Worcester Polytechnic Institute
Digital WPI

Interactive Qualifying Projects (All Years) | Interactive Qualifying Projects

August 2009

Comparative Study on Engineering Education in China and USA

Jie Bai
Worcester Polytechnic Institute

Xinyi Zhang
Worcester Polytechnic Institute

Comparative Study on Engineering Education in China and USA

An Interactive Qualifying Project Report Submitted to the Faculty of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the Requirements for the Degree of Bachelor of Science

Code:

By

Jie Bai (WPI)

Xinyi Zhang (WPI)

Partner with

Jun Chen

Minghe Sun

Fei Yu

Zhiping Zhou

From Beijing Jiaotong University (BJTU)

Approved by

Professor Yiming (Kevin) Rong, Advisor

October 2009

Abstract

The project, *Comparative Study on Engineering Education in China and USA*, studied the industrial need of professionals and engineering education in China and USA respectively in BJTU and WPI. The study evaluated the industrial need and the current engineering education practice including curriculums and methods of assessment. Based on the data analysis, we provided constructive perspectives on the changes of engineering education.

Acknowledgements

We would like to thank our advisor Prof Yiming (Kevin) Rong, Prof Jianzhong Cha and Prof Yiping Lu, for their support and guidance throughout the project process. Especially for Prof Yiping Lu, your unselfish advice and help will always be sincerely appreciated.

Thanks to our partners, for your contribution to the completion of the project

Thanks to WPI and BJTU for providing the opportunity and supplying related facilities to complete the project.

Thanks to MyCOS Ltd., for the data and annual report they provided.

Thanks to HUST for holding the final presentation for all groups.

And finally, a special thanks to our families, for their understanding and support that accompanies all the way.

Table of Contents

Chapter 1 Introduction

As global economics developed, the industrial need for quality engineers has been changing in both USA and China. China needs a great number of engineers for its fast growing economy, while USA needs a new type of engineers who can play roles in coordinating outsourcing and supplier chain management. Engineering education faces challenge to meet the demand of ever changing job market. Education is a cultural phenomenon. China and USA have diverse education traditions. Chinese engineering education focuses on knowledge accumulation, knowledge dissemination and the construction of knowledge systems. USA pays more attention to training students to master knowledge and practical ability. Chinese attitude tends to be static acceptance while attitude in USA is the dynamic changes of knowledge.

The inherent gap between the two systems is originated from industrial society, and the engineering education itself. Unfortunately, there are few organizations ever evaluating the distinctions. The engineering education is still continually evolving. Thus, the project is aimed to compare the two engineering education systems by analyzing the information collected from various sources and interacting with people in both education systems.

Therefore, in order to provide constructive perspectives in the end, we made the following 6 objectives throughout this project.

To Collect and Analyze the Industry Need of Professionals in China and USA

To Understand the Engineering Education in China and USA

To Collect and Analyze the Curriculum of ME/IE at WPI and BJTU

To Collect and Analyze the Outcome Assessment of ME/IE Majors to evaluate the match from the Curriculum

To Study the Learning Methods and Feedback from Students and Professors

To Provide Constructive Perspectives on the Changes in Engineering Education

The distinctions between the two systems are significant and have never been evaluated. It's literally difficult to find precise and updated comparative information and documents for references, while our cooperating institution, Beijing Jiaotong University (BJTU) is in need of outcomes to support their education module revolution.

By completing this project, we provided several constructive and practical perspectives, that may help promote the improvement and reforming of engineering education systems in China and USA.

Chapter 2 Background

As known to all, the world is evolving all the time. So does the engineering industry. The development of industry demands the corresponding education process to be simultaneously modified to keep on pace with it.

After several decades of reforming and opening-up China has become one of the mightiest and powerful countries those are more influential to worldwide industry. The manufacturing field is growing rapidly, and requires large amount of qualified engineers to help and promote its growth. According to CHINA’S LOOMING TALENT SHORTAGE, in the year of 2006, about 700,000 qualified engineer’s nick exists. While compared to the total number of engineering graduates of that year, only about 10% of them are geared with the expected talents of the industry (159k vs. 1589k). On the other hand, in US, the demand is not that large, around 70,000, but nearly 81% of the graduates are standards-compliant (538k vs. 667k), which is the result that both industry and education system want to see[1].

