Engineering Education in China

-Opportunities and Challenges

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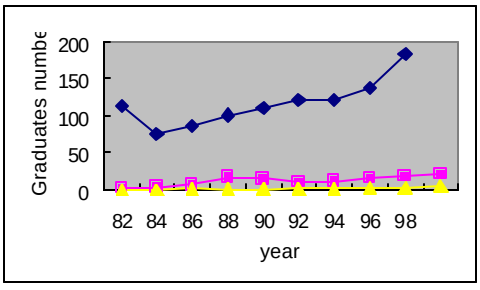
Introduction:

Engineering Education in the Peoples Republic of China began with the founding of Beiyang University in 1895. Since the establishment of the Peoples Republic in 1949, China has continued to improve its engineering education system. In 1952 China adjusted its college-department system, and emulating the Soviet model, re-designed the majors to meet the needs of an industrializing nation. In 1953 there were a total 215 majors for all disciplines.. This number increased to 328 in 1957, and then on to some 1039 in 1980, 537 of which were engineering majors. Since these majors were so narrowly defined and their curriculums were so specialized, the graduates of this era often felt it was difficult to meet the needs of their jobs. For this reason, the number majors have been continuously reduced since 1984. . The number of engineering majors was first reduced to 204, and the eventually to about 150 by 1998. [1] This was often done by consolidating several narrowly-defined majors into broader ones. For example, Chemical Engineering, Chemical Technology, Polymer Chemical Engineering, Fine Chemical Engineering, Industrial Analysis, Industrial Catalysis, and Electrochemistry were all combined into one new major called Chemical Engineering and Technology. While, the scale of engineering education has increased steadily in the past fifty years,, the pace has quicken noticeably since 1998. This is because of the increasing popularity of higher education in China. The following figure shows the number of the Bachelor's degrees conferred by engineering programs from 1982 to 1998. We can clearly see an increase over the past twenty years (Fig. 1). [2]



◆ Bachelor's degrees conferred;
¦ Master's degrees conferred,
? Ph. D degrees conferred
Axis Y: "Thousand graduates"

The opportunities brought by the globalization of engineering education

Globalization has presented China with the opportunity to further develop its engineering

education system by allowing for global research collaboration, improved faculty training, an increasing number of joint-programs between universities and international curriculum accreditation.

Firstly, the increase of international communication and collaboration brought on by globalization has caused a large increase in the amount of Research collaboration between universities. An increasing number of faculty members now get the opportunity to join world-class universities as visiting scholars or professors. By working in an excellent environment and learning from foreign partners, faculty members from China's engineering programs can not only improve their research work, but also increase China's role in the ongoing global efforts to advance humanity's scientific and technological frontiers. Research collaboration has also allowed an increasing number of engineering graduates to work abroad in laboratories as exchange-students.. This collaboration, helps graduates broaden their scientific vision and improve their research abilities.

Secondly, globalization has also benefited faculty training programs.: The Chinese government has paid increasing attention to the improvement of curriculum and teaching methods.. New faculty training programs give Chinese faculty members a chance to improve the quality of their teaching.. Every year since 2000, the Chinese Ministry of Education has given 150 faculty members the opportunity to visit the United States, Britain, or Australia as part of the Chinese Faculty Bilingual Teaching Training Program.. By taking part in courses taught in English,, learning new teaching methods, and observing classes, faculty members involved in this program are able to refresh their teaching content, and improve the overall quality of their teaching. The author of this paper went to UMIST as the member of this program and benefited from it a lot.

Thirdly, the past few years have seen several types of joint –programs have been developed between Chinese and foreign universities at both the undergraduate and graduate levels.. At the undergraduate level, one most commonly sees, 2+2 programs being run between Chinese and foreign universities.. Under this type of program, students from China spend first two years to learning fundamental knowledge and improving their English level to the point that they can pass the English test needed to go to abroad. While they are abroad the students complete their last two years of university. One example of this type of program is the Sino-France undergraduate joint program. The Chinese universities participating in the program are Tsinghua University, Shanghai Jiaotong University, Xi'an Jiaotong University, Xinan Jiaotong. The French universities partnering with them are the Ecole Centrale de Lille, Ecole Centrale de Lyon, Ecole Centrale de Nantes, and Ecole Centrale Paris. This program has been running since 2000. For a graduate joint program, both sides often provide courses confirmed by the program. Students go to oversea s universities to do their research work. Typically all students involved in these joint programs will obtain degrees from both institutions. For a graduate joint program, both sides often provide courses confirmed by the program. The success of these programs is dependent on collaboration between professors from both sides. A joint Master Program between Tsinghua Industrial Engineering Department and RWTH of Germany has been operational for four years. The Tsinghua-Tokyo graduate joint program, which focuses on the fields of nano-material, and biotechnology are examples of joint program at the Graduate level.

