

Jian-ya Jiang, Yang-wei Rao

Revealing Engineering Management System and Education Model in Developed Countries for Engineering Management Major Education Improvement in China

Abstract Different developed countries have differences in regulations for engineering management systems. The related education modes and their curriculum arrangement in universities in the US, UK, and Germany show their specializations. Through comparative research into engineering management systems and professional education modes between China and these developed countries, the paper proposes suggestions for improving the education of engineering management majors in China, which could speed up development of Chinese engineering general contracting enterprises and engineering project management enterprises.

Keywords: engineering management system, education mode, comparative research, training improvement

1 Introduction engineering management education in China

With the steady increase in construction scale and giant investment projects in recent years, there exists a huge demand for quality and quantity of talents, who have training in both engineering technology and management. To meet this requirement, China has developed an undergraduate education form of (construction) project management in the 1980s. Through the faculty reorganization in 1998, currently there are more than 300 universities offering undergraduate programs related to engineering management. In addition 161 universities provide education of a Master of Engineering related to project manage-

ment (Wang & Wang, 2009). After faculty reorganization in 1998, Engineering Management majors in China can be divided into different professional fields, such as project management, international project management, real estate operation and management, engineering cost management, investment management, engineering consulting (project planning), property management and others. Meanwhile, vocational training and certification related to construction management have been developing and include, among others, certified cost engineers, certified architects, certified consultants, real estate appraisers and other professional vocations.

The Engineering Management major especially emphasizes practical skills. This characteristic determines that a combination of professional education and professional qualification certification will be the future development tendency. Many Chinese colleges have made significant efforts in this direction. However, some shortages in college education still remain such as an emphasis on theory and a lack of practice; more classroom teaching and less critical thinking. The vocational training ability of enterprises is also not strong. Professional education in universities and vocational training within the industry related to engineering management do not meet present social requirements.

2 Engineering management education in developed countries

The analysis of how engineering management system and the mode of engineering management major education evolved in the developed countries provides significant reference value for Chinese engineering management education reform.

The professional education of engineering management majors in developed countries expanded in the late 1980s. Industrial engineering education, at that time, began to be closely assessed. It was recognized that traditional industrial engineering education focused only on produc-

Manuscript received June 10, 2014; accepted October 7, 2014

Jian-ya Jiang (✉)
Wuhan College, Zhongnan University of Economics and Law, Wuhan
430074, China
Email: jianglxj@163.com

Yang-wei Rao
Hubei Provincial Engineering Consulting Co., Wuhan, 430070, China

tion efficiency and mathematical methods. Graduates lacked necessary communication and management knowledge and skills. Although the engineering management education, under various names, does not have a long history, its educational forms are very rich. There are undergraduate education of 4–5 years and master education of 2–3 years in addition to three years of college education sometimes called technical college, higher professional schools. In addition, some schools offer open semester-long or year-long programs or training courses. The high education majors in foreign institutions are similar with Engineering Management major in China, and are usually called, among other things, Engineering management, Project management, Construction management, Industrial and Engineering Management.

2.1 Status in US

Students at US colleges are not divided in different professional fields when they enter first enter college. US universities emphasize liberal education and oppose early specialization. So there are no obvious professional differences between grade one and grade two students. Students major in both the arts and the sciences select the same university courses.

The Engineering Management major at US universities is cross-disciplinary between Business and Engineering. The main goal is to train graduates with science and engineering background into enterprise management. Traditional professional fields such as Engineering Management majors in US universities are divided into project management, information systems management, construction management and industrial management. There are also schools that have set up a separate professional Construction Management major.

In most institutions the Engineering Management major is in the engineering college. The result is that its courses are mainly technology and engineering. There are also some universities that set their Engineering Management majors are in the business or management school. Its courses focus on the school's professional fields. For example, the engineering management major at Purdue University belongs to the School of Management.

The above-mentioned professional fields have different educational focus.

Project Management: This professional field is associated with civil engineering disciplines, or industrial technology. The main courses include schedule control, quality control, cost control, contract management, security management, and organizational coordination.

