell" consists of the course modules within the major. The "course organization" is comprised of the cross-professional course cells, while the "course system" is comprised of the cross-discipline course organization. The three-layer structure of mutual intersection, deep integration, and gradual improvement enables students to gain a clear understanding of the relationships between various professional skills, projects, and tasks. This structure also helps them gradually enhance their ability to solve complex problems by applying engineering and design knowledge in a comprehensive and systematic manner.

"Course cell" forms task groups between the internal courses of the major, breaks through the course barriers, and enables students to integrate professional skills and knowledge into tasks in the mode of "holistic learning". Each cell curriculum group is assigned multiple instructors based on the training objectives and provides guidance at each stage based on task progress. "Course organization" primarily focuses on courses within the same discipline and different majors within the college. It establishes project groups to overcome professional barriers, allowing students to choose relevant courses based on their own interests during their time at school. Students then collaborate and communicate with other students in the project group through "interactive learning" to complete project-based learning. The "course system" combines the school and enterprise, creating interdisciplinary innovation and entrepreneurship groups that align with the characteristics of industrial design. The main focus is on practical teaching through project-based learning, selecting actual projects through school-enterprise cooperation and competition. This approach forms a "circular learning" mode that promotes the sustainable development of the industry, teaching, and research.

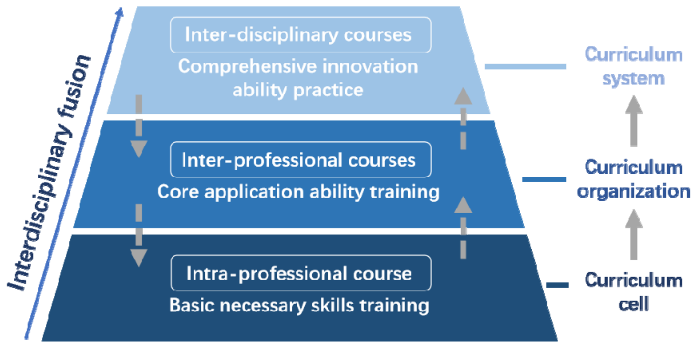

Fig.2. Cellular teaching system

3.3 Cellular course module

The cellular course module includes subject basic cell courses with engineering foundation as the core, professional ability cell courses with transformation and application as the connection, and system integration course cells with systematic problem solving as the goal, as shown in Table 1. The teaching content is progressive, and cultivates compound high-end design talents with a comprehensive integration of art and engineering.

Table 1. Styles available in the Word template

Cellular course module	Curriculum orientation	Driving mode	Main teaching place	Scope of implementation
subject basic cell	mechanics and structure, transmission and mechanism, intelligence and control, materials and feelings.	task-driven	professional laboratory, engineering laboratory, model processing room.	grade 1 to grade 2
professional ability cell	modeling design, CMF design, intelligent design, ergonomics design and other projects.	project-driven	design studio, professional laboratory, computer room.	grade 2 to grade 3
system integration cell	take specific products as research objects, integrate internal and external systems.	innovation-driven	workshops, practice bases, corporate projects.	grade 3 to grade4

"Subject basic cell" is the cornerstone of the cellular course module under the background of new engineering. In the course cell, mechanics and structure, transmission and mechanism, intelligence and control, materials and feelings, and other basic engineering courses are set up, driving students to complete learning and staged creation by task; "Professional ability cell" is the core of the cellular course module under the background of new engineering. Through modeling design, CMF design, intelligent design, ergonomics design, and other projects, the cross-integration of artistic design and engineering foundation is promoted, enabling students to acquire professional knowledge and skills. The "system integration cell" serves as the core component of the cellular course module. With an innovation-driven strategy, workshops, and practice bases are established to promote the joint progress of industry, academia, and research through practical projects with enterprises. The comprehensive practical ability of students is improved, and industrial design talents can solve real problems related to specific products for society.

