

# Optimization of the Talent Cultivation Model for Graduate Students in Mechanical Engineering

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**Abstract:** Reform and optimization measures have been proposed for the talent cultivation model of mechanical engineering graduate students. The teaching curriculum system for graduate students should introduce new technologies, methods, processes, and achievements in a timely manner. With practical and innovative ability assessment as the main line, emphasis is placed on assessing students' comprehensive abilities to identify, analyze, and solve problems. It is encouraged to integrate collective guidance from a team of supervisors on the basis of the supervisor responsibility system. Scientific research training and practice are necessary means and effective ways to improve graduate education. Establishing a feedback and continuous improvement mechanism for graduate student cultivation quality is an important method to enhance the quality of cultivation. By optimizing the postgraduate talent cultivation model, the Mechanical Engineering discipline at Hunan Institute of Technology has achieved remarkable results in fostering top-notch innovative talents, providing valuable insights and references for other universities in their postgraduate mechanical engineering training programs.

**Keywords:** Curriculum System; Teaching Methods; Graduate Student Guidance; Scientific Research Training; Feedback and Continuous Improvement Mechanism

## 1. Introduction

For the past two decades, as the scale of graduate education expands rapidly, great stress was imposed on enhancing the scientific research and innovation ability of graduate students, and great funds were invested [1,2]. Fan Mengbao and others did a comparative study on curriculum systems for graduate students in various universities at home and abroad for mechanical engineering master's degree students [3, 4]. They examined the issues

in China's graduate curriculum system, such as the irrationality of content and flexibility of courses design. They suggested ways to reform the curriculum system and bring up the comprehensive ability of graduate students. Qiu Xia and others introduced a multi-tiered teaching model to enhance the research ability of graduate students [5,6]. Introduced domestic and foreign monographs and textbooks together, reform teaching content and mode, further together analysis modeling, analysis simulation, control theory, electromechanics, dynamics to create a teaching content of graduate school course "Mechanical System Modeling and Simulation" are more comprehensive and systematic, gives full emphasis to the improvement of students' ability to analyze and solve practical problems and innovation ability. In addition, they collected and organized some teaching plans with engineering background and strengthen the desire of students to establish innovative ideas of "paradigm, pattern and model". These researches have played a certain promoting role in courses content, curriculums content and teaching mode reforms, are positive[7]. Yuan Xin'an proposed relying on the four-dimensional linkage of "interdisciplinary integration, innovation and entrepreneurship competitions, practical training, and collaborative education between schools and enterprises" to stimulate the innovation enthusiasm, inspiration, and practical engineering abilities of mechanical engineering graduate students [8-10]. Developed countries in Europe and America prioritize the cultivation of graduate students' innovation capabilities, actively encouraging them to embrace scientific research, stimulate new thinking, and generate innovative ideas. They promote innovative education for graduate students through a "government-university-industry-research collaboration" model, establishing a joint training approach that integrates enterprise technology development with academic talent cultivation [11,12]. However, systematic research on curriculum systems, teaching

methods, graduate guidance, scientific research training, as well as feedback and continuous improvement mechanisms is relatively rare.

## 2. Optimize the Curriculum System

In the new era of rapid iteration of Internet technology, the graduate curriculum system is being reshaped towards a deep integration of theory, practice, technology, and innovation, establishing a brand-new framework tailored for cultivating versatile high-end talents.

The curriculum setup needs to lay a solid foundation with "three-dimensional cornerstones", focusing on fundamentality, professionalism, and relevance, while also considering integrity, cutting-edge technology, and comprehensiveness. Fundamental courses are the foundation of the knowledge edifice, building a systematic theoretical framework for graduate students; professional courses focus on the core areas of the discipline, delving deeply into professional knowledge; and relevance courses break down disciplinary barriers, promoting interconnectivity between different knowledge modules. On this basis, the curriculum system should cover the complete development trajectory of the discipline, timely introducing cutting-edge research results and industry trends, organically integrating interdisciplinary knowledge, and enabling graduate students to not only grasp the essence of their discipline solidly but also possess the ability to think across fields.

