Construction of an Innovative Talent Cultivation Model for Mechanical Engineering Master's Students Based on Industry-University-Research Collaboration

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Abstract: Against the backdrop of manufacturing transformation towards high-end and intelligent development, the supply quality of innovative talents in Mechanical Engineering Master's programs directly relates to industrial upgrading and technological breakthroughs. Industry-university-research collaboration is a crucial pathway for connecting the education chain, talent chain, industrial chain and innovation chain. It can provide real scenarios, core resources and practice platforms for the cultivation of Mechanical Engineering Master's students, and solve the problems, such as disconnection between theory and practice, and inadequate cultivation of innovation capabilities, in conventional cultivation models. Based on the core requirements for the cultivation of Mechanical Engineering Master's students and aligned with the inherent logic of industry-university-research collaboration, this study analyzes the core problems in the current cultivation models, and constructs an innovative cultivation model for Mechanical Engineering Master's students that deeply integrates the advantages of industries, universities, research institutions from five dimensions—cultivation objectives, curriculum systems, practice platforms, faculty teams, and assessment mechanisms, providing actionable frameworks for universities to optimize the cultivation system for Mechanical Engineering Master's students and enhance their innovation literacy.

Keywords: Industry-University-Research Collaboration; Mechanical Engineering Master's Students; Innovative Talent; Cultivation Model

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1.Introduction

At present, the manufacturing sector is undergoing profound technological changes. The fields of high-end equipment manufacturing and intelligent equipment R&D demand significantly innovation capabilities and practical competence from Mechanical Engineering professionals. As a critical talent reservoir for high-caliber engineering professionals, the cultivation quality of Mechanical Engineering Master's graduates directly influences the enhancement of core competitiveness in the manufacturing sector. Traditional Mechanical Engineering Master's programs are mainly conducted by universities, focusing on the imparting of theoretical knowledge. There are problems such as monolithic practice environment, fragmentation of innovation training, and disconnection from actual industrial demand, struggling to satisfy the urgent needs for innovative talents in the industry. Industry-university-research collaboration can achieve precision alignment between talent cultivation and industrial demand with the advantages of universities in scientific research, the industrial resources and market insights of enterprises, providing fertile soil for the cultivation of innovative talents. Based on this, it has become an inevitable choice for the reform of Mechanical Engineering Master's education in universities to establish an innovative talent cultivation model for Mechanical Engineering Master's students based on industry-university-research collaboration, deepen industry-university-research integration, and solve the problems in the cultivation.

2.The Intrinsic Interdependency Between Industry-University-Research Collaboration and the Cultivation of Innovative Mechanical Engineering Masters

2.1 Industry-University-Research Collaboration Offers Authentic Practice Environment for the Cultivation of Innovative Talents

Mechanical Engineering, as an inherently practice-intensive discipline, requires authentic engineering environment to scaffold innovation capability cultivation. Academic laboratories predominantly focused on fundamental research and simulated experimentation fail to replicate the industrial-grade problem complexity,

dynamic system tuning requirements, and market-oriented goals in enterprise production environment. During the process of industry-university-research collaboration, enterprises offer Mechanical Engineering Master's students the opportunity to enter the production lines and the R&D centers, enabling them to directly participate in the design, research, debugging and optimization of actual projects of the enterprises, and gain exposure to the cutting-edge technologies and core challenges in the industry. This authentic environment can compel master's students to actively apply theoretical knowledge to solve practical problems, accumulate engineering experience in practice, stimulate innovation mindsets, break through the limitations of "empty phrases on a scrap of paper" in traditional cultivation, and achieve the leap from knowledge accumulation to capability transformation [1].

2.2 Industry-University-Research Collaboration Integrates High-quality Core Resources for the Cultivation of Innovative Talents.

