TALENT TRAINING OF MECHANICAL SPECIALTY UNDER THE MODE OF INTEGRATION OF PRODUCTION AND EDUCATION

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ABSTRACT: A summary of the history of mechanical industry and education integration in China, research development, application characteristics, industry's integration efficiency, and mechanical professionals' education and training is presented. The topics are analyzed from six aspects, including the education reform, the construction of major courses, the internship and training system, the talent cultivation model, and the development of an industry and education integration mechanism. Also, the future directions are discussed.

KEYWORDS: integration of production and education; mechanical specialty; talent training

INTRODUCTION

With the transformation, upgrading, and development of China's economy, the role of innovation in cultivating the new driving forces for economic growth has become increasingly prominent. The main factor for innovation is talents, and the traditional closed-door education model can no longer meet the development of modern innovation.

Industry and education integration means that the industry and universities must combine closely to promote education through production. The education model should directly face the needs of the industry. The integration of industry and education is not novel. However, influenced by multiple factors, including system and mechanism, talent training mainly relies on the universities themselves. The industry's intervention is neither active nor deep, resulting in no effective synergy among education, talents, industry, and innovation. Enterprises are an important subject in the integration of industry and education, and the enterprises should actively promote the industryuniversity-research cooperation during the process of its transformation and upgrading. Universities, especially local universities, should actively transform and develop to adapt to industrial development and technical process requirements. The integration of industry and education is a win-win way to promote the development of universities

and enterprises. Therefore, enterprises should participate more actively in the cooperation between industry and universities, build engineering practice education bases that combine industry, university, and research, and help upgrade industrial technology. Therefore, deepening the integration of industry and education is vital for the transformation and upgrading of the industry and the innovation-driven development in China.

Peigen Li points out that it is not enough to discuss engineering practice education only from the technical level. What enterprises demand are inter-disciplinary talents with professional quality and practical skills. Zhongqin Lin thinks that the universities should focus on cultivating talents' awareness of industrial civilization, strengthening the education on theoretical knowledge, and combine actual engineering and practice during talent training. Gaofeng Zhu thinks that for technical skills training, China needs to develop a high-end equipment manufacturing industry to face the current technology revolution challenge. Moreover, to have a high-end-oriented manufacturing industry, a group of high-quality talents with technical skills is needed. Tianwei Tan thinks that to provide talents support for economic transformation and upgrading, the engineer talents education should primarily focus on applied technology and cultivate talents according to the industry's demands. Also, a teaching team with an engineering education background should be built [1].

In June 2014, the *Decision on Accelerating the Development of Modern Vocational Education* was published, which made the integration of industry and academia in characteristic education one of the five basic principles to accelerate the development of industry and academia gradually. On October 18, 2017, Chairman Jinping Xi at the 19th National Congress of the Communist Party of China stated that integration of industry and education should be intensified. On December 19, 2017, the Chinese government published *Guidelines on Deepening the Integration of Industry and Education*, indicating that China's industry and education integration has entered a new era. As shown in Fig. 1, the articles on the integration of industry and education on HowNet were less than ten prior to 2014, increasing rapidly after the guideline publication in 2017. The integration of industry and education has been one of the hot topics of research on China's education reform.



Figure 1. The number of publications about the integration of industry and education

Notably, HowNet's analytical data reveals that the number of articles related to "integration of industry and education + mechanical" is continuously increasing. Suppose mechanical majors, as key for the cultivation of applied talents, do not focus on the synergetic cultivation of integration of industry and education. In that case, the students may lack industrial practice and manual skills training, which will finally cause the object of talent cultivation to be disjoint from the upgrading and development of the economy. Therefore, to cultivate innovative project technology talents who can adapt to the current economic and social development requirements, the integration of industry and education is the best way to improve the comprehensive quality of mechanical engineering students.

Development of integration of industry and education

Industry and education integration development in mechanical engineering is the main factor in efficiently promoting collaboration between the higher vocational colleges and the enterprises. To achieve this goal, the teaching quality in mechanical engineering major must be improved.

