Objective of Education Reform and Application Idea of Cooperation between college and enterprise on the Course-Education of Construction steel structure fabrication technology

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Abstract. Construction steel structure fabrication technology is one of the featured courses in the field of steel structure, and this course is closely related to applied engineering. To better cultivate application-oriented talents, this course adopts the college-enterprise joint lecture mode, adopting revolutionary approaches such as making course plans, constructing internship bases, compiling and editing textbooks and giving jointed lectures together with steel structure companies to enhance the effectiveness of the instruction and improve students’ creativity. Through 10 years of in-depth college-enterprise cooperation, we have achieved remarkable results and temporary success, and we believe our example will provide an exemplary case for the reform of similar courses as well as a new idea for the cultivation of application-oriented civil engineering talents.

1. Introduction
The progress of time has brought up new requirements for contemporary civil engineering college students, requiring them to not only master theoretical civil engineering knowledge but also possess hands-on and engineering application abilities. Society and enterprise’s demand for “high level” application-oriented talents is increasing steadily[1][2], which means more opportunities for private colleges with a goal of cultivating application-oriented talents like us, but meanwhile it also brings newer and higher requirements. To bridge the gap between college education and employment, in recent years, College of Urban Construction of Zhejiang Shuren University has made many active and effective explorations and experiments at the college-enterprise cooperation mode. The application-based course Construction steel fabrication technology, co-developed with Zhejiang Southeast space Frame Group Co.,Ltd. is a good example of the attempt.

2. The Establishment of the college-Enterprise Cooperated Application-based Curriculum

2.1 The establishment of the experimental class with a concentration in steel structure
In 2007, College of Urban Construction of Zhejiang Shuren University conducted an investigation with Zhejiang Steel Structure Association on medium and large steel structure companies’ demand for college graduates. According to the investigation result, as steel structure is being widely used in civil
engineering, construction steel companies’ demands for professionals specializing in steel structure design, fabrication and installation and for documentarians are increasing steadily, and the lack of professionals specializing in fields directly targeting at factories and construction sites like welding, fabrication, and installation is especially noticeable. On July 29th and September 19th of 2008, College of Urban Construction of Zhejiang Shuren University launched two professional panel discussions focusing on “establishing the concentration of steel structure” and “the reform for steel structure education”, respectively. The experts concorded that creating the new concentration of “steel structure” is realistic, feasible and urgent, which addresses the need of the economic development of Zhejiang Province, and the education reform is realistic and feasible. In November 2008, the College of Urban Construction selected 37 students from the structure engineering major to participate in the school’s talent cultivation innovative experiment, and they formed the first experimental class of steel structure concentration.

2.2 College and Enterprise cooperate to make educational plans, focusing on the establishment of application-based curriculum

Based on the demand for steel structure professionals, we invited core technicians of steel structure companies to make educational plans for cultivating talents. In addition to the original civil engineering (structure concentration) curriculum, we added new application-based courses including steel structure welding technology, steel structure fabrication technology, and steel structure installation technology. In terms of the experimental education, we made arrangement for students in the experimental class to intern at steel structure companies during their sixth semester in college and in the following summer break, for a total of two-month internship at different positions. Moreover, all students are required to complete an internship relevant to their graduation design at a steel structure company during their eighth semester.

2.3 College-enterprise cooperated instruction mode

The curriculum adopts the instruction mode of “college and enterprise cooperate and give joint lectures”. The curriculum of construction steel structure fabrication technology emphasizes both on theory and application, requiring that the instructors must have rich experience in engineering applications. Because only those who hold chief engineer and technician positions in steel structure companies are qualified for this type of instruction, we used Zhejiang Steel Structure Association as a platform and hired the chief engineer of Zhejiang Southeast space Frame Group Co.,Ltd as the chief lecturer of the course construction steel structure fabrication technology, and instructors from our college assisted him as co-instructors to teach the class.

During the course instruction, we valued the organization of the course content and every learning scenario is designed according to the features of steel structure components. Through making the content of the class reflect real products which further develops into different knowledge modules, we trained students’ professional abilities as well as cultivated their professional qualities [3]. In construction steel structure fabrication technology, the curriculum includes three major parts, “construction steel structure material and performance”, “general component fabrication and processing”, and “typical component fabrication and processing” which helps students master the essential knowledge of steel structure fabrication technology through project training. Meanwhile, vivid instructions from experts with rich experience in application spark students’ interest in their major, which creates positive learning atmosphere and achieves good instruction outcomes.

