World Journal of Management Science
Print ISSN: 2959-9628
Online ISSN: 2959-9636
DOI: https://doi.org/10.61784/wms3081

ESTABLISH A TEACHING REFORM FOR THE PRACTICAL ENGINEERING MANAGEMENT MAJOR

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Abstract: With the rapid development of the engineering industry, the traditional model of engineering management education is facing the dilemma of being disconnected from practice. In order to cultivate engineering management talents with innovative spirit, practical operation ability and good project management literacy, this paper analyzes the current situation of engineering management education and explores the necessity of establishing a practice-oriented engineering management major and the path of teaching reform. The study points out that curriculum system reform, deepening of school-enterprise cooperation, strengthening of practical teaching links and construction of the teaching staff are the key factors for implementing the reform. Based on the analysis of successful cases at home and abroad, specific reform measures are proposed and prospects for the future development of engineering management education are presented.
Keywords: Engineering management; Practical education; Teaching reform; Curriculum system; School-enterprise cooperation

1 INTRODUCTION

Engineering management, as an interdisciplinary subject, shoulders the responsibility of cultivating high-quality management talents. However, the current teaching model focuses too much on theoretical education and neglects the cultivation of practical ability, making it difficult for students to adapt quickly to industry demands after graduation. Especially in the rapidly changing engineering environment, the traditional teaching model fails to meet the demands of modern enterprises for engineering management talents. Therefore, establishing a practical engineering management major and improving students' practical operation ability and innovation ability through teaching reform has become an important direction of educational reform at present.
This paper analyzes the current situation of the engineering management major, explores the problems existing in the current education system, and combines the successful experiences of engineering management education reform at home and abroad to propose the teaching reform path of the practical engineering management major.

2 THE CURRENT SITUATION AND PROBLEMS OF ENGINEERING MANAGEMENT

2.1 The Current Educational Model and System of Engineering Management

The education system for engineering management in China started relatively late, but with the increasing demand for engineering management talents in society, related majors have gradually been established and developed in colleges and universities. The current engineering management courses are mostly theoretical, with the curriculum mainly focusing on principles of management and basic methods of project management, while neglecting industry practice and specific operations. Although some universities have included practical courses such as project management and construction technology, these courses often remain at a superficial level of knowledge imparting, lacking depth and innovation, and are difficult to meet the requirements of modern enterprises for comprehensive project management capabilities.

2.2 Main Problems

Disconnection between theory and practice: Traditional engineering management education has mostly focused on the teaching of basic theoretical knowledge, with poor application of course content and a lack of effective cultivation of students' practical abilities. Liu et al. pointed out that building innovative practice bases is a key measure to enhance students' practical abilities [1].
Weak practical teaching: Although many colleges and universities have experimental or practical courses in engineering management, due to the scarcity of practical bases and the limited resources of enterprises, students have fewer opportunities to participate in project internships and cannot gain sufficient practical experience.

Insufficient faculty: Many engineering management teachers are mostly from academic backgrounds and lack real project management experience, unable to effectively convey the latest industry trends and practical operation skills.

2.3 Requirements for Talent in the Industry

With the increasing complexity of engineering project management, the traditional "armchair theorizing" management model can no longer meet the demands of today's market. Enterprises have higher demands on engineering management talents: not only a solid theoretical foundation, but also the ability to effectively manage risks, coordinate resources, collaborate in teams, etc. in complex projects. To meet these requirements, engineering management education must be adjusted and optimized accordingly to cultivate compound talents with strong innovation ability, comprehensive ability and project management practice ability.