Information Systems Management: This is interdisciplinary between computer software and management science.

Construction Project Management: This professional field on managing the entire construction process. It studies management and technical aspects of construction industry.

It researches mainly building management and coordination, and supervision of the building process. Its main courses include: commercial estate research, mechanical building equipment, electrical environment, industrial buildings, facilities management, project planning, budgeting and cost control, logistics and materials management, personnel management and labor relations, safety of construction site, construction technique and technology, organization and scheduling, as well as applicable laws and regulations.

Industrial Project Management: This field includes systematic management of plant operation, especially the management of technology, production and marketing strategy. Main courses include: accounting, engineering economy, financial management, human resources management, industrial psychology, management information systems, mathematical modeling and optimization, quality control, operations research, safety and health issues and environmental project management.

Such professional fields in different schools have some differences, but the basic curriculum includes the following course groups: project management, risk analysis and management, decision analysis, engineering economics, marketing, and finance.

2.2 UK engineering management major

British universities usually have a three-year educational system, including engineering management majors. Those who pass the examination are awarded a Bachelor of Science degree. Graduates are employed generally in construction companies, consulting firms, quantity surveying departments, and public service sectors.

In contrast to China, where Engineering Management major undergraduate education focuses on training of application-oriented talents, who possess civil engineering technology as a basis, with related knowledge in economic and management professional skills. Engineering management major education in British institutions takes into account professional skills training and overall quality. The training of communication, coordination, leadership skills needed by the excellent managers and professional knowledge education are all emphasized with no special emphasis on civil engineering technology.

Engineering management education in UK institutions pays special attention to practical teaching. Many schools take advantage of cooperative projects with enterprises in related industries. They combine the advantages of school research and enterprise resource, and have established practice bases within the enterprise for students. Generally, students are organized to make production practice in companies in the second school summer.

Engineering management teaching possesses significant flexibility, with a specifically wide range of professional optional courses and many different professional fields. Students can select professional directions by themselves.

Professional fields are divided into several types: building surveying, construction management, project management and measurement, real estate management and investment.

Engineering management education must have dual assessment by education administration and related industrial associations. Education administration assesses mainly for training objectives, course plans, teachers, and hardware and software conditions of schools. An industry association evaluates the rationality of school curriculums and whether the personnel training objectives meet the societal requirements (Liu, 2006). All Engineering Management majors must pass industry association assessments, such as the Royal Institution of Chartered Surveyors (RICS), or Chartered Institute of Building (CIOB). If the institutions are not approved their graduates cannot get social recognition and it will be difficult for them to be employed in the corresponding industry. Engineering management education is not only a threshold for entry to the construction management profession, but also a good foundation for the students to apply the member of industry associations in the future.

Engineering management education is focused on cross-penetration and is multi-disciplinary. In some universities majors are set up jointly by engineering school, economics school and business school, such as the EEM (Engineering & Economic & Management) program offered by Oxford University. EEM is based on engineering technology, with two-thirds of the curriculum related to engineering. EEM education integrates management knowledge and engineering technology.

2.3 German engineering management education

The similar disciplines in German universities have different names and professional direction, depending on the faculty structure of the universities. Some disciplines are in the civil engineering school and focus on construction management. Some are in the school of industrial engineering and focus on industrial project management.

The German construction engineering management system is similar to the world's most developed countries. Within a market economy system, it has formed a construction management mechanism with tripartite constraints consisting of project owners, consulting engineers and contractors. For quality supervision on a construction project, the German government has implemented an indirect supervision model. Supervision companies in the field of project quality are composed of a certificated quality supervision engineer, commissioned by a state government construction administration to implement mandatory supervisory and quality review on all new construction projects as well as alteration projects involving structural safety, on behalf of the government. The German government does not control directly the qualifications of consulting engineers involving construction project

management. Their qualification is reviewed by the relevant professional societies and associations (Lei, 2006).

3 Suggestion for engineering management training reforms

By comparing Engineering Management major, or similar majors, between China and the developed countries, we provide revelations for Chinese educational reform.