2.4 Enterprise participates in the entire process of curriculum establishment

The college-enterprise cooperation requires the enterprise to participate in the entire process of building the steel structure curriculum system, and participation in processes from designing the synopsis and determining the curriculum to organizing and implementing the course instruction and receiving feedbacks and evaluations of their employment companies from the students after their
graduation is essential to facilitating the process of constructing the new mode for cultivating application-oriented talents.

3. College-Enterprise Cooperation in Creating Featured Course Materials

3.1 College and enterprise cooperate and complement each other to build a high-level course material compilation team

Due to the addition of application-oriented curriculum in the talent cultivation plan and the lack of featured course materials domestically, the compilation of course materials for the major is very urgent. Meanwhile, to enhance the practicality of the course material, it is crucial to build a high-level college-enterprise course material development team, which is also the premise for ensuring the quality of the new course material. For this reason, we relied on Zhejiang Steel Structure Association as a platform and organized a team led by professors in prestigious colleges in China who have firsthand teaching experiences for nearly 30 years as well as rich experience in compiling and publishing textbooks, and 7 expert technicians from famous steel structure companies in China, to compile with great care the textbook Construction Steel Structure Fabrication Technology which takes into account the characteristics of application-based talent cultivation.

3.2 Curriculum development and construction solidifies the foundation of course material compilation

Construction Steel Structure Fabrication Technology starts with the basics and application, including basic contents to contents that require deeper understanding, coming up with the framework for course material compilation and forming the lecture-style instruction. In addition to the comprehensiveness of the content, the course material makes emphasis on the key points and is easy to understand, concise and practical; in terms of the content, organization and logical connection, the course material pays close attention to providing guidance to students and by the first half of 2009, the first draft of approximately 20,000 words was completed and put into use in the first class of steel structure of our university. Basing on the first draft, we initiated the key construction of the curriculum. In 2009, we applied for the Eleventh Five-Year course material construction key program of Zhejiang Province, which was successfully approved at the end of the year. Using this as a stimulant, 8 experts from colleges and enterprises got together and discussed the recompilation, expansion and modification of the course material. By October 2010, the textbook of 77,000 words has been completed and published in April 2011 by the most prestigious national publishing press in the field of architecture – China Construction Industry Press. In addition to completing the textbook compilation, the course material construction completed the construction of a variety of multimedia courseware for complementary engineering cases.

3.3 Featured course material has higher practical value

Adding the application-based curriculum of steel structure fabrication to the college education of civil engineering ended the history of the lack of similar course materials in the field of construction steel structure. Incorporating the fabrication technologies practiced by enterprises into college course instruction bridged the gap between theoretical education in college and real application in enterprises [4].

This course material is based on the evaluation for steel structure professionals (mid-level) and the accompanying preparation materials for construction steel structure fabrication technology. Therefore, in terms of the detailed content description, concise language was used whenever possible in the description of the fabrication processes for each steel structure component. Following the principles of “basic to complex”, “easy to difficult” and “concrete to abstract” in the process of compilation, the course material focuses on the introduction of theoretical background and practical application of the theories. It also adopts the latest national standards for steel structure design and material, which makes it directly applicable to readers and provides valuable reference to engineering technicians.
In addition to the comprehensiveness of the content, the material emphasizes the introduction of important real-life cases and combines theory comprehension with skill training, which provides the foundation for self-learning and innovation abilities for the students.

4. Temporary Success of College-Enterprise Cooperation

4.1 Establishing the “college-enterprise win-win” cooperation mode for cultivating talents in the field of steel structure