The cultivation of innovative Mechanical Engineering Masters requires the support from various resources such as research equipment, technological achievements, and industry information. Universities have advantages in fundamental research and research teams. However, they have shortcomings in engineering equipment and cutting-edge industry information. Enterprises possess advanced production equipment, mature technical systems and acute market insights. However, they demand fundamental research and talent reserve [2]. Industry-university-research collaboration facilitates mutual complementation of resources, enabling shared utilization of R&D equipment, bidirectional translation of technological achievements, and seamless flow of industrial information, thereby generating synergistic advantages. Universities can conduct engineering research by utilizing enterprise equipment, while enterprises can rely on the research teams in universities to break through technical bottlenecks. As a collaborative nexus, Mechanical Engineering Master's students can directly engage in resource integration and technology translation, thereby enhancing their innovation capabilities and holistic literacy with the empowerment of high-quality resources.

2.3 Industry-University-Research Collaboration Calibrates Precision-targeted Innovative Talent Cultivation Objectives

The essence of innovative talents lies in meeting the demands of industrial development and promoting the iteration and upgrading of technologies. In conventional talent cultivation models, universities often anchor cultivation objectives within siloed academic frameworks, and lack a precise understanding of actual industrial demand, resulting in misalignment between graduates' competencies and employers' operational imperatives. In industry-university-research collaboration, enterprises deeply engage in the setting of cultivation objectives, and calibrate the core requirements for Mechanical Engineering Master's students in terms of innovation capabilities, professional skills, and professional ethics based on the industry development trends and their own job requirements [3]. These industry demand-oriented cultivation objectives can ensure that talent cultivation aligns with the development of the industry, enabling Mechanical Engineering Master's students to possess innovation capabilities and job-role adaptability that satisfy the industrial demand, thereby enhancing the precision-targeting and operational effectiveness of talent cultivation.

3.Core Problems in the Cultivation of Mechanical Engineering Master's Students Based on Industry-University-Research Collaboration

3.1 Chronic Deficiency in Collaborative Depth, Manifesting as Ritualized Superficiality in Implementation

Current industry-university-research collaboration remains trapped at a perfunctory level, suffering from chronic deficiency in sustainable deep-level collaboration mechanisms. Most of the collaboration is carried out in the form of short-term project matching, corporate site touring, and expert lectures. Enterprises fail to deeply engage in the whole process of talent cultivation, while universities do not fully optimize their cultivation systems in accordance with the needs of enterprises as well. This superficial collaboration is unable to offer continuous support from practice platforms and core projects. Mechanical Engineering Master's students cannot deeply engage in the

core R&D and production processes of enterprises, resulting in that the cultivation of innovation capabilities lacks systematization and sustainability. Meanwhile, university-enterprise collaboration is mostly carried out for short-term interests and lacks a long-term strategic consensus. The cooperative relationship is easily affected by factors such as project cycles and personnel changes, struggling to establish a stable collaborative mechanism for talent cultivation [4].

3.2 Curriculum Systems Suffer from Systemic Disconnection, Failing to Align with Innovation Cultivation Imperatives

The curriculum systems for Mechanical Engineering Master's programs still focus mainly on traditional academic knowledge, and the curriculum design does not fully integrate cutting-edge industrial technologies and actual engineering demands. The curriculum content mainly focuses on theoretical derivations and basic concepts, which is disconnected from the practical application in enterprises and technological innovation demands. There is a lack of precision-targeted courses on engineering innovation and technology translation. Furthermore, the curriculum systems suffer from systemic disconnection, struggling to keep up with the technological evolution rate in Mechanical Engineering sector, with insufficient integration of cutting-edge technologies such as high-end equipment manufacturing and intelligent control. Under industry-university-research collaboration, the curriculum systems fail to achieve the integration of the theoretical advantages in universities and the practice advantages of enterprises, failing to build a complete knowledge system of "theory → practice → innovation" for master's students, which restricts the improvement of innovation capabilities [5].

3.3 Faculty Monoculture, Inadequate Co-teaching Competence

The faculty teams for Mechanical Engineering Master's programs are mostly composed of university faculty. Although university faculty has solid theoretical foundation and research capabilities, they exhibit critical deficits in frontline industrial engineering practice, and have insufficient understanding of the actual industrial demand and the technology application scenarios, struggling to effectively guide students in solving practical engineering problems and conducting innovation practice. Although technical specialists in enterprises have rich engineering experience, they lack systematic teaching methods and talent cultivation philosophy, struggling to convert their practice experience into effective teaching content. The faculty teams from both sides fail to establish a collaborative teaching mechanism. University faculty and enterprise mentors fight the enemy separately, lacking overall planning of teaching content and effective cooperation in the teaching process. This results in a disconnection between theory teaching and practice teaching during the talent cultivation process, failing to realize the comprehensive cultivation of innovation capabilities.