3.4 Evaluation system

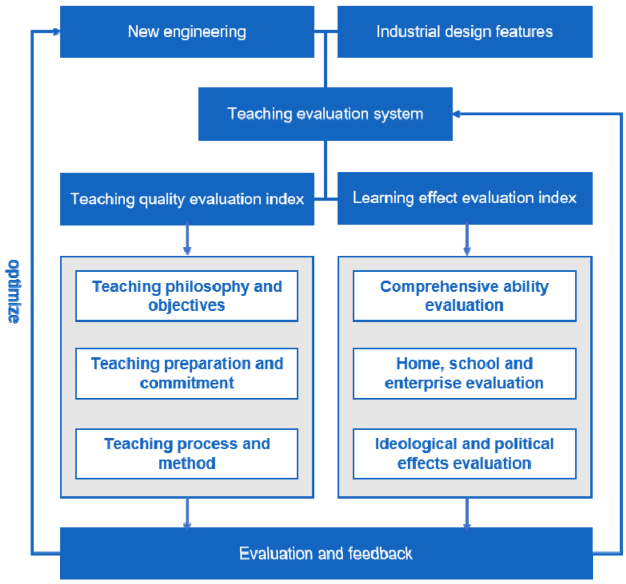

Fig.3. Evaluation System

The teaching quality evaluation index system comprehensively assesses the teaching of teachers and the learning of students. It combines process assessment with outcome assessment, as depicted in Figure 3. Teaching quality is improved through the evaluation of teaching level while learning quality is enhanced through the evaluation of learning effects. Additionally, process evaluation and feedback evaluation are given importance in order to enhance practice. The combination of the two adjusts and optimizes the entire teaching system.

In the practical application of the traditional evaluation model, the main problems are that the evaluation index is too single, the weight of the outcome evaluation index is larger, the weight of the process evaluation index is smaller, the scope of the evaluation subject is too small, and the subjective influence is too large. Under the context of new engineering, the cellular course teaching system emphasizes the development of students' practical problem-solving skills. The evaluation system needs to take students' comprehensive practical ability as the core and establish a multi-level,multi-dimensional, diversified, and dynamic evaluation system.

Taking teachers and students in the implementation of teaching as the evaluation objects, the teaching quality is evaluated from the aspects of teaching concept and objective, teaching preparation and input, teaching process and method, etc., through the subjects of teaching supervision, teachers, research department colleagues, and students. The learning effect is evaluated from the aspects of comprehensive ability, project practice ideological and political performance, etc. Through the involvement of on-campus teachers, off-campus intern tutors, and project group students, the evaluation and feedback mechanism requires educational departments to assist in dynamically tracking the evaluation index of practical effects. This helps achieve continuous improvement in training objectives, discipline construction, and curriculum systems based on comprehensive evaluations from multiple parties, including home, school, and enterprise. Additionally, the mechanism takes into account regional strategies and industrial demands and leverages the feedback and optimization role of course evaluations in the course and professional construction. This creates a virtuous cycle of teaching and learning.

4 Conclusions

Guilin University of Electronic and Technology Beihai Campus opened the application-oriented undergraduate industrial design major in 2013, adhering to the orientation of "regional, application-oriented, international", taking the training of practical talents for regional development as the fundamental task, guided by the demand of modern industrial development, with the integration of school and enterprise, innovation and entrepreneurship, international cooperation as the school-running characteristics, and adhering to the purpose of serving local economic development. Since the teaching and research team of industrial design has promoted education reform, it has achieved more than 500 municipal department-level design competition awards, a number of excellent instructor awards, and excellent organization awards in 9 years. The educational achievements have preliminarily verified the teaching quality and education reform direction of the training of new engineering talents.

