Engineering education of electrical information courses: a comparison between Germany and China

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ABSTRACT: This article is based on five years' personal experience in Germany gained while the author studied at Dresden University of Technology for an electronic information engineering diploma. Against the background of seven years' first-line teaching experience in technology automation at Wuhan University of Science and Technology, the author in this study has compared and analysed electrical information specialties offered in China and Germany, from the basic objectives of education, curriculum and other aspects. The similarities and differences between the specialties of the two countries were identified. The aim was to find an innovative higher engineering education model that fuses the educational advantages of the Chinese and German specialties in electrical information and which will assist the reform of engineering training in China. References for the development of engineering higher education were also gathered.

INTRODUCTION

After a century of developing engineering education, there is no doubt Germany holds much of the world's esteem for setting a successful example regarding engineering higher education. Its distinctive features include a unique training philosophy and training model [1]. German training in engineering has a strong historical continuity. The country has trained a large number of excellent engineers, which has been of economic, scientific and technological benefit. This laid a solid foundation for Germany's national strength and international status [2]. In electrical information, Germany has a strong and stable force of engineers leading to German companies, e.g. Siemens, having a good ranking world-wide [3].

China's engineering higher education started late. Due to historical reasons, for a long period after the founding of the new China, the country's educational system completely reproduced the model of the former Soviet Union, regardless of whether aspects of the model were essential or non-essential. During ten years of turmoil, China suffered a severe setback in higher education, resulting in a shortage of students receiving an engineering education in the eighties and nineties. This interfered with economic construction and development [4].

Since the 1990s, China has reformed higher education, and the teaching of electrical information is most important given the speed of modern industrial development [5]. The reason why the electrical information specialty is considered vital, is because of the demand for power and the rapid development of information systems.

Over the past two decades, Chinese electrical information engineering education has made great strides, but engineering education has not changed, and is not able to adequately meet the modern industrial demand for engineering and technical personnel. The aim of this study was to identify several deficiencies.

ADVANCED ENGINEERING TRAINING

The Chinese Education System

China has nine years of compulsory education and, then, a three-year senior middle school education. At senior middle school, the students choose between liberal arts and science. Students enter university through a college entrance examination.

Students who select the electrical information specialty chose science in their senior middle school. As China's basic education system is very structured, students who study engineering find it difficult to immediately adapt to college, which compromises teaching effectiveness.

The German Education System

Compulsory education in Germany is from the age of six to 18. There are 10 years of full-time schooling followed by three years of senior middle school (i.e. Gymnasium). Students are streamed into different senior middle schools viz. science and technology (Technisches Gymnasium); economics (Wirtschaftsgymnasium); senior professional (Berufsoberschule), etc. Senior middle school graduates obtain high school diplomas (Hochschulreife). Students of the electrical information specialty are *Technisches Gymnasium* graduates. German engineering education is practice-based, and there are engineering practicals in senior middle school. Therefore, German students can adapt very well to engineering higher education.

TERTIARY SCHOOL SYSTEMS

The Chinese University System

Chinese students study electrical information for four years, divided into eight semesters. The first three semesters are foundation courses, the fourth and fifth semesters are the main courses, the sixth and seventh semesters are the professional courses, the eighth semester is the graduate course. Students are awarded a Bachelor's degree through submission of a graduation thesis.

The German school system

The German professional education system, under which electrical information is offered, is divided into two stages: the *entry* or basic, stage (Grundstudium) of four semesters, which deals with the basics; second, there is a professional stage (Hauptstudium), usually of six semesters of advanced study to develop professional skills. After the basic stage, students must pass mid-term examinations (Zwischenprüfung) to enter the professional stage. Here, students select a direction of study and proceed to complete the professional courses leading to a degree in engineering, the Diplom-Ingenieur (Dipl. Ing.) (Universität), which some believe to be equivalent to an MEng.