3.4 Rigid Assessment Mechanisms, Innovation Orientation Deficit and Processual Consideration Gap

The current assessment mechanisms for Mechanical Engineering Master's students are still dominated by traditional assessment methods, focusing on theoretical knowledge assessment and the quantification of research achievements, while lacking scientific assessment of innovation capabilities and practical competence. The assessment content mainly focuses on course grades, publication of papers and other aspects. However, there is a lack of effective assessment indicators for students' performance in practice, innovative ideas, and technology translation achievements in the industry-university-research collaborative projects. The assessment methods mainly rely on summative assessment, neglecting the phased performance and capability improvement during the cultivation process, struggling to comprehensively reflect students' innovation literacy and integrated capabilities. This rigid assessment mechanisms fail to encourage students to value practice innovation, and industry alignment, and equally struggle to motivate universities and enterprises to optimize the cultivation process, thereby restricting the effective implementation of the industry-university-research collaborative cultivation model.

4.Construction of the Innovative Talent Cultivation Model for Mechanical Engineering Master's Students Based on Industry-University-Research Collaboration

4.1 Anchoring Industrial Demand to Calibrate Collaborative Cultivation Objectives

Centered on the demands of industrial high-end and intelligent development, university-enterprise co-engineering mechanisms for goal-setting should be established. Leveraging universities' disciplinary strengths in Mechanical Engineering and enterprises' technical bottlenecks/job requirements, both parties jointly define core literacy requirements for Mechanical Engineering innovative masters, prioritizing innovation capabilities, practical competence, and technology translation capabilities as central cultivation objectives. The cultivation objectives should focus on key areas such as high-end equipment manufacturing and intelligent equipment R&D, and balance theoretical depth with practical application, which not only ensure that students have solid foundation in Mechanical Engineering theory and cutting-edge technical knowledge, but also cultivate students' engineering innovation capabilities to identify and solve problems, as well as their professional qualities that align with industry development so as to achieve precise adaptation of talent cultivation and industrial demand.

4.2 Integrating the Advantages of Both Sides to Optimize the Curriculum Design

Traditional curricular silos should be deconstructed to establish a tripartite framework integrating theory, practice, and innovation, enabling deep integration of universities' disciplinary strengths and enterprises' practical expertise. At the theoretical course level, while retaining the core fundamental courses, universities should integrate cutting-edge technology content from the industry, add advanced courses such as intelligent control, high-end equipment design, and digital manufacturing, and continuously evolve the course content to align with technological iteration cycles. At the practice course level, universities should rely on the industry-university-research collaborative projects to establish practice modules, and transform actual enterprise projects into teaching content, and offer practice courses, such as engineering practice, project R&D, and technology translation to lead students to directly engage in the whole-process operation of enterprise projects. At the level of innovative courses, universities should add innovation methodology, patent portfolio, technology entrepreneurship, and other courses, and engage industry technical specialists to co-teach with academic research teams to cultivate students' innovation mindsets and technology translation capabilities, forming a curriculum system where "theories scaffold practice, practice stimulates innovation, and innovation feeds back to the industry".

4.3 Constructing Collaborative Platforms to Strengthen Practice Innovation Training

Multi-tiered industry-university-research collaborative practice platforms should be constructed to deliver comprehensive practice innovation training for Mechanical Engineering Master's students. Universities establish joint R&D centers, practice teaching bases, and innovation incubation platforms with enterprises, use corporate production workshops and R&D centers as the core venues for practice teaching to provide students with stable practice positions and project resources, and implement "project-driven" cultivation model, enabling students to participate in the core R&D projects and technical transformation projects of enterprises as project members to accumulate engineering experience and enhance their innovation capabilities through these projects. At the same time, they should construct the platforms for academic exchanges and technical transformation, regularly organize students to participate in industry seminars and technical exchange meetings to align with the latest industry trends, encourage students to transform the innovation achievements in the industry-university-research collaboration, and rely on the incubation platforms to promote the implementation of technological achievements, forming a "practice → innovation → translation" closed-loop training system to comprehensively enhance students' practice innovation capabilities and technology translation capabilities.