Country	Suitable Number (Unit: 1000)	Total Number (Unit: 1000)	Ratio
China	159	1589	10.0%
USA	538	667	80.7%

For next 5 years, China will have about 10 million job opening opportunities, while US will have about 2.5 million positions available. It’s easy and obvious to see that they both are in desperate need of new and potential engineers for implement of their explanations. The market is developing, that more qualified engineering talents are demanded.

Meanwhile the US is outsourcing in industry, it needs qualified engineers with different talents. Because of this, there is a gap of the need with different talents. What is more, United States is lack of engineer resources.

However, for example, parts of the engineering education in China are at a standstill. Some of the course contents still focus on industry flows that were adopted in the 50’s or 60’s, and are eliminated for current circumstances.

---

[1] <China’s looming talent shortage>, Mckinsey Quarterly, 2006

What's more, the definition of "qualified talents" may vary under different systems. The standards of a desired engineer various also.

As the world's leading aerospace company and the largest manufacturer of commercial jetliners and military aircraft combined, Boeing is an ideal example we take from the industrial society to study the desired engineer standard in USA. Boeing has customers in more than 90 countries around the world and is one of the largest US exporters in terms of sales. As a major service provider to NASA, Boeing operates the Space Shuttle and International Space Station. The company also provides numerous military and commercial airline support services. Boeing Engineering, Operations & Technology supports Boeing's business units and growth strategy by providing the right people, technologies, processes and performance at the right time and in the right place across the company worldwide. This strategy is delivered in various ways by the primary organizational groups -- Research & Technology, Intellectual Property Management, and Information Technology, and its leadership role in the Engineering, Operations, Quality, and Information Technology process councils. Through all its activities, Engineering, Operations & Technology helps ensure the future success of Boeing by winning strategic new programs, providing innovative technology and process solutions, transforming Boeing into a global network-centric enterprise, enhancing and protecting the company's intellectual capital, and fostering a culture of innovation.

Boeing's desired engineer has a good understanding of basic engineering science, design processes, and context in which engineering is based. A desired engineer has good communication skills, high ethical standards, flexibility to adapt to rapid or major change, the desire to learn for life, the profound understanding of importance of teamwork and ability to think critically and creatively[2].

This clear expression from leading industry in USA reflects the importance of the basic engineering science knowledge and the mind of thinking and utilizing knowledge in the work, the well ability to cooperate with partners.

However, on the other hand, common general criterion in Chinese industries for a desired engineer is mainly determined by the diploma. The traditional Chinese industries

[2] http://www.boeing.com/

tend to pay attention to graduate study certificates, intern experience and recommendation. The overall assessment is lack of systematic criteria of ability for engineering graduates. Although the internship experience is emphasized on the assessment, 57% of national companies consider the intern experience necessary and only 5% of those open the intern positions. What is more, there is a little connection between the education in college and the work in the industry.

The comparison of different standards reflects the reason why many Chinese engineers cannot work well in multinational companies when they graduate from college. More and more people have recognized that Chinese engineer graduates need enhancing their practical knowledge and experience to be integrated with the industrial society.

In summary, the gap between the quality and population in Chinese industry demand is originated in the attitude of the industries themselves and the college engineering education in China. And USA, with a considerable number of qualified engineers, is lack of engineer resources.

Studying the gap between industry demand and education and is to build some perspectives for better connection for them, which is exactly the original goal of our project.

2.1 Techniques and Review

From literature review, we've found that the distinction has never been evaluated and the gap between the two diverse engineering education systems is also significant. We would like to first look through some previous related research.

The United States is interested in the engineering education in global scale. The US-based Association, Accrediting Board for Engineering and Technology (ABET), conducts some substantial equivalency evaluations at Chinese engineering education institutions in the past but the program has been terminated[3]. ABET is now "doing direct international accreditation and is continuing work on that program"[4]. The goal of this effort is to develop models and pilot studies for an accrediting program and to develop connections to decision-making bodies to advance the idea of new accreditation models. There is considerable confusion regarding the number of "qualified" baccalaureate engineering degrees being awarded each year in China. China is creating "new" universities by combining programs from different specialty schools. The relation of this imitative to NSF's cpaths program which looks for multi-disciplinary engagement is unclear. Some of the proposals to NSF were seeking to work with international programs in China[5].

Through MIT and Stanford University's Computer Science curriculum objectives, structure and materials, it was analyzed and then therefore made some useful references for the Chinese higher engineering education curriculum setting characteristics[6].