CURRICULUM AND CONTENT

In terms of the curricula, there are no major differences between China and Germany. The curricula consist of five parts:

- First are the basic courses, mainly humanities, social science, economics and management, foreign languages, sports and other. Germany; however, does not have foreign languages and sports courses. Instead, students can earn credits by belonging to associations or other interests.
- Second are the professional courses, including for the electrical specialty obligatory courses in mathematics, physics, electronics, circuits and other basics and various elective courses.
- Third is a professional experimental course.
- Fourth are the professional practical courses, which include various types of internship and a graduation project.
- Fifth is the individualised programme, tailored to each student.

It can be stated that German engineering higher education focuses on practical teaching, while Chinese engineering higher education is more biased in favour of theory.

Since the German schooling period is longer than that in China, the German curriculum has more content (see Figure 1 and Figure 2). There are also differences between the Chinese and German electrical information courses in content and organisation.

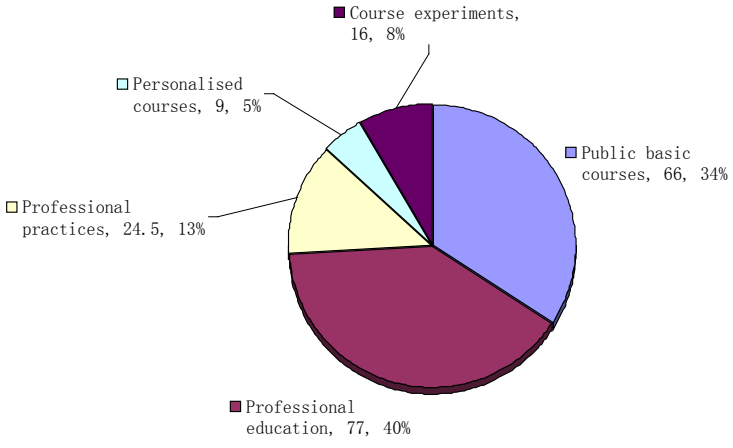

Figure 1: Course composition, credits for Chinese electrical information.

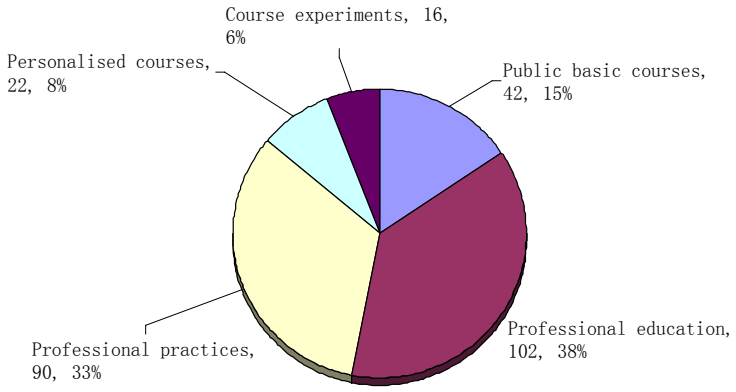

Figure 2: Course composition, credits for German electrical information.

Differences of Theory Content between the Courses

Most universities in China position themselves as research universities, with the target of training scientists rather than engineers. Engineering education and science education are different. China requires a large number of senior electrical information engineers. Scientists engage in research, while engineers *invent*.

The main goal of the electrical information specialty should be to train engineers. In Germany, it is clear, the aim of their electrical information specialty course is to train engineers, and even the diploma indicates *qualified engineer*. In the past four years, the Chinese Ministry of Education has clearly stated a requirement for an *excellent engineer training programme*.

With the continual emergence of new knowledge and the lack of integration between courses, the number of electrical information courses in China keeps increasing. There is often a teacher-centred lecture-style of teaching, which assumes textbooks contain all knowledge.

In Germany, the electrical information teachers mostly are engaged in frontline research. They attach great importance to knowledge, and have a profound understanding of current scientific and technological research. In receiving such a cutting-edge education, students not only become competent but are also forward-looking. Because knowledge updates are so frequent, German teaching often ends up relying on a series of teacher handouts rather than a fixed textbook; this is student-centred heuristic teaching.