To meet the urgent demand of society for versatile talents, it is a key breakthrough in curriculum reform through interdisciplinary integration. By promoting the intersection and integration of different disciplines, the boundaries of traditional disciplines have been broken. For example, the combination of computer science and medicine has led to bioinformatics, while the fusion of mechanical engineering and artificial intelligence has led to intelligent robots. Graduate students have examined problems from multiple perspectives by the interdisciplinary curriculum. Their ability is cultivated to apply interdisciplinary knowledge to solve complex problems.

For graduate students with special abilities, it is the core of teaching students according to their aptitude by personalized training and humane care. Exclusive course modules should be customized for these students in universities. More targeted research guidance and practical

opportunities should be provided and greater flexibility in management should be offered. It is important to delve into their professional fields and fully unleash their innovative potential.

The updating of teaching content should stay in line with the times. It is critical to achieve an organic unity of "breadth, precision, depth, and novelty" in teaching content. "Breadth" means that knowledge be expanded, including content related to multiple disciplines; "Precision" is to extract core knowledge to avoid redundancy; "Depth" is to deeply understand knowledge to reach the forefront of academic theory; It requires that the latest research results, major technical issues in the industry, and advanced methods and processes in the discipline should be timely introduced in novelty. Through such a setting of teaching content, graduate students' pioneering consciousness and innovative spirit are stimulated, enabling them to not only master solid theoretical and practical skills but also possess the potential to lead the development of the discipline.

## 3. Improve Teaching Methods and Assessment Methods

The purpose of graduate student cultivation is to equip students with autonomous learning abilities, independent thinking skills, critical thinking abilities, and the motivation to explore the unknown [13]. Therefore, teaching will extensively adopt problem-based teaching methods such as case studies, guided learning, discussion, and specialized lectures, and strengthen students' abilities in self-study curriculum systems, literature review, social practice innovation, and achievement summarization. Graduate students are encouraged to actively participate in teaching activities and increase the intensity of teacher-student interaction. Modern educational technologies such as multimedia should be used reasonably and effectively to fully demonstrate the numerous advantages exhibited in the educational and teaching process, such as large amounts of information, three-dimensionality, strong interactivity, dynamic intuition, etc., making them an effective auxiliary and supplement to traditional teaching methods. The two should be integrated, and the best teaching methods should be selected according to the specific characteristics of the teaching content to maximize the effectiveness of classroom teaching. At the same time, different assessment

forms should be adopted according to the nature of the course, such as comprehensive course design, special topic papers, innovative works, reading reports, etc., with practical and innovative abilities as the main line of assessment, focusing on assessing students' comprehensive abilities in discovering, analyzing, and solving problems.

#### **4. Implement a Model Combining the Mentor Responsibility System with Collective Guidance from Mentor Groups**

Supervisors play a crucial role in determining the quality of graduate student training. To enhance the quality of graduate education, it is encouraged to integrate collective guidance from a team of supervisors on the basis of the supervisor responsibility system. Supervisors serve as mentors and navigators in graduate students' academic journeys, playing a pivotal role in inspiring academic literacy and upholding academic ethics. Therefore, adhering to the supervisor responsibility system requires supervisors to possess cutting-edge scientific research thinking, innovative engineering practice abilities, an international perspective, and high academic ethics. However, individual scientific research supervisors have specialized and segmented knowledge and research expertise, which poses certain limitations in the development of graduate students, such as the cross-cutting and cutting-edge nature of research. Nowadays, the country advocates "organized scientific research," where research teams are composed of personnel with different professional titles, educational backgrounds, and career levels. Graduate students can gain access to richer professional knowledge and utilize more resources from different supervisors or classmates, thereby broadening their knowledge fields, expanding research ideas, and promoting academic innovation. The adoption of collective guidance from a team of supervisors can accommodate diverse perspectives and has obvious advantages in multi-dimensional, multi-directional, and interdisciplinary aspects.

