

Exploration on Cultivation Mode of Graduate Student in Mechanical Engineering

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Abstract: Despite significant achievements in graduate education in mechanical engineering in China, challenges still exist such as a disconnect between theory and practice, insufficient extracurricular tutoring, and a lack of international perspective. To address these issues, the optimization and innovation of graduate student cultivation mode in mechanical engineering major from a global perspective is explored in this paper. Three main approaches were proposed. Firstly, the practical skills of graduate student can be enhanced through a combination of enterprise practice and project-based learning. Secondly, the dual tutor system can be implemented to integrate resources from both academic and industry mentors. Thirdly, international supervisors can be introduced in a flexible manner to expand students' global perspectives. Using these strategies, the professional knowledge and international perspective of graduate supervisors in mechanical engineering can be enhanced and the highly skilled mechanical engineering professional skills of graduate student can be cultivated, thereby contributing to the sustainable advancement of the mechanical engineering field.

Keywords: Mechanical Engineering; Graduate Student; Cultivation Mode; Global Perspective

1. Introduction

In the tide of globalization and rapid scientific-technological advancements, mechanical engineering, a cornerstone of manufacturing, is undergoing unprecedented transformations. The significance of graduate education in mechanical engineering, as a pivotal avenue for nurturing future engineers and leaders, has

grown increasingly paramount. This paper endeavors to delve into the construction of a graduate student training model for mechanical engineering major, tailored to address the demands of the new era from a global perspective^[1].

As the Industry 4.0 era dawns, advanced technologies like intelligent manufacturing, the Internet of Things, big data, cloud computing, and artificial intelligence are seamlessly integrating into traditional industrial processes, profoundly reshaping the landscape of mechanical engineering. This paradigm shift necessitates mechanical engineers to possess not only a robust theoretical foundation but also proficiency in cutting-edge technologies, coupled with the practical acumen to tackle intricate engineering challenges and foster innovation. Consequently, the cultivation of mechanical engineering degree graduate students must stay abreast of the times and intimately align with the evolving needs of industrial development^[2,3].

Currently, China's mechanical engineering graduate education stands at a pivotal juncture, marked by remarkable achievements amidst numerous challenges^[4]. The faculty team often grapples with a lack of comprehensive understanding of the Industry 4.0 concept, and the instructional content lags behind the rapid technological advancements in the industrial realm. This dissonance poses a formidable obstacle for students seeking an education that resonates with the contemporary era, significantly impeding the enhancement of graduate training quality and the sustainable progression of the mechanical engineering field^[5].

In this context, the imperative to devise a graduate student cultivation strategy tailored to the Industry 4.0 demands cannot be overstated. By meticulously examining the present landscape of mechanical engineering education

within the Industry 4.0 ecosystem, this study endeavors to pinpoint the shortcomings and deficiencies in China's graduate student education development endeavors within this domain. Furthermore, it offers targeted recommendations aimed at addressing these identified gaps. By refining the graduate student education mode, a new generation of high-caliber mechanical engineers will be cultivated. Then the students will be equipped with an international perspective, an unwavering innovative spirit, and robust practical skills, thereby contributing meaningfully to the advancement of China's mechanical engineering sector.

2. Current Status of Graduate Student Education in Mechanical Engineering

Amidst the current global paradigm shift towards Industry 4.0, the cultivation of graduate students in mechanical engineering major shoulders the weighty task of driving the transformation and upgrading of the manufacturing sector. Nonetheless, this endeavor confronts multifaceted challenges. The education of graduate students is designed to groom individuals adept at resolving technical hurdles encountered in manufacturing processes, while also mastering fundamental theoretical research and development competencies. It necessitates a robust theoretical framework coupled with hands-on practical skills. However, as the cultivation process of these graduate students in mechanical engineering, certain issues have gradually surfaced, posing obstacles to the enhancement of their educational quality^[6]. To tackle these challenges, it is imperative to undertake a thorough analysis and synthesis of the current state of affairs in the cultivation of graduate students in mechanical engineering. Furthermore, an exploration to devise a postgraduate curriculum that aligns seamlessly with the technological requirements of the contemporary manufacturing industry will be conducted, thereby fostering graduates who are equipped to contribute to its advancement.

(1) Separation of theory and practice

While theoretical learning forms the foundation of mechanical engineering education, the prevalent issue of 'focusing on theory while neglecting practice' remains a significant challenge in current training systems^[7,8]. This imbalance not

only limits students' problem-solving capabilities in real-world applications but also impedes their innovation potential. Despite the increasing accessibility of theoretical knowledge due to advances in information technology, the true value of this knowledge lies in its practical application rather than mere accumulation. The progress of mechanical engineering depends more on engineers who can effectively translate theory into practice and address real engineering challenges.

