

# **Developing a Practicum Plan for Undergraduate Students in Railway Design and Operation Major of Transportation Engineering**

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## **Abstract**

Because of the increasing complexity and advancements in the area of railway industry, there is a growing demand for graduates to be specialists with systematic views, specialized skills and innovative abilities. This paper presents an overview of the present typical arrangements of practicum curricula in railway design and operation major in transportation engineering education for the rapid development of railway industry in China. The experimental and practical courses are divided into several modules such as the module for basic skills, for specialized skills, for synthetic ability and for innovative ability. They are arranged into eight semesters and employ various learning styles and evaluation strategy according to their relations and positions in learning sequences. The national experimental and engineering education platforms are basis of this practicum plan to enhance practical skills and innovative ability of the students.

## **Introduction**

This paper presents an overview of the changes in practicum plan made as a result of the curricula system reform project granted by the Ministry of Education (MOE) of China and the Sichuan Provincial People's Government of China within the past decade.

Researches and practices<sup>1,2</sup> have demonstrated that for a developing country of continental nature like China with huge population and vast territory, railway, a rapid transportation mode with large capacity, plays an essential part in its economic and social development. The necessity of improving the design and operation of railways continuously results in the birth of transportation engineering education as a major focusing on railways in China in 1937, the recovery of this major in higher education from economy collapse in 1956, and the upgrading as one of the main disciplines chosen by MOE in 2009. As the initial department in this field, we keep improving our engineering education in railway design and operation, and rank the first among the counterparts of domestic universities/colleges. Our experiences<sup>3,4</sup> in practicum plan reform helped to establish the criterions of China engineering education accreditation. The reform continues to comply with the increasing demand, complexity and advancements in areas of railway industry toward a systematic<sup>5</sup>, adjustable and project-based<sup>6</sup> curriculum structure.

## **Demand Analysis of Experimental and Practical Ability**

Railways industry develops rapidly in recent years in China and will last for a certain long period, which creates a growing demand for graduates to be specialists with systematic views, specialized skills and innovative abilities in railway design and

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operation field. Meanwhile, large overseas contracts of railway construction, equipment manufacture and operation management grow in numbers, demanding more specialists in this field with international recognition. In addition, the design and operation of urban rail transit systems in many Chinese cities requires the graduates to accept a flexible education on urban rail transit systems while inheriting the traditional railway knowledge and practical skills.

The education of this major has a close relationship with the industry. The degree plans made before 2004 were based on the idea of generalization education because of the laggard development of the railway industry in China. The courses in the degree plan are mainly focused on the general theoretical knowledge of civil engineering and transportation engineering, leaving the practicing skills training as part of the career for students after their graduation. The equipment used for the operation is quite old and almost non-automated at that time, and it usually took little time for the graduates to learn how to use them skillfully. There was few computer aided design or operation software employed in the industry as well. With the development of railway industry in recent years, however, the employers of the railway administrations and design institutions were faced up with the urgent need that the graduates must be familiar with the conventional and updated knowledge of railway operation and design in university, become skillful in utilizing the improved and newly invented equipment, and find solutions for problems never happened before. Since the business in the industry increased so rapidly, educators in the university soon realized that the curriculum and practicum plans should change to meet this need. It also brought a fully awareness of the importance of the experimental and practical skills training in the railway engineering education. The experimental and practical training influences immediately on the comprehension of knowledge and skills of students, as well as the cultivation of their innovative abilities.

As a direct consequence of the new industrial development and the educational demand, the practicum plan of the railway design and operation major has been prepared based on the reformed degree plan to meet the following objectives:

- To impart to students the knowledge and skills of transportation engineering, that of related industries such as electronics and mechanics, that of economic and management science such as economics and marketing, and that of humanities and social science such as philosophy and psychology to cultivate a systematic view in education and career of design and operation of traditional railways and urban rail transit systems.
- To provide a good foundation in mathematics and information technology and a synthetic ability training for students. Enable them to be familiar with the methods and procedures of the comprehensive technology in railway engineering such as infrastructure design, technology application, product/service development and operation schedule determination, and to train the students to learn and accumulate by the results and to maintain sensitivities to trends of new thoughts, technologies and its applications.
- To initiate students into capabilities of running engineering projects with the traditional technical and business management methods and being adaptive and innovative in investment evaluation, quality control, budget analysis, human resources evaluation, administrative arrangement and crisis responding, etc. under transportation management system reform circumstances.
- To encourage students to develop the capability of inter-disciplinary and

inter-culture communication, the adaptability of different working environments, the competence of information searching and processing, and the favorability of teamwork.

### Basic Structure of Practicum Plan

Experts from administrative and enterprise sections in related areas of the railway industry participate in drawing up of the practicum plan and work with educators in our department to build the basic structure (as Figure. 1).