4.4 Establishing Dual-Mentor Faculty Teams to Enhance Co-teaching Level

A dual-mentor team of university faculty and enterprise mentors should be established to optimize faculty composition, and enhance the teaching quality of talent cultivation. In terms of universities, they should improve the

mechanism for teachers' practical training, and regularly send teachers to assume a temporary post in cooperation enterprises for personal training and development to engage in corporate project R&D and production management, accumulate engineering experience, and enhance their engineering teaching competence. From the perspective of enterprises, they should select technical specialists with rich engineering experience and strong sense of responsibility as enterprise mentors. These mentors are responsible for guiding students in practice activities and innovation projects. Meanwhile, universities provide training on teaching methods and talent cultivation philosophy for these enterprise mentors to enhance their teaching competence. A dual-mentor collaborative teaching mechanism should be established to clearly define the responsibilities of university faculty and enterprise mentors. University faculty focuses on theory teaching and scientific research guidance, and enterprise mentors concentrate on practice teaching and project guidance. Both sides jointly make teaching plans, carry out teaching activities, and assess students' performance, forming a teaching team with complementary strengths and efficient collaboration.

4.5 Innovating Assessment Mechanisms and Enhancing Cultivation Support Systems

It is necessary to establish a multidimensional and process-oriented assessment mechanism to break through the limitations of the traditional assessment models, and implement holistic assessment of students' innovation literacy and integrated capabilities. In terms of assessment content, it should take into account theoretical knowledge, performance in practice, innovation achievements, and other aspects, include course learning, project practice, innovative design, and technology translation in assessment scope, focusing on students' innovative ideas, practical competence, and contributions in industry-university-research collaborative projects. In terms of assessment entities, it should involve universities, enterprises, and industries. University faculty assesses students' theoretical knowledge and research capabilities, enterprise mentors assess their performance in practice and engineering capabilities, and industry experts engage in the assessment of innovation achievements, ensuring the objectivity and comprehensiveness of the assessment results. In terms of assessment methods, it should adopt a combination of process-oriented assessment and summative assessment, and lay emphasis on assessing the phased achievements and improvement of capabilities during the cultivation process to replace the monolithic summative assessment, and guide students to value practice innovation, and capability enhancement. At the same time, it is necessary to enhance the support mechanisms for talent cultivation, establish a university-enterprise collaborative management system, clarify the rights and obligations of both parties in talent cultivation, and ensure the orderly implementation of cooperative cultivation.

5.Conclusion

It is an inevitable pathway to construct an innovative talent cultivation model for Mechanical Engineering Master's students based on industry-university-research collaboration for adapting to the transformation and upgrading of the manufacturing sector and improving the quality of talent cultivation. It can effectively solve the problems, such as the disconnection between theory and practice and the insufficient cultivation of innovation capabilities in conventional cultivation models. This model is oriented towards industrial demand. By calibrating the collaborative cultivation objectives, optimizing the integrated curriculum system, constructing multi-tiered practice platforms, establishing a dual-mentor collaborative team, and innovating a multidimensional assessment mechanism, it can achieve the complementary advantages of universities and enterprises, providing comprehensive support for the cultivation of the innovation capabilities of Mechanical Engineering Master's students. Universities should deepen the depth and breadth of industry-university-research collaboration, continuously optimize the cultivation model, and enhance the innovation literacy and practical competence of Mechanical Engineering Master's students, in order to provide more high-caliber innovative engineering talents for the high-end and intelligent development of the manufacturing sector. In the future, it is necessary to conduct further exploration of the long-term mechanism for industry-university-research collaboration, and dynamically adjust the cultivation system based on industry development and technological changes, promoting the high-quality development of Mechanical Engineering

Master's education.

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