In China, there are some issues with education. For example, courses do not keep up-to-date with technological developments and so the longer students learn, the more distant is the knowledge from the real world. Fortunately, the Chinese Ministry of Education has recognised this problem, and proposed that a *Remarkable Engineer Training Programme* be set up, stressing the need to improve existing lectures to keep them up-to-date.

Differences between Practical Teaching and Engineering Training

In contrast with the content of engineering practical teaching, the theory course experiments include validation experiments, which are the basis for consolidating theoretical knowledge. In this respect, there is not much difference between China and Germany. However, the practical sessions do differ. In China, electrical information students are organised by the schools into internships. But the students tend to be passive in the social and corporate culture, and rarely accept responsibility. German students are required to apply to a company for an internship. If a student cannot complete the required tasks during the internship, proof of completion of the internship will not be obtained, and so the student will be prevented from entering the next phase of the study programme.

The time spent on professional practical sessions within the Chinese electrical information course is dispersed through the course, while in Germany it is more concentrated, with far more time spent on this than in China. The majority of German students spend more time on internships and academic design tasks than the specified time. For Dresden University of Technology graduates in 2003, the average number of semesters to graduate was 11.2. Most students in Chinese engineering higher education schools graduate on time; more variability reflecting individual differences in students would be expected.

Chinese electrical information internship instructors are mentors, who may be drawn from research. The selection of topics may not match the needs of the students. Another difficulty is that an instructor may have more than one student, and so it is difficult for them to carry out one-to-one guidance. In Germany, each student of the electrical information

course, on an internship, has a college tutor and an internship tutor. University tutors are responsible for guidance on theory, and the internship tutor is responsible for topic selection and day-to-day guidance. The subjects chosen are drawn from the company's actual needs and so mirror reality. This provides a solid foundation for students to quickly become engineers and technologists after graduation. Table 1 and Table 2 show the differences between Germany and China in practical teaching.

Table 1: Engineering practical teaching and training in the electrical information course in China.

Time	Theory courses/course design	Internship courses
First grade	Physics, circuit	Cognition (one week)
Second grade	Electronic technology, MATLAB	Electronic technology (2 weeks)
Third grade	Motor learning, automatic control theory	Production (two weeks)
Fourth grade	Microcomputer principles, PLC	Graduation (three weeks)

Table 2: Engineering practical teaching and training in the electrical information course in Germany.

Time	Theory course/curriculum design	Internship programmes
Basic learning (semesters 1-4)	Computer technology, physics, circuits	(Enterprise) 12 weeks' basis internship
Professional learning (semesters 5-8)	Electronic technology, information technology	(Enterprise) 450 hours internship
9th semester		(Enterprise) 18 weeks' internship
10th semester		(Enterprise) six months' graduation

CONCLUSIONS

Germany has a long history of fruitful engineering higher education. Over the past decade, universities in Germany have joined the European Course Credit Transfer System in order to conform to international standards, and have launched international Bachelor's and Master's Degree programmes. Germany maintains an excellent tradition of engineering higher education, selectively learning from foreign experience.

China is actively implementing educational system reform, especially of engineering higher education. In recent years, the Chinese Ministry of Education's *Excellence Engineers Plan* for the school system, curriculum, and instructors, has promoted reform. It is hoped that in the next few years a new engineering higher education system will be seen in China.

REFERENCES

1. Bastian, J., Germany: German tiger or European growth engine. *World Today*, 67, **8**, 16-18 (2011).
2. Lange, T., German training revisited: an appraisal of corporatist governance. *Educ. Training*, 54, **1**, 21-35 (2011).
3. Zuo, J.Y. and Chen, Z.K., Engineering-oriented practical training methodology for undergraduate and a case study. *Research J. of Applied Sciences, Engng. and Technol.*, 5, **3**, 848-857 (2013).
4. Williams, C., The discursive construction of the competent learner-worker: from key competencies to employability skills. *Studies in Continuing Educ.*, 25, **8**, 26-38 (2005).
5. Zhang, Q.L. and Wu, H.J., Construction project management training for China's engineers and managers in Singapore: meeting present and future demands. *Inter. J. of Continuing Engng. Educ. and Life-Long Learning*, 7, **2**, 203-211 (2009).