The structure design follows the rules of learning sequence. For example, the ability training should be carried out from easy projects to harder ones gradually, as well as simple to comprehensive; experiments focused on the recognition take precedence over those on the synthetic application; internship projects of routine work go as a predecessor of those dealing with new events in real operation; the class teaching and experimental/field teaching are closely related with some items opened up during class time while others in the short term before summer vacation. The items/courses in the practicum plan are arranged in modules in different levels and time sequence in eight semesters.

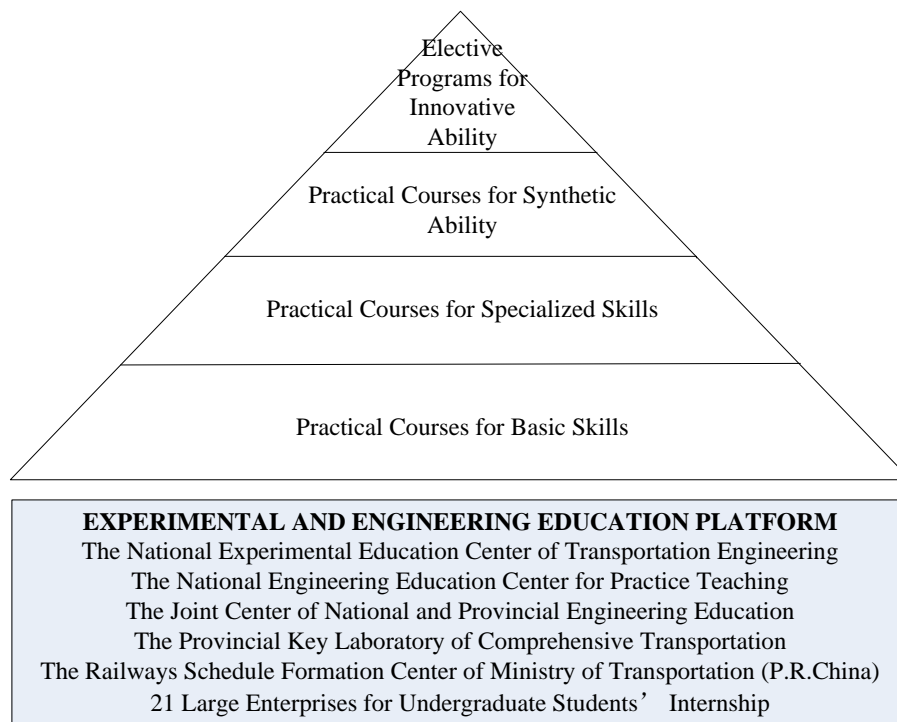


Figure1. Basic Structure of Practicum Plan

The first level is the module for basic skills, including the demonstration tests, authentication experiments, basic operational training, recognition internships, simple engineering project practices and social activities. This level is designed for the freshmen and sophomores to get basic manipulative skills and scientific and engineering thoughts. These practical courses or experimental items are usually carried out during the first two years of university.

The second level is the module for specialized skills, including the experiments and design assignments from engineering specialization courses in class, the project field

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investigations, and the productive internships. The practical courses in this level are suitable for the junior students who have taken the specialized courses in class and need further training in the particular field of railway design and operation and deep experiences in the real environment of the field.

The third level is for both the junior and senior students to develop their synthetic ability by means of taking various project assignments, comprehensive experiments, graduation designs/papers and specialized internships. Unlike the courses in the first two levels where the experimental items and practical courses are directly connected with certain class teaching contents, experiments and internships in this level require the integration of knowledge of several related courses and are mostly project-oriented, that is, they are the revision of real engineering projects.

Those three levels are the obligatory ones, while the highest level is comprised of elective courses designed for innovative ability training, including the individualized experiments, self-designed trials, projects from the national Student Research Training Program, various Science and technology competitions, exchange programs and special training programs. These experiments and projects are conducted by the teachers and laboratory assistants and usually carried out in teams. The issues are all come from the researches or industry frontier. When they choose some certain items according to their interests, undergraduate students are often organized to take part in the whole development process and to do some element tasks which mostly become the foundation of their further education and careers.

### **Practical Courses Arrangement in Practicum Plan**

The practical courses arrangement in the practicum plan is discussed and settled according to their relations in learning sequence and to their connections with class teaching courses if have any. The curricula arrangement of the degree plan of the railway design and operation major (as Figure. 2) is displayed with the practical courses arrangement of the practicum plan (as Figure. 3) to show the detailed connection and expansion of the contents in practicum design.