Finally, the increasing mobility of employees in the worldwide marketplace makes

international curriculum accreditation more and more necessary. During the process of curriculum accreditation, course content, teaching methods, teaching facilities, and environment are all assessed. The standardization of curriculum makes it possible for engineering graduates move from one country to another country for the purpose of study or finding employment. ABET has cooperated with the Chinese Ministry of Construction to undertake the Civilization Engineering curriculum accreditation.

Good opportunities from the development of China

Enlarge the scale of engineering education.

Globalization has caused rapid economic and technological development. This rapid development means that many of China's traditional industries need to undergo modifications and thus a large number of high quality graduates with theoretical knowledge and engineering abilities are required to carry them out. Increasing the number of engineering students and improving the quality of their education are urgent tasks facing Chinese engineering education today. Even though the percentage of students enrolled in higher education has increased 16%, the stringent requirements for entry into higher education are often too difficult for average Chinese families meet. In other words, only a limited percentage of students can be educated as engineers or technicians. China's yearly production of new engineers still lags behind industry's requirements.

Renew the majors and improve the quality of education:

History shows that the speed of economic and technological development depends on education. In the 1950's, China modeled its higher education system on the former Soviet Union's , and designed highly specialized disciplines which met needs of China's industrialization.. Today, Chinese Engineering education has been adjusted so that the majors are broader thus improving the graduates' ability to find work. The Chinese ministry of Education has even permitted some universities to design new majors by themselves. Many new name majors have been setup to meet the requirements of new industries and technologies.

Revise the course module:

By learning from America, Britain, Germany and other countries, China has been reforming its education ideology since the 1980's. Questions like "What kinds of abilities should students have as a well-trained engineer?" and "What are the measurable indicators for high quality engineering education?" are hotly debated in Chinese engineering education circles. In the traditional Chinese engineering education of the past fifty years, instruction tended to emphasize specialized technical knowledge rather than the underlying fundamental scientific knowledge. They resulted in Curriculums that emphasized too much textbook knowledge and neglected practical application. While the importance of natural sciences was recognized, the importance of social sciences for engineers was practically ignored. As a result, we provided too much technical and engineering knowledge but insufficient instruction in social sciences like economics, management, safety, and environment., We are currently revising course material and designing a arts and social sciences course group, from which students will need to select several courses as a general requirement.

The challenges of Chinese engineering education confront

Entering the 21st century, Chinese Engineering Education confronts many challenges. The main challenges stem from the changes in the requirements of the graduates' knowledge and abilities imposed by a rapidly changing society and increasing international competition.

The first challenge facing Chinese Education in the next century is the change of the domestic job markets in China and the way new graduates find employment. Before the end of 1990's, college graduates were all assigned jobs by the government. Since then, however, the government has gradually abandoned this job allocation scheme and so today new graduates must find employment by themselves. Today the liberalized job market provides students with many more choices than before. For example, before the reforms enacted, graduates in Chemical Engineering mainly found employment in the petrochemical and other related chemical processing sectors. Today, however, many Chemical Engineers have taken positions in the Biomedical, Consumer products, Materials, Electronics, and Consulting fields. The development of the Chinese economy demands well-trained graduates because China has finished the transformation from a planned economy to a market one. The changing job market dictates that engineering education must take note of the needs of industry. Also because of Globalization, students not only find jobs in Chinese companies, but are also often are employed by foreign companies and are either working in China or in abroad. As a consequence, we need to train students how to adapt different kinds of work environments and conditions. Thus we are working to re-design the curriculums and teaching methods in order to produce graduates with greater adaptability.

The second challenge facing the Chinese Education system is the competition for top students with other "hot" majors: Ten or twenty years ago, top Chinese high school students generally chose engineering majors because they could easily find job easily after graduation. We also traditionally emphasized science and technology over social science in Chinese higher education. There were nearly 17 times more Engineering degrees conferred than those of Economics in 1981 (Fig3). However, by 1999 this ratio was down to 3 to 1 . The number of graduates from social science majors increased greatly during the past decade. This is a reflection of industry re-organization. Heavy industry was the main part of the Chinese economy before 1980. It was only after 1980 that China began to develop the service sector. This change saw an urgent need for graduates from such majors as Economics, Management, Law and Financial majors and so these majors were rapidly developed.[3] These new majors have more attraction to top high school students. While some traditional industries were looked upon as "sunset" industries. So majors like Metallurgical Engineering, Machinery engineering and to some extent Chemical Engineering majors became 'cold' majors and thus attracting students became more difficult.