3 EXPERIENCES OF EDUCATIONAL REFORM IN ENGINEERING MANAGEMENT AT HOME AND ABROAD

3.1 Drawing on International Experience

3.1.1 The United States: a project-driven practical teaching model

The core feature of the engineering management program at the Massachusetts Institute of Technology (MIT) is "teaching through real projects" :

Course and project binding: Students are grouped to participate in real corporate projects upon enrollment, and the course content revolves around project requirements - the "Engineering Cost Management" course requires students to complete project cost estimation and optimization, and the "Project Risk Management" course requires students to identify geological risks in the project and develop response plans;

School-enterprise collaboration: Each student team is assigned one on-campus mentor and one enterprise mentor, and project promotion meetings are held weekly, with enterprise mentors directly commenting on the project proposals submitted by students;

High proportion of practical credits: Practical credits account for 40% of the total credits. Students are required to complete "mid-term project presentation" and "final outcome defense". The defense judges include enterprise executives and industry experts to ensure that the outcome meets industry standards.

Stanford University focuses on "deep integration of technology and management" and offers cutting-edge courses such as "Intelligent Construction and Project Management" and "Economic Analysis of Carbon Neutrality Projects". Students can use the university's "Smart Engineering Laboratory" (equipped with BIM5D and VR construction simulation equipment) to simulate scenarios such as progress control and quality monitoring in smart construction sites.

3.1.2 Germany: university-enterprise collaboration model centered on "dual system"

The Engineering management program at the Technical University of Munich (TUM) in Germany adopts an alternating model of "3 months of on-campus study +3 months of enterprise training", with the core feature being:

Deep involvement of enterprises in the training program: The school works with companies such as Bosch and Siemens to develop the curriculum system. Companies put forward requirements for talent capabilities, and the school designs course modules accordingly;

Standardized training content: During the enterprise training, students are required to complete 10 standardized tasks such as "project planning", "construction safety inspection", "cost deviation analysis", etc. Each task requires the submission of an outcome report signed by the enterprise mentor, and the report is included in the course assessment.

Qualification certificate connection: After graduation, students can directly obtain the German "Construction Project Manager" professional qualification certificate and start working without additional training, with an enterprise satisfaction rate of over 90%.

3.1.3 UK: competency development model centered on "interdisciplinary integration"

The Engineering management program at Imperial College London emphasizes the compound ability of "engineering technology + management + law" :

Interdisciplinary course modules: Courses such as Engineering Contract Legal Practice, Infrastructure Project Financing, and International Engineering Dispute Resolution are offered, and students are required to select more than two interdisciplinary modules;

Internationalization of case teaching: International projects are often selected for cases (such as "A certain super high-rise building project in Dubai" and "A certain highway project in Africa"), requiring students to analyze the impact of laws and regulations and cultural differences of different countries on project management.

In addition to corporate internships, students are required to participate in activities such as "simulated international bidding and tendering" and "simulated engineering dispute arbitration" to enhance cross-cultural communication and problem-solving skills.

3.2 Domestic Status Quo and Reform Exploration

3.2.1 Tsinghua university: a practice platform centered on "virtual simulation + real projects"

Tsinghua University builds the "Virtual Simulation Experiment Center for Engineering Management" and develops the "Full Cycle Simulation System for Engineering Projects" covering the entire process of "bidding - design - construction

- acceptance" : Students can simulate the layout of construction sites through VR devices, analyze the interaction between progress and cost through BIM5D software, and train emergency response capabilities through the built-in risk event library of the system; In collaboration with China Construction First Group, students are grouped to be responsible for sub-tasks such as quality control and progress optimization of a residential project. Enterprise mentors come to the school every week to provide guidance, and the proposals submitted by students are directly applied to the project practice.

3.2.2 Southeast university: reconstruction of curriculum system centered on "BIM technology"

Southeast University incorporates BIM technology throughout its curriculum: In the lower grades, "BIM Basic Modeling" is offered to cultivate software operation skills; For middle grades, "Application of BIM in Construction Management" is offered, with case studies on "BIM-based collision checking" and "progress simulation". "BIM and EPC Project Collaborative Management" is offered in the upper grades, and students are organized to complete the practical training of "BIM-based EPC project full-process management". In collaboration with China Academy of Building Research, a "BIM Practice Base" is established, allowing students to participate in the application of BIM in key national projects. The introduction of BIM technology provides a full-process digital teaching platform for the engineering management major, significantly enhancing students' project simulation and risk assessment capabilities [2-3].