Via the concepts of the engineering concept as well as the interpretation of the concept of large projects, it was pointed out that the higher engineering education must respond to the globalization project and engineering complexity of social challenges,

---

[3] http://www.abet.org

[4] Engineering Education in China, http://www.law.gmu.edu/nctl/stpp/engineering_education.htm

[5] http://www.nsf.gov/pubs/2006/nsf06608/nsf06608.htm

[6] Published in the Journal of Xi'an University of Post and Telecommunications (Jan, 2009), http://yuanbao.xupt.edu.cn/

established and implemented the “big project” concept under guidance of the reform of personnel training mode[7].

For the personnel training objectives, training content, training methods, and management systems, the 20th century American research-oriented undergraduate training model can be compared and some inspiration can be draw out.

In summary, the researches mainly focus on one perspective of the distinction, not on the comprehensive analysis. Our project analyzes the industry need of professionals and the engineering education (curriculums and assessment) in China and USA.

[7] Published in Science of Science and Management of S. & T. (Mar, 2000)

http://www.scrtvu.net/thesis/files/lwk/lw0543.html

http://www.tjkxx.com/cn/qkjs.asp

Chapter 3 Methodology

The goal of this project is to compare the two different engineering education systems and provide perspectives in the end of this project. To achieve this goal finally, we need to first of all understand the engineering education in China and USA, and absolutely the industry need. After comparing and analyzing, we provide constructive perspectives and final conclusion for this project.

To insure the project goes orderly and smoothly, we make six objectives spread of the whole project.

The first objective is to collect and analyze the industry need of professionals in China and USA. We believe that engineering education is served for the industry need in the society. So beginning with the study of the society need, we see the basic engineering background in China and USA, including the population, the quality and the standard of an engineer.

The second objective is to understand the engineering education in China and USA. This is the core objective in our project; that is, to compare the two different education systems in China and USA. To achieve this, we study for the 3rd, 4th, and 5th objective respectively first. We collect and analyze the curriculum of ME/IE at WPI and BJTU, the outcome assessment of ME/IE majors to evaluate the match from the curriculum, and study the learning method and feedback from students and professors.

The last objective is to provide constructive perspectives on the changes in engineering education. Summarizing the comparison of the engineering education, we provide an improvement model for teaching method and practical/industrial experience of teachers.

During the project process we collected data of industry need and engineering education in related publications and websites. Collating and summarizing what we have collected, we analyze by comparing the differences in China and USA, and came up with constructive perspectives, which is as expected.

Chapter 4 Results

This section presents the results that were drawn from collected data. These results are the differences of the curriculums, teaching models, and assessment methods.

4.1 Curriculums and Course Contents

A curriculum can be defined as the planned educational experiences offered by a school which can take place anywhere at any time* in the multiple context of the school.

Based on disciplines and knowledge, the curriculums in Chinese engineering education are government-dominated and competence standards are not widely used while curriculums in USA are based on the standard of abilities, like ABET and CDIO.

Comparing to the foundation of curriculums, we conclude that Chinese engineering education tends to be the basic knowledge rather than the professional abilities and experiences while the engineering education in USA is based on professional standard of engineering abilities.

The curriculums of IE and ME which are short for Industry Engineering and Mechanical Engineering respectively are compared between WPI and BJTU. In WPI, the largest proportion is the courses about the major; Industrial Engineering Topics is 33.3% and Mechanical Engineering (MQP included) is worth 40%. In BJTU, the largest proportion is also the major courses; the proportion of major courses in Industry Engineering is 16.8% and the proportion of major courses in Mechanical Engineering including the Major Design is 27.6%.

BJTU			WPI		
Curriculum	Credit	Percentage	Curriculum	Credit	Percentage
Human Sciences and Arts	24	12.2%	Humanities and Arts	2	13.3%
Social Science	19	9.7%	Social Science	2/3	4.4%
Physical Education	9	4.6%	Physical Education	1/3	2.2%
Subject Categories Basement	79	40.3%	Mathematics and Basic Science	4	26.7%
Major Courses	25	12.8%	Industrial Engineering Topics	5	33.3%
Major Design	19	9.7%	MQP	1	6.7%
Curriculums Design	11	5.6%	IQP	1	6.7%
Free Electives	10	5.1%	Free Electives	1	6.7%
Sum	196		Sum	15	