The current educational model often emphasizes theoretical instruction at the expense of practical skill development. Although students acquire extensive theoretical knowledge, they frequently lack opportunities and platforms to apply this knowledge to real engineering problems. This disconnect between theory and practice not only hinders the development of students' application skills but also fails to meet the demands for mechanical engineers in the Industry 4.0 era.

(2) Insufficient guidance from external mentors

In the current educational model, the involvement of external supervisors in the supervision of MSc students in mechanical engineering is generally low. External supervisors usually refer to those professionals from industry with rich practical experience who are able to provide students with professional guidance and support on practical engineering issues. However, due to various reasons, including insufficient institutional arrangements, resource allocation or co-operation mechanisms, these experienced professionals play a limited role in students' academic careers^[9,10]. This insufficient mentoring situation has a serious impact on students' research output and innovation. Students often lack professional guidance when faced with real engineering problems, making it difficult for them to effectively translate their theoretical knowledge into practical skills. The lack of off-campus mentors also means that students have limited exposure to engineering practice and industry dynamics, which restricts their vision and understanding and prevents them from fully understanding and grasping the latest development trends in the field of

mechanical engineering^[11].

(3) Lack of international perspective

In today's global economic integration, the development of mechanical engineering field has crossed national boundaries and become a highly internationalized industry. Examining the current cultivation status of graduate students in mechanical engineering, it is not difficult to find a significant problem: the lack of international vision. This lack of vision is not only reflected in the students' unfamiliarity with the international development trend of mechanical engineering technology, but also more profoundly reflected in their difficulty in adapting to the cross-cultural working environment and their lack of ability to communicate effectively with their international counterparts. The traditional education model often focuses on the teaching of local knowledge and skills training, but neglects the cultivation of students' global vision and international competitiveness, resulting in graduates being overstretched when facing international competition.

With the deep development of globalization, the demand for talents in the field of mechanical engineering is no longer limited to the local market, but is expanding globally. This requires graduate students in mechanical engineering to possess not only solid professional knowledge and skills, but also cross-cultural communication skills, global vision and international cooperation spirit. They need to be able to quickly adapt to working environments in different cultural contexts and work closely with international teams to solve complex engineering problems. Unfortunately, however, the current education system still has obvious deficiencies in these areas, making it difficult to meet the industry's demand for international talents

3. Exploration of Graduate Student Cultivation Mode in Mechanical Engineering

In today's rapidly developing industrial era, the optimization and innovation of the cultivation mode of professional degree postgraduate education, as the cradle for cultivating future mechanical engineers, is particularly important. The traditional

education mode has been difficult to meet the demand for high-quality and high-skilled talents in the modern engineering field. Therefore, according to some problems in the cultivation of mechanical postgraduates, three different cultivation modes are explored - the combination of enterprise practice and project declaration, the introduction of dual tutor system and the flexible introduction of overseas tutors, which aim to improve the quality of mechanical engineers through the combination of theory and practice, the complementary resources of tutors inside and outside the university, and the international perspective. These three modes aim to improve the practical ability, innovation ability and international competitiveness of postgraduates through the combination of theory and practice, the complementary resources of internal and external supervisors, and the broadening of international vision. These explorations not only respond to the needs of the times, but also provide new ideas and directions for the development of Mechanical Engineering graduate education. Using these methods, more high-level engineering technology and engineering management talents with solid theoretical foundation, rich practical experience and broad international vision can be delivered to the field of mechanical engineering.

3.1 Enterprise Practice and Project Driven Based Cultivation Model

The enterprise practice-project declaration-graduate student training mode directly integrates graduate students into actual engineering projects through in-depth cooperation with enterprises, thus enabling them to face and solve real engineering problems^[12]. In this process, graduate students can not only have an in-depth understanding of the actual needs and operational processes of enterprises, but also accumulate valuable practical experience in the various stages of project implementation. In addition, when participating in enterprise projects, graduate students will have the opportunity to declare relevant research projects and conduct innovative research in combination with enterprise needs. This cultivation mode, which combines the actual needs of enterprises and academic research, can effectively link academia and industry, and promote the dual

enhancement of graduate students' practical ability and innovative spirit. Through this practice-oriented cultivation mode, high-end mechanical engineering talents with practical operation ability, complex problem solving ability as well as innovative thinking will be cultivated, which can meet the urgent demand for compound and practice-oriented talents in the modern engineering industry.