3.2.3 Chongqing university: training model centered on "university-enterprise collaborative education"

"University-enterprise collaborative education" Chongqing University signed an "order-based training agreement" with China Construction Fifth Engineering Division: jointly developed the training program of the "China Construction Fifth Engineering Division Class", and added enterprise-customized courses such as "EPC Project Management Practice" and "Construction Supply Chain Management"; Enterprise experts undertake 30% of the class hours of teaching, with the content mainly based on real project cases of enterprises; Students undertake 3 months and 6 months of on-the-job internships in their junior and senior years respectively, covering project coordination, cost control and contract management. The internship assessment is led by the enterprise, and those who pass will be directly employed after graduation (Table 1).

Table 1 Comparison of Engineering Management Talent Cultivation Models in Universities Across Different Countries

Country	Educational Pattern	Characteristic	Successful Case
The United States (MIT, Stanford)	Project-driven model	Students participate in real enterprise projects, with courses and projects closely linked, and school and enterprise jointly provide guidance.	The engineering management course at the Massachusetts Institute of Technology
Germany (TUM)	Dual system model	On-campus study and enterprise training are carried out alternately,and enterprises deeply participate in the course design.	Technical University of Munich collaborates with Bosch
United Kingdom (Imperial College London)	Interdisciplinary integration model	Engineering technology is integrated with management and law, and case-based teaching is diversified.	Imperial College interdisciplinary courses
China (Tsinghua University)	Combination of virtual simulation and real projects	The combination of virtual simulation and actual projects, with the participation of enterprise mentors in teaching	Tsinghua University collaborates with China Construction First Engineering Co., Ltd.

4 PRINCIPLES AND STRATEGIES FOR BUILDING A PRACTICALENGINEERING MANAGEMENT MAJOR

4.1 Adjustment and Positioning of Educational Objectives

The primary goal of the practical engineering management major is to cultivate capable and high-quality management professionals who can independently take responsibility for project management tasks in complex engineering projects. These professionals should not only have a solid foundation in engineering theories and management principles but also possess strong practical abilities to analyze and solve real-world project challenges.

To achieve this, the educational focus should shift from traditional knowledge transmission to the development of comprehensive professional skills. Students should be trained to demonstrate innovation, teamwork, project coordination, and risk management abilities in various project contexts.

In addition, the objectives of this major should align closely with the current and future needs of the engineering industry. As project management increasingly involves multidisciplinary collaboration, professionals must be equipped to handle complex decision-making environments. Therefore, the curriculum design and teaching strategies should aim to integrate theory with practice and prepare students to adapt to diverse project conditions.

Previous research on practical teaching reform has highlighted that strengthening faculty development and deepening school-enterprise cooperation are core factors in improving teaching quality and achieving sustainable educational reform [4].

4.2 Curriculum System and Teaching Content Reform

Addition of Practical Courses:The curriculum should include more practice-oriented and industry-related courses, such as Construction Project Management Practice, Engineering Risk Analysis and Management, and Construction Site Management. These courses should emphasize real-world applications and guide students to connect theoretical concepts with actual project management tasks. Practical assignments, workshops, and industry case analyses can be incorporated to enhance students' hands-on experience.

Interdisciplinary Integration: A practical engineering management curriculum must be comprehensive, combining knowledge from multiple disciplines including engineering, management, economics, and information technology. Interdisciplinary courses such as Engineering and Economic Decision Analysis or Project Financial Evaluation can help students understand the economic logic and decision-making processes behind engineering projects. This integration not only broadens students' knowledge base but also improves their ability to make informed, data-driven decisions in complex project environments.

Case-Driven Teaching:The use of case-based teaching methods should be expanded to bring real-world project experience into the classroom. By studying actual engineering projects—both successful and failed—students can gain deeper insight into project dynamics, management challenges, and strategic solutions. Through guided discussion and analysis, students learn how to apply theoretical frameworks to solve realistic engineering management problems, thereby strengthening their analytical and practical capabilities [5].