Yuan et al. [2] believe that with industrial technology development, the concept and technology of machinery manufacturing will undergo great changes. As the production technical level increases, the manufacturing enterprises have higher practice requirements for the graduates, especially in professional skills, work innovation, and field contingency. The mechanical engineering students need to integrate current learning resources and equipment; thus, this should define the teaching direction and

content. The pace of practice and enterprise production should be followed, and the major integration and cross-teaching scheme should be studied to meet the needs of era and production.

Yang et al. [3] claimed that constructing the long-term integration-based mechanism for the college and enterprise is important for developing the current educational system reform of the higher vocational college. The National Program has presented this for Implementation of Vocational Education Reform as an important measure on perfecting the vocational education and training system. Fu et al. [4] claimed that integration of industry and education is an important pathway for developing numerical control in mechanical engineering majors. In the industry and education integration model, students' professional knowledge and professional skills majoring in numerical control mechanics can be improved and help students understand the market development condition deeply so that more professional talents who meet market development requirements can be cultivated. Tan et al. [5] analyze the background and current condition of the combination of learning with working in the cultivation of talents in mechanical engineering major of the engineering application-oriented universities and study this mechanism from the aspects including cultivation scheme, curriculum system, practical teaching system, double-professionally-titled teaching and teams, and industrial and education modes.

Personnel training mode

The promotion of integration of industry and education should first be established on building new talent mode.Education of graduate students: Yang *et al.* [6] reported that lack of talents is one of the bottlenecks that restrict the innovation and development of middle and small-sized enterprises. By deeply integrating the industry and teaching, the university and enterprises should bring their superiority into full play to cultivate graduate students with a professional degree. On the one hand, it provides the practice platform applied talents to solve vulnerable internships and practical training for graduate students with a professional degree. On the other hand, it is beneficial to help enterprises solve technical issues and optimize their technical research and team development. Yang *et al.* [6] suggest that the co-culture model for graduate students with the integration of industry and education can lead to both achievements and talents, which can effectively solve the complex issue of "introduce talents and make them stay" for the medium and small-sized enterprises in the underdeveloped area and provide power for the transition from old to new kinetic energy.

Surrounding the high-end applied talent needs of industry and enterprise, Zheng *et al.* [7] established the research directions corresponding to the characteristic objective of

cultivation. Among the suggestions are optimizing the cultivation scheme and curriculum provision, reforming the teaching mode, integrating the industry and education resources, and establishing the platform for academic exchange. Moreover, the authors suggest intensifying the construction of characteristic cultivation to culture graduate students with strong practical ability, innovation ability, and excellent comprehensive quality.

Education of undergraduate students: Based on the development condition of integrating industry and education in China, Mei *et al.* [8] discussed integrating industry and education mechanism during mechanical professionals training in the application-oriented university. He thinks that by intensifying the characteristics of training of mechanical professionals, the integration of industry and education mechanism can be further perfected, the education level of mechanical major in application-oriented university can be further promoted, and more high-quality, comprehensive talents can be exported to the society. For the existing issues in the application transition of the undergraduate program, Zhang *et al.* [9] put forward the conception of taking comprehensive ability as the objective for the application transition of mechanical majors, determines the requirements for the knowledge, quality, and ability of the applied talents with mechanical majors. They integrate industry and education to perform a series of reforms in education and practice and study the target location of the talent cultivation, training mode, curriculum content system, and teaching methods.

Higher vocational education: Zhang *et al.* [10] claimed that higher vocational education is the cradle of cultivating application-oriented, skill-oriented, and high-quality talents. Higher vocational education should insist on the talent cultivation method of "integration of industry and education, university-enterprise cooperation, a working-study combination," and actively explore and innovate to transport more inter-disciplinary talents for the construction of a new era. Gao *et al.* [11] analyzed the connotation of "integration of production and education" and "manufacturer education" and proposed that they have relevance coupling between professional demand and professional development, practicing standard value, and professional quality education. Simultaneously, taking the mechanical design and manufacturing concentration majors in higher vocational colleges as an example, exploring and practicing the construction of the manufacturer's space combining production and education with craftsman education, and formulate and organize production and education integration of craftsman training plans.