#### **5. Strengthen Scientific Research Training and Practice**

Scientific research training and practice are essential means and effective ways to enhance postgraduate education [14]. Scientific research training and practice are key paths to addressing the issue of "the disconnect between theory and

practice" among graduate students majoring in mechanical engineering, and they are also the core approach to cultivating compound engineering and technical talents. By using scientific research projects as a carrier, graduate students can independently apply their professional knowledge to analyze and solve practical problems in real research and development scenarios. This not only consolidates their theoretical foundation but also hones their innovative thinking and practical abilities, delivering high-quality talents with depth, precision, and breadth to society.

Our school relies on abundant resources of enterprise mentors to build a practical training system featuring "school-enterprise collaboration and project-driven learning". Senior engineers and technical experts from leading enterprises in the industry serve as enterprise mentors, bringing a wealth of real-world engineering practice projects from the production line - ranging from process optimization of high-end equipment to software development for intelligent production lines, from structural design of core components to performance testing of complex systems. These projects directly address industry pain points and combine practicality with innovation. Under the joint guidance of enterprise mentors and on-campus mentors, graduate students participate in the entire process of project research and development: from project requirement analysis and scheme design to experimental verification and results implementation, each step requires the theoretical knowledge of mechanical engineering to be transformed into practical solutions.

In this process, the engineering capabilities of graduate students are comprehensively strengthened. Participating in the "Electrical System Design for Spindle Experimental Platform" project, students are required to independently complete the entire process from Siemens PLC hardware setup to control program development, systematically mastering the integrated application of automation technology. Engaging in the "High-precision Air Spindle Design" project, students are required to combine Ansys software to complete structural optimization and performance analysis, honing their precision design capabilities through practice in national major special projects. More importantly, according to the uncertainty and challenge in real projects, it requires that

graduate students should break through their inherent thinking, extract scientific problems from engineering practice. In order to solve complex problems, it is essential to cultivate innovative consciousness and the ability through repeated trial and error.

Through scientific research training and enterprise practice, graduate students majoring in mechanical engineering in our university can not only build a solid theoretical system and professional skills, but also develop comprehensive qualities that meet the needs of