4.3 Strengthen the Practical Teaching Links

School-Enterprise Cooperation:Colleges and universities should build long-term and stable partnerships with enterprises to ensure continuous interaction between academic study and industrial practice. Regular enterprise internships, joint training programs, and project collaborations can help students gain real project management experience. Enterprises, in return, can provide authentic case studies, guest lectures, and mentorship opportunities that enrich teaching content and expose students to current industry practices. Such collaboration also ensures that academic programs stay aligned with evolving market needs.

Simulation Platform Construction:Higher education institutions should establish various types of practical learning platforms, such as virtual simulation systems, digital engineering management tools, and BIM (Building Information Modeling) laboratories. These platforms allow students to experience project management processes—such as scheduling, budgeting, and risk assessment—in a simulated but realistic environment. Virtual practice not only enhances students' operational proficiency but also provides a safe and efficient way to understand complex project workflows before entering real construction settings.

Project-Oriented Teaching:Project-oriented learning should be embedded throughout the program as a central pedagogical approach. Students can be organized into teams to participate in either real-life engineering projects or project simulations guided by faculty and industry mentors. Through these experiences, they develop essential skills such as leadership, problem-solving, and effective communication. Project-based teaching not only consolidates theoretical knowledge but also builds confidence and professional readiness for students to take on managerial roles upon graduation [6].

5 BUILD THE IMPLEMENTATION PATH OF THE PRACTICAL ENGINEERING MANAGEMENT MAJOR

Building a practice-oriented engineering management major requires comprehensive reform of the education system and teaching mode, especially deepening and innovation in aspects such as the construction of the teaching staff, the model of school-enterprise cooperation, and the evaluation and feedback mechanism. The following will start from these key areas and propose corresponding implementation paths.

5.1 Faculty Development

Introducing industry experts: Universities should proactively invite industry experts with rich experience in project management, senior managers of enterprises, etc. to serve as part-time professors or guest lecturers. These industry experts can not only impart cutting-edge industry knowledge to students, but also help students better understand the connection between the theoretical knowledge learned in the classroom and the practical operation through specific practical cases. For instance, world-class institutions such as the Massachusetts Institute of Technology (MIT) have developed an efficient academic-industry collaborative education model by bringing industry experts into the classroom, which has greatly enhanced students' industry adaptability.

Teacher practice enhancement: Universities should regularly organize teachers to participate in field trips and practical training for enterprise engineering projects. By participating in the actual work of project management, teachers can not only gain an in-depth understanding of industry trends, but also bring the latest technological advancements and management methods into the classroom. This not only contributes to the improvement of teachers' own capabilities, but also enhances the timeliness and industry orientation of their teaching content. For instance, many engineering management teachers, through long-term cooperation with enterprises and participation in project decision-making and management, have not only enhanced their own practical perception but also provided valuable practical materials for the innovation and improvement of course content.

Diversified teaching methods: In terms of teaching methods, schools should encourage teachers to adopt diversified teaching methods,
including case teaching, project teaching, teamwork, etc. These teaching methods can effectively enhance students' practical abilities and overall qualities. The reform of practical teaching in applied undergraduate colleges, through multi-dimensional improvements such as teaching materials, faculty, and school-enterprise cooperation, makes the practical abilities of graduates more in line with the demands of enterprises [7]. For example, the case teaching method helps students gain a deeper understanding of problems and solutions in complex project management by analyzing real engineering cases. The teamwork teaching model can cultivate students' collaborative spirit, communication skills, and team leadership skills, all of which are essential qualities for engineering managers [8].

5.2 Deepening of School-Enterprise Cooperation Models

Establish a stable school-enterprise cooperation mechanism: Colleges and universities can jointly establish engineering practice bases with enterprises to provide students with long-term practice opportunities.
Joint development of courses and projects: Jointly develop course content with enterprises and invite enterprise staff to participate in the teaching process to ensure that the course content keeps up with industry development trends.
Regular internships and practical training: By arranging regular internships and practical training for students at partner companies, ensure that students can accumulate sufficient industry experience before graduation. The training model that strengthens engineering practice has significantly enhanced students' project management skills by improving the practical teaching system and assessment mechanism [9].