Major achievements

With the continuous promotion of education reform, how mechanical and electronic majors perform in local applied universities based on the integration of industry and education has become a key issue.

Major group construction: Deng *et al.* [12] proposed the central group construction model of "nine chain docking" between the universities and enterprises. Through the oriented modern apprenticeship talent training, the practical education of four levels and five platforms, and the quality training model of school-enterprise cultural integration, the improvement in test and practice has promoted the in-depth docking of modern vocational education and industry. Thus, strengthening the construction of professional groups. Peng *et al.* [13] reported that industry and education integration is the pathway for major construction. Through the construction mode of intelligent manufacturing, major groups of "mechanical design and manufacturing major +" with the integration of industry and education, new significant characteristics can be formed.

Brand major construction: Wang *et al.* [14] took "China manufacturing 2025", the industry and education integration strengthening, and the talents technical skills manufacturing training as a starting point. Based on the current status of the mechanical manufacturing concentration analysis, they explore the importance of brand major construction and provide the thoughts for developing primary connotation, characteristic development, and improvement of the professional talents training and service industry development.

Teaching team construction: Xie *et al.* [15] take mechano-electronic major as the study entry point and start from the necessity of integration of industry and education on the teaching team construction of mechano-electronic major in the local applicationoriented university. They discussed the problems existing in constructing the teaching team of mechanical and electronic majors in China's local applied universities and combined the industry and education integration elements to illustrate the construction strategy comprehensively.

Reform in education

Take the mechanical design and manufacturing major as an example; the higher reform in education is explored under the current background of integration of industry and education. Xu *et al.* [16] believe that to do talent cultivation with the mode of "integration of industry and education" can improve students' comprehensive quality and enhance their professional skills. In addition, the education quality of the university can be improved so that the talent requirement for the society and enterprise can be met.

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Song *et al.* [17] claimed that under current teaching conditions, although the talent cultivation is increased under the condition of industry-university-research cooperation, its mechanism needs to reform effectively according to their condition to realize better development.

Shen *et al.* [18] investigate and analyze the current condition of graduation project and practice in the enterprise, and all students believe that they learn more professional knowledge in the enterprise, which indicates that students can contact actual production situation in the enterprise and consolidate their theoretical knowledge learned in school. Li *et al.* [19] reported that to improve the talent cultivation quality of people in mechanical major, participating in World Skills Competition should be a vital means. They should focus on cultivating high skilled talents with an international view and explore a Siemens Germany dual system skilled talent cultivation mode with Chinese characteristics of education of skilled workers.

Curriculum construction

The construction, development, and reform of curriculum are the basis for talent cultivation. Many researchers analyze the construction of public and professional courses in the mechanical engineering major under the integration of industry and education.

Public courses: Liu *et al.* [20] claimed that the current public introductory course "advanced mathematics" in mechanical majors is not accurate, separated from the needs of mechanical engineering students. The current teaching mode has a teaching dilemma, including substantial theoretical property, bad viability, and lack of demand in curriculum reform. We should set reform targets, clarify reform orientation, construct double reform subjects, innovate reform thinking, and seek the innovation and reform mode reversely to provide support for talent training by centering it on vocational ability using the academic curriculum the base. Zeng *et al.* [21] reported that curriculum innovation is the inevitable trend during development. "Mechanical Engineering Mathematics" constructed by interdisciplinary professional courses and introductory courses can tamp the basic knowledge via theory on the one hand, and make the student have conceptual cognition on the practice by combining with new knowledge on the other hand.