### **Guarantee Measures for Performance of Practicum Plan**

The academic and industrial exchange atmosphere is very important for the effect and improvement of practicum plan. For example, seminars focusing on some certain experiments or practical courses are regularly organized inviting experts from industries and universities. It is also results in the new items in experiments or courses to meet the growing demand in industry circles and research communities.

The motivation mechanism is also established to promote the enthusiasm of students and teachers to take part in the elective experiments and contests. For example, the special grants from the key laboratories of our department support most of the items and experiments carried out in the fourth year of students' college life.

Evaluation strategies vary according to the characteristics of different items. For example, in demonstration experiments the result evaluation is important, while in the graduation designs/papers evaluation, the process control method is used to guide the students to learn the standard procedures of engineering projects or academic papers. As for the elective practical courses, there are actually no fixed evaluation criteria; the achievements are what the students obtain during his work.

Experts from outside the university are invited as part-time teachers in our department

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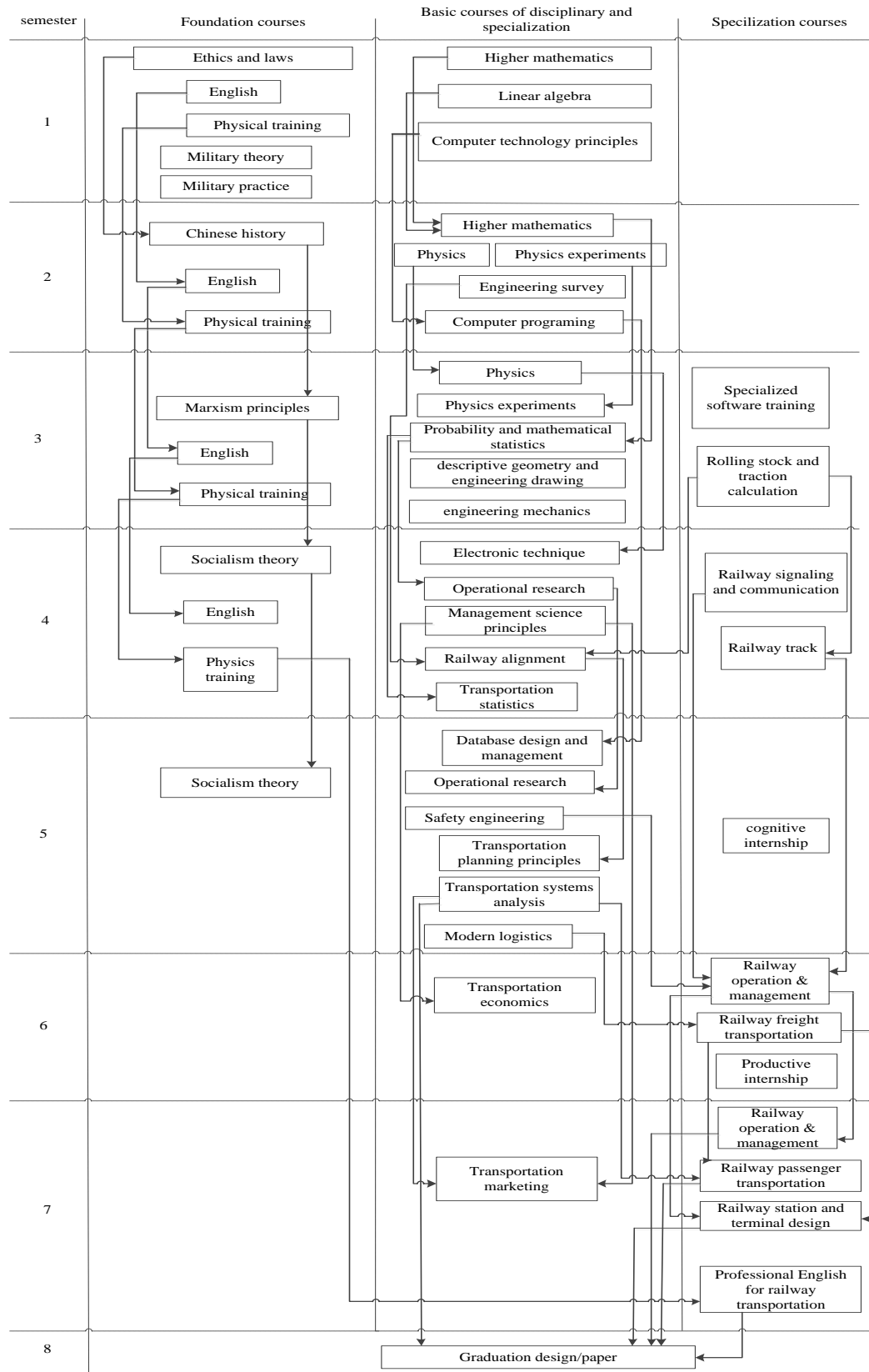