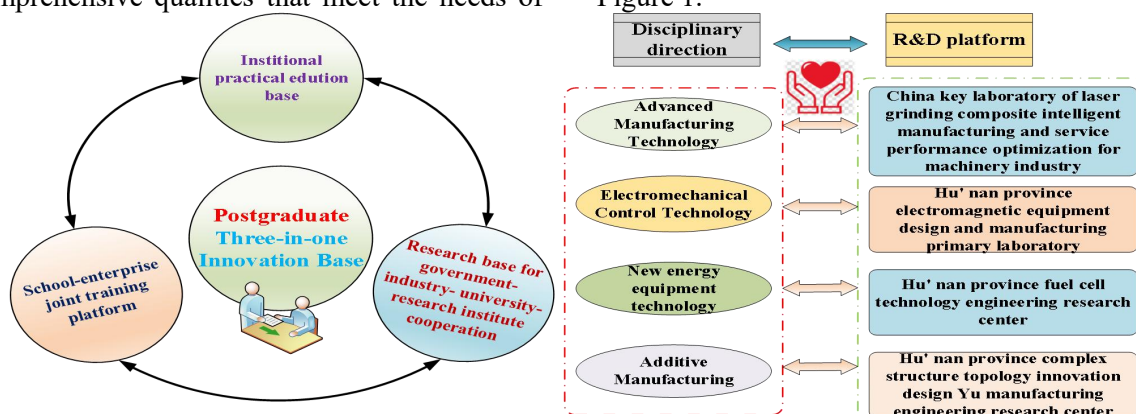


Figure 1. Graduate Research Platform

### 6. Establish a Feedback and Continuous Improvement Mechanism for Graduate Student Training Quality

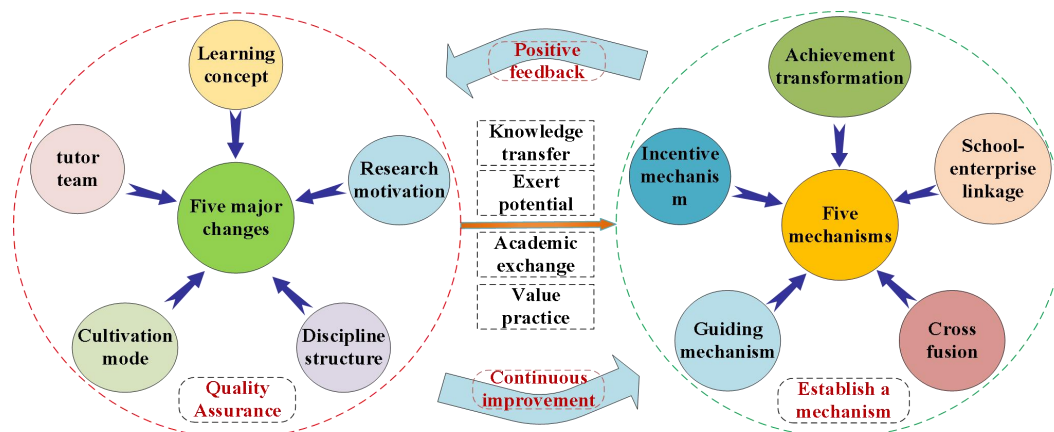
Based on the integration of theory and practice, and aimed at stimulating graduate students' learning motivation, the graduate training program implements "five integrations" and achieves "five transformations", which is show in **Figure 2** First, graduate training should be integrated with scientific research practice, achieving a transformation from passive scientific research to independent scientific research; second, the talent training program should be integrated with the training mode, enabling students to shift from a passive learning attitude of "being asked to learn" to an active learning attitude of "wanting to learn"; third, graduate theoretical learning should be integrated with quality education, achieving a transformation from professional teaching to multidisciplinary integration; fourth, graduate education should be integrated with enterprise practice, achieving a transformation from a single training mode to joint training between schools and enterprises; fifth, graduate training should be integrated with project implementation, achieving a transformation from teaching and scientific research training to

the industry, truly growing into composite engineering and technical talents that drive industry development.

The above content expands around the core information, elaborating on the role of scientific research training and practice in the cultivation of mechanical engineering graduate students, as well as the advantages of our school's enterprise mentor resources and practical projects. The word count meets the requirements. The postgraduate research platform is illustrated in Figure 1.

project training.

In the process of implementing the "five combinations" and achieving the "five transformations" in postgraduate training, five mechanisms have been established: First, an incentive mechanism to foster internal motivation for talent cultivation has been formed, promoting students' autonomous learning and research abilities. Second, a guidance mechanism for cutting-edge scientific issues has been established, facilitating students to digest and absorb learned knowledge, internalize it into their personal knowledge system, and develop innovative thinking. Third, a multidisciplinary integration mechanism has been formed, combining with quality education to promote cross-integration among multiple disciplines and enhance the comprehensive qualities of postgraduates. Fourth, a seamless docking mechanism between schools and enterprises has been formed, with joint training of postgraduates by schools and enterprises, enhancing students' ability to solve practical engineering problems. Fifth, a mechanism for the transformation of scientific research achievements has been established, improving the transformation rate of scientific research achievements and promoting the improvement of postgraduate training quality.



**Figure 2. Quality Feedback and Continuous Improvement Mechanism**

Establishing a feedback and continuous improvement mechanism for graduate student training quality will focus on taking measures in the following aspects: First, enhancing information acquisition and processing capabilities, being able to use modern information technology, proficiently reading Chinese and foreign literature in the discipline and related fields, quickly obtaining the background knowledge required for research development in either direction, and possessing the ability to transfer and expand knowledge; second, strengthening research capabilities in scientific research projects, focusing on research topics at the forefront of the discipline, with theoretical value or practical significance, and striving to promote the development of individual characteristics and the realization of innovative potential of graduate students; third, encouraging graduate students to participate more in academic exchange activities related to or similar to scientific research, give more academic presentations, improve oral expression and public speaking skills, as well as strong service awareness and communication skills; fourth, emphasizing practical links, deriving true knowledge from practice, summarizing patterns and refining mechanisms and principles from practice, and other things with scientific research value.