Year	Phil.	Eco.	Law	Peda.	Arts	Sci.	Eng.
1981	1328	2473	1685	2256	11218	17316	41743
1990	2991	19199	10246	6586	24155	42558	109862
1998	780	58095	14832	14611	38885	40213	181890

Data: The number of degrees conferred (persons)

A third challenge comes from the globalization of education. WTO membership in

particular has caused many new challenges to arise. On the one hand, China has benefited from its access to global markets.. On the other hand, the competition from abroad is tremendous. Other countries are permitted to enter China to recruit students now. In recent years, more and more students go abroad to finish their higher education, especially in U.S., Australia, Britain, New Zealand. These countries attract top Chinese students by providing high quality courses, well-organized training programs and scholarships. When compare with these overseas universities, domestic institutions in China have only basic facilities for teaching and research and thus are still insufficient even though the national government has invested in some of China first-class universities in the past decade though the 211 Program and the 985 Program. From the statistic of Ministry of Education of China, in 2004, 114663 students go to abroad to continue their learning, some 10382 were supported by government, and other 104281 were supported by their families or scholarship. [4]

Another challenge is curriculum accreditation. On the one hand, the accreditation brings opportunities to improve the quality of education and the mobility of graduates. On the other hand, we often struggle to keep programs that are able to meet the unique demands of Chinese industries. Keeping graduates being able to meet the needs of Chinese industry is a serious problems we must confront. In Chinese industry, we still have a large number of problems that need to be solved in traditional industry. In China the structuring of industry is different from western countries. Key industries such as manufacturing, processing, still need a tremendous number of graduates whereas the number of students majoring in traditional engineering majors has decreased in western countries. At the same time, a great number of international companies build their factories in China, and need well-trained engineers. This means Chinese engineering education must keep balanced between globalization and localization.

The trends in Chinese engineering education reform:

First, China must increase the number of students. China is making a great effort to increase the number of students in higher education in order to provide more technicians who can meet the needs of industry. Even though we have realize that the efforts to develope education cannot exceed GDP or other aspects such as economy, society and culture development levels. [5]

Second, since the early 1990s we have been working to renew course content and revise curriculum of engineering education.. The research and development of new manufacturing processes, the modification of traditional ones, and the emergence of new technologies has provided engineering education with several new missions. New research fields continue to attract students. For example, nano-particle technology, bio-and ecological engineering, fuel-cell technology, as well as new concepts such as process intensification, product engineering design have all made engineering majors more attractive to young students. Meanwhile, curriculum will continue to be revised from time to time. More social science and humanities courses have already been added to the curriculum for engineering education. Also some courses related to philosophy, law, management and finance have been incorporated into the engineering course modules. Communication and organizational skills are also being phrased into the teaching process.

Third, we are continuing to work at improving the quality of higher engineering education.

Presently the Chinese government emphasizes education, especially higher education, more strongly than any other time in Chinese education history. There has been a steadily increasing level of investment in higher education and R&D. Using these funds form the government and industry, universities have improved their teaching and research infrastructure in the past few years. We are dedicated to reforming the teaching methods and improving the quality of high education. In traditional Chinese engineering education, most of the time, we taught students knowledge by a "spoon-feeding" teaching method. Students spent most of the time memorizing facts. These students had systematical fundamental knowledge but lacked the ability to put them to use in their future work. Today, we are changing our teaching methods by using the heuristic teaching method. Teaching skills and methods have been improved by using various audio-visual aids. Lecturers have even designed multimedia course-wares to improve the teaching quality. By using course-wares appropriately, the content can be delivered in a more lively fashion, which allows students to comprehend it much easier. In recent years we have come to realize that the ability to learn is more important than knowledge itself. Many new kinds of courses and design projects have been introduced in to our curriculums. We emphasizes the cultivation of creativity in our teaching. For example, Undergraduates can participant research training program by SRT (Student Research Training) program and Bachelor thesis research work.

Finally, we are working to develop a continuing education program for engineering education. Because of there is a need to retrain or reeducate some of the nearly 10 million engineers and technicians in China, Chinese engineering education has many opportunities in this area. Many universities have designed the continuing education training programs for engineers and managers coming from many industries.

Conclusion

More and more engineering graduates are faced with the rapid economic and technological development in China. Increasing the scale of engineering education and improving educational quality are the major aims of Chinese engineering education today. By learning from other countries, Chinese engineering education will make great strides in the near future. Engineering education is very important and it can satisfy students' their career ambitions and so developing better a engineering education system is an urgent task facing Chinese higher education today.

References:

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