Through the establishment of college-enterprise cooperation, we developed the win-win talent cultivation mode and successfully established internship bases with steel structure companies. In recent years, our college has signed contracts and established experimental education bases outside school with enterprises such as Zhejiang Southeast space Frame Group Co., Ltd., Hang Xiao Steel Structure Co., Ltd., Sheng Da Iron Tower Co., Ltd., and Jing Gong Steel Structure Co., Ltd., which provides advantageous conditions for students to intern at different positions, and opportunities for instructors to visit the enterprises and participate in their production activities, get a hang of the skill requirements for different positions and gain an insight into the newest technology, fabrication technique and methodology in the industry to improve their own professional and instruction abilities. Meanwhile, our teachers participated in steel structure companies’ research projects. For example, in 2008, Hong Feng Industrial Group Co., Ltd. and the College of Urban Construction of Zhejiang Shu Ren University conducted the study of the structure and stress performance of the glued junction of steel structure and new glue types, a key project funded by the Technology Department of Zhejiang Province. Hong Feng Industrial Group Co., Ltd. provided 300,000 RMB research funding and the final project was shared between the college and the enterprise. This mode became an exemplary case for other schools in China to learn from and refer to, and it also obtained very positive approval from Zhejiang Steel Association and peer universities in China.

4.2 Through college-enterprise cooperated cultivation, the qualities of the students improved significantly

College-enterprise cooperation cultivates students’ perceptivity of the society, analysis ability of real cases and practical hands-on ability[5], which makes experts and leaders in relevant employing companies recognize and affirm the abilities of graduates from our college. Meanwhile, through cooperating with steel structure companies and enabling students to participate in their work, solid professional background and dedicated working spirit demonstrated by the students often made them more attractive to the matching companies. As a result, the employment rate of graduates from our college has been in the top percent of the entire university in the recent few years. Moreover, most graduates are able to adapt to their job positions very quickly and work independently in their technical positions, which has achieved popularity and unanimous approval from the employing companies. So far there have been approximately 20 graduates working in the company participating in the college-enterprise cooperation program, Zhejiang Southeast space Frame Group Co., Ltd., and the students work in departments from production to design, many of whom have become core technicians of their company.

4.3 The course material is rich in content and has broad application fields

Construction steel structure fabrication technology textbook was published in April 2011 by China Construction Industry Press. According to the sales record of the press, the majority of colleges have used this text in their steel structure course instructions and Zhejiang Steel Structure Association also used this material in their professional training. They all think the content of this text is detailed, comprehensive and systematic, and the focuses are clear, easy to understand and concise and practical. As a result, this text is widely used in steel structure instruction in colleges in China and is recognized by both teachers and students. This text has been printed twice within one year of its publication, reaching a total of 4,000 prints so far.
4.4 The publication of this text has obtained very positive feedbacks from steel structure experts
The publication and application of this text has elicited extensive responses in the field of steel structure, and it has obtained sufficient affirmation from experts. The president of Zhejiang Steel Structure Association and expert technician, Hongqiang Fang, highly recommends Construction Steel Structure Fabrication Technology, an excellent text compiled by Professor Jian Yao’s team from Zhejiang Shuren University and master-level professional technician Guangen Zhou and other experts from Zhejiang Southeast space Frame Group Co., Ltd, which actively summarizes the techniques used in key steel structure engineering projects including the award-winning project National Aquatics Center, and carefully and systematically describes the entire process of steel structure construction project including the material and performance of construction steel structure, detailed construction design, component processing, steel structure welding, real cases of typical component processing and fabrication technology, bolt junction, steel structure pre-assemblage, steel structure coating, component quality inspection, packaging and transportation, steel structure fabrication quality control and typical steel structure construction detailed graphical examples. President Fang approves that the innovative text not only makes up the lack of similar texts in the field but also is very practical, which not only satisfies domestic colleges’ need to cultivate applied-oriented talents in the field of steel structure, but is also a very valuable reference for steel structure engineering design, construction, supervision and management.

5. Conclusion
The application-based curriculum of construction steel structure fabrication technology and the course material construction is a temporary success of college-enterprise cooperation. The course instruction emphasizes on the combination of theory and real case and seeks in-depth cooperation with enterprises. The diverse and innovative instruction methodology has achieved remarkable success and improved students’ professional abilities through systematic learning of the application-oriented curriculum and other knowledge in the major. Students from the experimental class have won the national first and second prize and provincial special, first and second prizes in the structure design competitions for college students. The compilation of the featured course material has made up the lack of course materials in steel structure related field, and enhanced students’ competitiveness for intense competition[6]. Construction steel structure fabrication technology has been listed as one of the application-based courses of the university, and the education reform of the curriculum also provides an exemplary case for the reform of similar courses in the future.

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