5.3 Establishment of Evaluation and Feedback Mechanisms

Multi-party evaluation mechanism: In the construction of the evaluation system, diverse evaluation subjects should be introduced, including student self-evaluation, teacher evaluation, enterprise evaluation, etc. Through students' self-reflection and assessment, teachers can understand the specific difficulties and needs of students in the learning process, thereby optimizing teaching content and methods. At the same time, enterprise evaluation can professionally assess students' practical abilities from the perspective of industry demands. This ensures that the educational content matches the industry demand and that the engineering management talents cultivated are in line with the actual market demand.
Feedback and Adjustment: The implementation of teaching activities should have a continuous feedback mechanism to promptly collect opinions from students, enterprises, and industry experts, and make corresponding adjustments based on the feedback. For example, in the project practice session, students may encounter various problems in actual work. Through regular feedback meetings and questionnaires, teachers can identify deficiencies in the curriculum and optimize it accordingly. This ensures the sustainability and adaptability of educational reform, enabling educational models to keep pace with the development of the industry.

6 CASE STUDIES AND PRACTICAL OUTCOMES

6.1 Specific Case Analysis

A prime example of effective engineering management education reform can be seen in a project management course offered by a university in partnership with a major construction enterprise. In this course, students actively participated in real engineering projects managed by the enterprise. This project-based learning approach allowed students to confront actual challenges faced by the industry, thus deepening their understanding of project management principles in a real-world context.
For instance, students worked on tasks such as project scheduling, cost estimation, and risk management alongside experienced industry professionals. The collaboration provided them with valuable hands-on experience that is often lacking in traditional classroom settings. The active involvement of students in real projects led to a significant improvement in their practical skills, making them more prepared for their future careers.
Moreover, this approach resulted in positive outcomes for the enterprise as well. By participating in the education and training of students, the company was able to identify potential future employees and evaluate their skills in a real work environment. As a result, the satisfaction of the enterprise with the graduates significantly increased. The company reported that many of the students who completed the course were able to transition smoothly into full-time positions upon graduation, contributing to the overall success of the partnership.

6.2 Reform Achievements and Experience Summary

The reform of engineering management education, particularly through the integration of project-based learning and close industry collaboration, has yielded significant achievements. A notable outcome of this reform is the increase in the employment rate of graduates. Many students have been able to adapt quickly to the demands of the workforce after completing their studies, thanks to the practical skills and real-world experience they gained during their academic programs.

Employers have reported higher levels of satisfaction with graduates who have participated in industry-linked projects, as they are better equipped to handle complex tasks and manage projects efficiently. This has not only helped graduates secure jobs faster but has also improved their long-term career development prospects.

At the same time, the university has developed a more mature and industry-relevant model of engineering management education. This new model is highly adaptable, enabling the institution to stay aligned with the evolving needs of the industry. The school's curriculum now integrates practical industry experience with academic knowledge, making it forward-thinking and responsive to the changing demands of engineering management in a global context.

This shift has also enhanced the university's reputation among industry partners, leading to further collaborations and providing students with more opportunities to engage with leading companies in the field. The overall experience has shown that when academic institutions and enterprises work together to bridge the gap between theory and practice, both students and employers benefit from a stronger, more capable workforce.

7 CONCLUSIONS AND PROSPECTS

By analyzing the current situation and problems of engineering management education and drawing on successful educational reform experiences at home and abroad, this paper proposes a reform plan for building a practice-oriented engineering management major [10]. Practice has shown that school-enterprise cooperation, curriculum system reform, faculty team building and project-driven teaching methods are the keys to improving the quality of education. In the future, as the industry continues to develop, the educational reform of engineering management needs to be further deepened to cultivate more high-quality engineering management talents that meet market demands.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

The project was supported by Research on Theoretical Exploration and Practical Innovation in the Application-Oriented Transformation of Engineering Management Major (Project No.: 2025GJJG286).

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