3.2 Dual Tutor Collaboration Based Cultivation Mode

The implementation of dual tutor system is an effective way to improve the quality of professional degree graduate training^[13]. This model aims to build an educational environment that places equal emphasis on theory and practice and closely integrates industry, academia and research by integrating the academic depth of university teachers with the practical experience of enterprise engineers. Under this model, on-campus supervisors are mainly responsible for the guidance of basic theories and academic research of graduate students to ensure that students have a solid professional foundation and scientific research ability; while off-campus supervisors focus on the teaching of practical skills and industry dynamics, and through the participation of actual engineering projects to enhance the engineering practice and problem solving ability of students.

Dual-mentor collaborative guidance can not only effectively solve the problem of disconnecting theory and practice in traditional education, but also promote the deep integration of academia and industry. Through close co-operation between the two sides, graduate students can be exposed to cutting-edge technology of the industry and understand the market demand during the study stage, so that they can carry out their research work in a more targeted way. The model also encourages postgraduates to participate in the solution of practical problems in enterprises, transform academic achievements into practical applications, and contribute to social and economic development^[14].

In order to ensure the smooth implementation of the dual-mentor collaborative mentoring model, universities and enterprises need to work together to develop detailed training plans and mentoring program, and clarify the

responsibilities and division of labour between the two sides. At the same time, an effective communication mechanism is established to ensure the smooth flow of information between internal and external tutors, and to pay joint attention to the growth and development of graduate students. In addition, schools and enterprises can also jointly set up steering committees to supervise and evaluate the whole process of postgraduate training to ensure that the quality of training meets the expected goals.

3.3 Flexible Introduction of International Supervisor Based Cultivation Mode

Under the background of globalization, the development of mechanical engineering majors is increasingly showing an international trend. In order to cultivate graduate students of mechanical engineering with international vision and competitiveness, flexible introduction of overseas supervisors has become an important cultivation strategy. This mode introduces internationally renowned scholars and experts to participate in the cultivation of postgraduates through flexible and diversified ways, such as remote guidance, short-term visit and cooperative research.

The introduction of overseas supervisors not only brings cutting-edge academic ideas and research results to postgraduates, but also broadens their international vision and enhances their ability of cross-cultural communication and cooperation. Under the guidance of overseas supervisors, postgraduates are able to get in touch with international advanced scientific research methods and experimental techniques, and improve their scientific research ability and innovation ability. Meanwhile, through cooperative research with overseas supervisors, graduate students also have the opportunity to participate in international academic conferences and exchange activities, further enhancing their international influence.

In order to ensure the smooth implementation of the mode of flexible introduction of overseas supervisors, universities need to formulate perfect introduction policies and management methods, clarify the responsibilities and rights of overseas supervisors, and provide necessary financial support and guarantee. In addition, colleges and universities need to strengthen cooperation

and exchange with overseas universities and research institutions, establish stable cooperative relationships and talent exchange mechanisms, and create more favourable conditions for the international cultivation of postgraduates.

4. Conclusion

In the rapid wave of globalization and scientific and technological progress, the quality of graduate students in mechanical engineering is directly related to the transformation and upgrading of national manufacturing industry and international competitiveness. In this paper, the main problems in the current graduate education mode of mechanical engineering major was pointed out, such as the disconnection between theory and practice, insufficient guidance from off-campus supervisors and the lack of international vision. The existence of these problems seriously restricts the improvement of the quality of postgraduate students and hinders the sustainable development of the mechanical engineering field. To cope with these challenges, this paper proposes three optimized and innovative cultivation modes: the combination of enterprise practice and project declaration, the introduction of dual tutor system and the flexible introduction of overseas tutors.

Through the implementation of these innovative cultivation modes, the cultivation quality of postgraduates in mechanical engineering has been significantly improved. Specifically, the students' employment rate, the number of international patent applications, the number of Science Citation Index (SCI) papers published and the award-winning rate of domestic and international competitions have been significantly improved, which has strongly enhanced the quality of postgraduate cultivation and the competitiveness of the industry. The exploration and application of these cultivation modes have injected new vitality into the graduate education of mechanical engineering, effectively promoted the comprehensive improvement of students' overall quality, and cultivated more high-level engineering talents with solid theoretical foundation, rich practical experience and broad international vision for the development of the national mechanical engineering field.

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