Professional courses: Wang *et al.* [22] dissect the demand for industrial talent to analyze the location of talent cultivation and curriculum construction demand and put forward advice for developing and designing the curriculum of mechanical engineering majors. Simultaneously, they point out that the guarantee for the operation element of the

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curriculum system, that is, the specific teaching management mechanism, the representative practical training base, the double-professional-titled education team with complementary advantages, and high-quality curriculum resource. Luo et al. [23] claimed that talent cultivation is an integral part of the deep collaboration between universities and enterprises to integrate industry and education. Under the integration of industry and education of university and enterprise cooperation, the talent cultivation in mechanical manufacturing and automation major will finally have curriculum reform. They put forward ideas on implementing the CAM curriculum for the universityenterprise cooperation in the teaching process design, curriculum implantation, and teaching evaluation. Wang et al. [24] reported that the connection between the major and industry, the curriculum content and professional standard, and the teaching process and working process should be realized. By taking the integration of industry and education as the lead, the university-enterprise cooperation as the means, reform should be conducted via major optimization, curriculum system reconstitution, teaching practice perfection, construction of teaching team with double-professional titles, so that the requirement of high-quality applied talents can be accommodated for the transformation and development of the local industry.

Practice course: Lei *et al.* [25] use the integration of industry and education as the baseline to reform the current talent cultivation mode and curriculum system to accommodate the demand of the society for the innovation-type practical talents in a new era, which is the primary reform task of talent cultivation in universities. Depart from the production practice, integrating theory and practice cannot be implemented in the teaching plan. Liu *et al.* [26] believe that the reform in the education of integration of industry and education needs to be done on constructing and implementing an applied curriculum. Taking the mechanical manufacturing major as an example, they put forward the ideas of project-based curriculum reform in the application-oriented universities based on the integration of industry and education, and cultivate the knowledge integration ability, engineering practice ability, and application innovation ability of students.

Internship and practical training system

By deepening the integration of industry and education, the rational universityenterprise cooperation mode is explored to construct the internship and practical training system integrating the education and scientific innovation ability, which is beneficial for improving the study ability and job-hunting ability of students.

Construction of practical platform: for the major teaching problems in the applied talent cultivation process under the background of integration of industry and education, Ni et al. [27] claimed that the co-construction of engineering practice base and cocultivation of university and enterprise could boost the comprehensive reform of the applied talent cultivation, which can form the engineering education mode of "whole journey participation, deep integration, joint cultivation" to improve the quality of talent cultivation. Liu et al. [28] use industry and education integration as the premise to analyze the current development of the mechanical manufacturing hands-on training, and intensify the construction of a practical training base to promote the development of students better fitted to the market demand. For the construction of "new engineering," Jiang et al. [29] take provincial experimental teaching demonstration center as the carrier, the cultivation of high-quality applied talents with strong practice ability in mechanical design manufacturing and automation. They are innovative and down-toearth as the objective, to deepen the integration of industry and education and explore the rational university-enterprise cooperation mode via the construction of the practice teaching base inside and outside the school. They construct the internship and practical training system integrated with teaching and innovative scientific ability to form an objective, fair, and practical talent evaluation system, which increases the study ability and job-hunting ability for students. The teachers, students, and employers fully recognize this inside and outside the school, which is highly effective.

Practice competition: for Made in China 2025, Wen *et al.* [30] put forward new requirements for integrating industry and education. They think skill competition in the mechanical industry has a great promotion effect on talent cultivation. They propose that by using the skill competition as the chance to construct the platform of integration of industry and education for high-end equipment manufacturing industry, and from the organizational structure of the platform, the objective of talent cultivation in high-end equipment manufacturing, the reform of talent cultivation to construct the function and mechanism of the integration of industry and education platform that is suitable for the high-end equipment manufacturing industry.

CONCLUSIONS

The development of the modern manufacturing industry needs numerous talents who master the professional knowledge with an engineering application background. Especially as the transformation and upgrading of the industry in China deeply proceed, the demand for high-level technical talents is steadily increasing. To meet the demand of the society, the mechanical major takes the cultivation of technical application ability as the baseline and adopts the teaching mode of integration of industry and education

and working-study combination to promote the thorough process of reform in education, which has become the effective way to explore the cultivation of high-level applied talents.

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