These similar disciplines in different universities may have different names and different curriculum, even different schooling lengths. Every school should form their own distinctive education style according to their professional structure background, academic advantages, teacher conditions, and research strength. They must determine their education mode; focus on research or training engineers, or technicians. The similar disciplines can be designated with different professional fields and emphasis, such as, among others, engineering technology, or project management or real estate management. The curriculum in universities should also reflect their own advantages and training characteristics, in order to train talents adapted to different levels and direction on basis of social requirements.

According to social requirements and professional development tendencies, training programs must be continuously adjusted and optimized, especially emphasizing practice and cooperation with construction companies or consulting firms. For example, in addition to summer practice, short-term practical training courses should be increased. Schools need to establish cooperative relations with construction companies, real estate development companies, construction supervision enterprises, or consulting firms to complete this practice plan. Enterprises can also send technical personnel into universities to teach, which would also be helpful for training of company human resources. Dual certification by the educational sector and professional associations should be introduced into some universities having good cooperation conditions. Graduates will benefit from such dual authentication system.

Institutions focused on the training of application-oriented talents need to especially emphasize practical training. For example, instruction in using amount calculation and pricing software, should focus on introducing the special characteristics and application environment of several common softwares, rather than simple an in-depth teaching of the particular software available at the school. Graduates will face different environments and should have a technical base for such different conditions. We found that a calculation software currently widely-taught in China may not suitable for some students, because other software has greater advantages in direct data exchange between the CAD (Computer Aided Design)

design diagram and such calculation and pricing software.

Avoiding project risk, enhancing coordination with project stakeholders, and optimizing project implementation, mature or new management modes of engineering management are developed and have been recently used. Programs such as DB (Design-Building) mode, EPC (Engineering-Procurement-Construction) mode, PMC (Project Management Contract) mode, Partnering mode, Partnership mode, and Dynamic alliance mode, are simply a few examples. Such modes integrate many functions related to the entire engineering management process of an enterprise or organization, from project proposal, feasibility study, engineering survey and design, bidding, project financing, project construction, and engineering supervision on through to project completion. This is different from the conventional engineering management methods, in which each part, or a collection of several parts, of the whole process is undertaken by different companies or organizations. For example, currently in Germany, many architectural design firms and consulting firms can undertake the comprehensive functions of feasibility studies, engineering survey and design, construction supervision, and project management. Some construction companies and even some large-sized equipment suppliers can also complete for feasibility studies, engineering survey and design, construction, equipment installation, and even to project management. Furthermore, there are also many engineering project management companies with different scales having similar multi-function.

However, today in China, many companies are only able to participate in one aspect the entire engineering management process. When a German company built a medium-sized plant in Beijing a few years ago, its company representative could not find a qualified domestic contractor to complete the entire engineering management process according to the requirements of the technical design. In

addition, domestic enterprises generally lack high-level engineering management experts in the fields of business, law, foreign languages, personnel or managers with experience of international engineering contracting projects. This is particularly true with regard to talents in design and professional procurement fields. This problem causes great difficulties for Chinese project contractors and project management companies when entering the international market.

These new management modes put forward higher requirements for training students majoring in engineering management. Education in this major should adhere to the reform policy, namely "wide training range, thick foundation, focus on training of ability and overall quality". The old, simple knowledge teaching mode must be transmuted into training practical ability and quality education, especially training complex management talents with project practice ability and innovation ability. The curriculum should provide students with specialized profession courses and optional courses with a multi-disciplinary orientation, and give students more choice according to their knowledge structure. We should pay more attention to curriculum combination and interdisciplinary of different disciplines, to develop the wide knowledge and skills basis for students.

References

- Lei, Y. (2006). Survey report of German project management. *Journal of Construction Supervision*, (3), 42–44
- Liu, G. (2006). A comparative study of training program of construction project management professional. *Journal of Chinese University Education*, (12), 49–51
- Wang, Y., & Wang, S. (2009). Education status of master of engineering in the field of project management, *Journal of Project Management Technology*, (11), 84–88