Most of the emerging industries in the regional development strategy are supported by new technology, which undoubtedly presents higher demands for skilled professionals and educational methods. The industrial demand, practical innovation, and cross-integration that new engineering focuses on coincide with the development direction of industrial design. Therefore, the new training mode for engineering industrial design professionals is an inevitable choice for industrial upgrading and economic development. The research analyzes and explores the construction mode of the industrial design major under the background of new engineering. Through the analysis of relevant literature and construction cases, the training mode for industrial design talents and the concept of cell-based course module construction are summarized. On this basis, the new engineering training mode for developing industrial design talents is explored and implemented, providing valuable insights for the teaching reform of industrial design programs in local colleges and universities.

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References

[1] Ye Min, Kong Hanbing, and Zhang Wei. "New Engineering Education: From Concept to Action." Higher Engineering Education Research. Vol. 1, pp. 24-31 (2018)
[2] Department of Higher Education, Ministry of Education. "Notice on Conducting Research and Practice of New Engineering Education" [EB/OL]. (2017) http://www.moe.gov.cn/s78/A08/tongzhi/201702/t20170223_297158.html
[3] Ji Tie. "Ji Tie: Research on the Talent Training and Teaching System of 'New Engineering Education, New Design' at Hunan University's School of Design and Arts." Design. Vol. 34(20), pp. 50-57 (2021)
[4] Sun Yinghao and Xie Hui. "Basic Connotations and Characteristics of the 'New Engineering Education' Concept." Heilongjiang Education (Theory and Practice). Vol. Z2, pp.11-15. (2019)
[5] Yuan Lin and Lei Qing. "Construction of School-Enterprise Community: Research on the 'Dual-Element' Education Model at the Undergraduate Level—Inspiration from Dyson School of Engineering and Technology." Higher Engineering Education Research. Vol. 3, pp. 166-171. (2022)
[6] Graham, R. The global state of the art in engineering education. Massachusetts Institute of Technology (MIT) Report, Massachusetts, USA (2018)
[7] Somerville, M., Anderson, D., Berbeco, H., Bourne, J. R., Crisman, J., Dabby, D., ... & Zastavker, Y. The Olin curriculum: Thinking toward the future. IEEE Transactions on Education, Vol. 48(1), pp. 198-205. (2005)
[8] Kamp, L. Engineering education in sustainable development at Delft University of Technology. Journal of Cleaner Production, Vol. 14, pp. 9-11.(2006)
[9] "Fudan Consensus on the Construction of 'New Engineering Education'." Higher Engineering Education Research. Vol. 1, pp. 10-11. (2017)
[10] "Action Plan for the Construction of 'New Engineering Education' (TianDa Action)." Higher Engineering Education Research. Vol. 2, pp. 24-25. (2017)
[11] "Guidelines for the Construction of 'New Engineering Education' (Beijing Guidelines)." Higher Engineering Education Research. Vol. 4, pp. 20-21. (2017)
[12] Lu Chunfu. "Reform of 'Atypical' Engineering Education: Construction Practice of Industrial Design Discipline at Zhejiang University of Technology." Design. , Vol. 34(20), pp. 81-85. (2021)
[13] Yu Suihuai. "Necessity Analysis and Construction Path Thinking of 'New Engineering Education' in China's Industrial Design." Design. , Vol. 34(20):, pp. 58-61. (2021)
[14] Zainal Abidin, S., Sigurjonsson, J., Liem, A., and Keitsch, M. On the role of formgiving in design. New Perspectives in Design Education. In DS 46: Proceeding of the 10th International Conference on Engineering and Product Design Education. Universitat Politecnica de Catalnya: Barcelona, Spain 04.-05.09., 365–370. DOI: 10.13140/2.1.1922.4649 (2008)
[15] Dong Zhanjun. "Development and Theoretical System Construction Issues of Industrial Design Discipline in the Context of 'New Engineering Education'." Design. , Vol. 34(20), pp. 70-74. (2021)
[16] Toyong N., Abidin S.Z., and Mokhtar S. A Case for Intuition-Driven Design Expertise. In: Chakrabarti A., Poovaiah R., Bokil P., Kant V. (eds) Design for Tomorrow—Volume 3. Smart Innovation, Systems and Technologies, vol 223. Springer, Singapore. (2021)