## 7. Conclusion

Combining the characteristics of four research directions in our school's mechanical engineering discipline, namely advanced manufacturing technology, mechatronic system control technology, additive manufacturing technology, and new energy equipment technology, we explore and practice new models for enhancing the scientific research and

innovation capabilities of graduate students. Based on the professional training plan, teaching and research platform, and cutting-edge research directions, this project focuses on two main lines: exploring the connotation and influencing factors of graduate students' scientific research and innovation capabilities, and constructing a model for enhancing these capabilities. Through improving five measures, we aim to enhance the scientific research and innovation capabilities of our graduate students and promote the comprehensive ability cultivation of our graduate students to a new historical height. In the past three years, great progress has been made in the construction of school-enterprise cooperation training bases, with a total of two bases established. Students' scientific research and innovation capabilities have been greatly improved. Students have published high-level papers and achieved fruitful results in academic competitions. The employment rate of master's degree students in mechanical engineering and master's degree students in mechanical engineering at our school is 100%, and the enrollment rate for further studies is 20%. Employers have responded positively.

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## References

- [1] Duan Y M, Huo Q Qing, Zheng Y. Cultivation Model and Innovation of Full-time Professional Degree Graduate Students. *Value Engineering*, 2025(20): 176-177
- [2] Li N, Diao S Y. Research on Interactive

- Teaching Based on the Cultivation of Students' Innovation Ability. *Innovation Research Education*, 2018, 6(6): 421-426
- [3] Fan M B, Li Wei, Cao B H. Research on the Curriculum System Design for Professional Degree Graduate Students - Taking Mechanical Engineering as an Example. *Educational Technology and Equipment*, 2021, (2): 9-11
- [4] Wang Lei, Zhang Z L, Xia X H, et al. Exploration and Practice of the Training Mode for Professional Degree Graduate Students in the Intelligent Manufacturing Direction of Mechanical Engineering Serving the Development of New Quality Productivity. *Degree and Graduate Education*.  
<https://link.cnki.net/urlid/11.1736.G4.20251215.1644.006>
- [5] Qiu X. A Brief Discussion on the Cultivation of Research Capacity of Postgraduates in China. *New West (Second Half)*, 2021 (2): 193, 195.
- [6] Gao Q, Shi B, Zhang L, et al. Exploring the Training Model for Graduate Students in Mechanical Engineering Based on the OBE Concept. *China Educational Technology and Equipment*, 2026 (02): 76-78+82.
- [7] Song F Z, Ma Y Z, Wang Na. Content System Construction of Graduate Course "Mechanical System Modeling and Simulation" in Higher Education Research. *Higher Education Research*: 2010, (2): 24-25
- [8] Yuan X AN, Li W, Cai B P, et al. Exploration and Practice of Cultivating Outstanding and Innovative Postgraduate Students in Mechanical Engineering under the "Four-Dimensional Linkage and Three-Element Co-cultivation" Model: A Case Study of the Mechanical Engineering Discipline at China University of Petroleum (East China). *Journal of Higher Education*, 2025(3):63-66.
- [9] Jin Z Z, He D Q, Deng J X. Exploration of Innovative Talent Cultivation Mode for Mechanical Postgraduate Students - Taking Guangxi University as an Example. *Equipment Manufacturing Technology*, 2025(2):51-54
- [10] Zhang X L, Liu X C, Zhou P L, et al. Construction of teaching case library for "Modern Manufacturing Technology" for mechanical engineering master's degree students. *Equipment Manufacturing Technology*, 2024(4): 83-86
- [11] J. V. Peluchette. S. Jeanquart, Professionals use of daffiness mentor sources at various career stages: Implication for career success. *Journal of Organizational Psychology*, 1996, 140(5).
- [12] G. Elles Lanser, Reaping the benefits of mentorship. *Healthcare Executives*, 2000
- [13] Zhang X L, Liu X C, Zhou P L, et al. Construction of teaching case library for "Modern Manufacturing Technology" for mechanical engineering master's degree students. *Equipment Manufacturing Technology*, 2024(4): 83-86.
- [14] Zhou L, Jiao F, Chen G Q, et al. Exploring the Innovation Ability Cultivation Model for Professional Degree Graduate Students in Local Universities - Taking the Mechanical Specialties of Henan Polytechnic University as an Example. *Journal of Henan Polytechnic University (Social Science Edition)*, 2026, 27(02): 86-93.