Figure 2. Courses Arrangement in Degree Plan According to Semesters and Categories

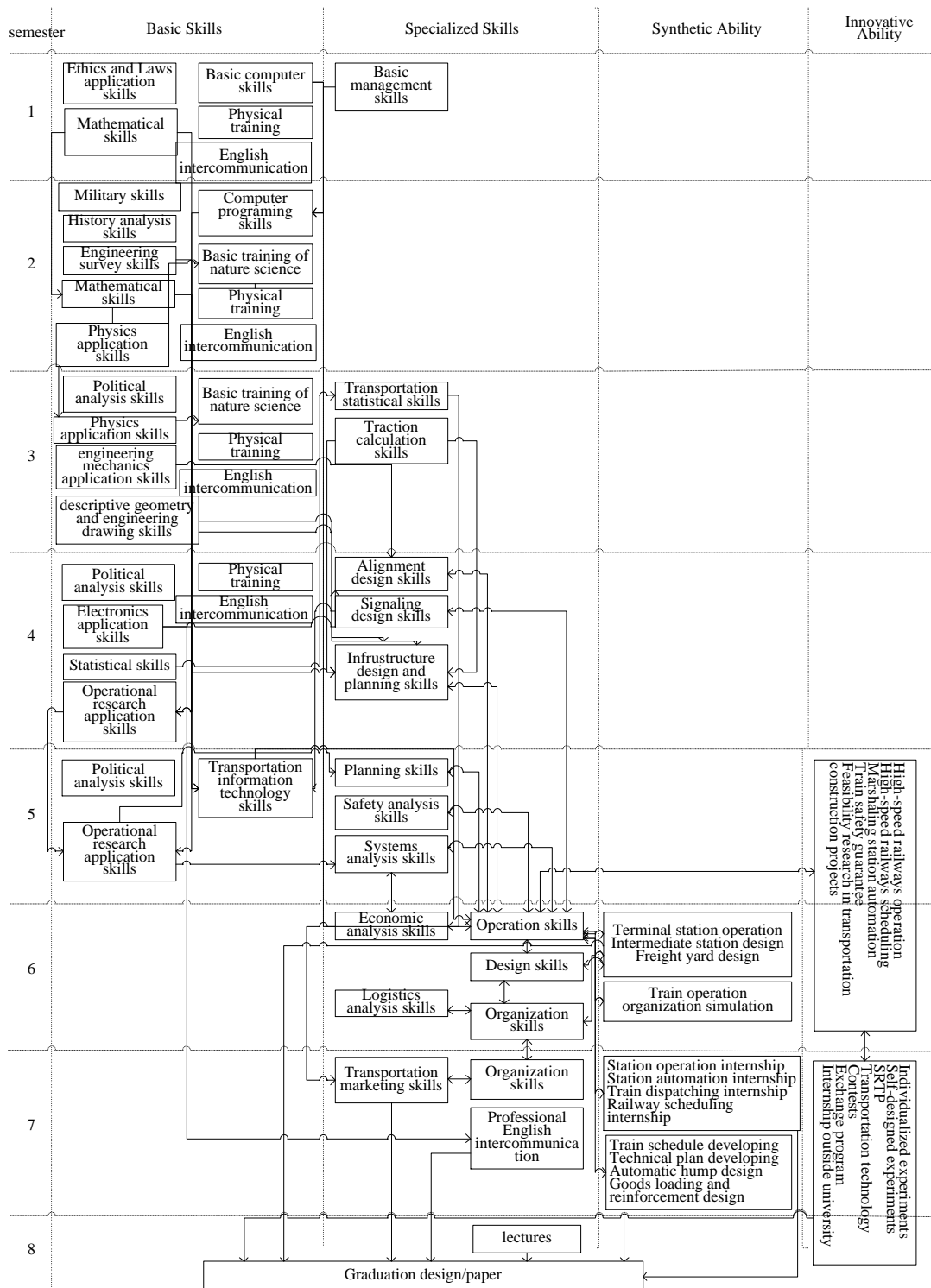


Figure 3. Courses Arrangement in Practicum Plan According to Semesters and Categories

to teacher and tutor in some experiments and internship courses. Working with the full-time teachers in our department, they build a much closer relationship between industry and university, which is helpful for the improvement of both.

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## Conclusion

This practicum plan of railway design and operation major has been improving during these years under its basic structure. The graduates showed competence in the job markets relating to the administrative department, the research institutes, the design and construction companies, and the railway operation enterprises. Faculty of other universities and colleges kept visiting us for the experiences in the practicum design and some detailed methods. But as any other fields of engineering education, the practical courses in the undergraduate curriculum cannot cover all the topics on the job, what we actually do and will continue is to provide a solid undergraduate foundation for their graduate or continuing education.

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