(Curriculum Comparison of ME)

BJTU			WPI		
Curriculum	Credit	Percentage	Curriculum	Credit	Percentage
Human Sciences and Arts	24	12.2%	Humanities and Arts	2	13.3%
Social Science	19	9.7%	Social Science	2/3	4.4%
Physical Education	9	4.6%	Physical Education	1/3	2.2%
Subject Categories Basement	77	39.3%	Mathematics and Basic Science	4	26.7%
Major Courses	27	13.8%	Mechanical Engineering	5	33.3%
Major Design	19	9.7%	MQP	1	6.7%
Curriculums Design	11	5.6%	IQP	1	6.7%
Free Electives	10	5.1%	Free Electives	1	6.7%
Sum	196		Sum	15	

(Curriculum Comparison of IE)

Although both WPI and BJTU focus on the major courses, BJTU has a larger percentage in Basic Courses like Basic Science, Social Science, Mathematics, Subject Categories Basement and Physical Education, giving students more choices and widen their horizons. WPI otherwise consider the students’ professional abilities as the standard of a qualified student.

4.2 Educating and Teaching Models

The guiding Ideologies or theories for teaching for the two education systems are quite different from each other. In China, the task of teachers is delivering facts to students, while a good student should sit still, waiting to listen and accept the knowledge. On the contrary, in US, the teachers are more likely to be instructors or inspirators that would encourage students to take part in the learning/studying process. The interaction between instructors and students is quite common and normal, but we can hardly find any atmosphere of livened up discuss in class in China. In the regular education process in China, the teachers are the main characters. In US, however, they pay much more attention to students. The students' participation is paramount for the value of education.

Objectives of the two educations are also diverse. Traditional education in China focuses on the concepts, rules and theories of knowledge, and aims at cultivating students' intelligence. On the other hand, in US, education emphasizes more non-intelligence facts, which provides more opportunities for students to develop their ability to practice, social and find their individual personality.

Chinese teachers usually teach same courses over the time, and they are able to teach in the same procedure with same content facing different students. No surprises, no accidents. It's actually a good way to deliver the textbook content to students, but it kills the possibilities that different students may have. As the teachers treat themselves as instructors or inspirators, who will instruct and inspire, but not pump facts, they're willing to help distinct students to develop their own way of study and build their own study, or even career. This is like the difference between "deduction" and "induction", as first explained by Prof Chen Ning Yang when he made comparison of education systems between China and US in 1945[8].

The teaching factors include teachers, students, teaching materials, methods and facilities. We have talked about teachers and students in previous discussion, and teaching materials is covered in the Curriculum and Courses Content section. There used to be big distance between the teaching levels of the two systems. However, both

---

[8] http://www.qzwb.com/gb/content/2003-05/12/content_857628.htm

countries are growing and developing, the gap is gradually vanishing. Universities in China now have many modern and helpful media and teaching equipment that can assist the teaching process much better. We believe that there'd be no difference in facilities for teaching in the short run.

4.3 Assessment and Evaluation Methods

The method of assessment of the courses is what the colleges focus on for the engineering education.

In BJTU (China)		In WPI(USA)	
Courses	**Method of Assessment**	**Courses**	**Method of Assessment**
Calculus (1st Semester)	Homework + Project(20%) Final Exam(80%)	Calculus (MA1021)	Quiz (40%) + Lab (20%) + Final (40%)
Linear Algebra (1st Semester)	Homework + Project(20%) Final Exam(80%)	Linear Algebra (MA2071)	Project + Quiz(60%) +Final Exam(40%)
Physics (2nd Semester)	Homework + Project(20%) Final Exam(80%)	Physics (PH1110)	Experiment +Project+ Quiz(60%) +Final Exam（40%)
Engineering Mechanics (3rd Semester)	Homework + Project(30%) Final Exam(70%)	Introduction to Engineering (ES1020)	Quiz (36.4%)+Homework (33.3%)+ Group & Individual Project (25.8%) & (4.5%)
Principle of Mechanic (4th Semester)	Homework + Project(30%) Final Exam(70%)	Design of Machine Elements (ME3320)	Exam (60%) +Design Project (40%)
System Analysis (5th Semester)	Homework + Project(20%) Final Exam(80%)	Industrial Robotics (ME4815)	Homework and Test (30%) +Project (30%) +Lab(40%)

We took some common courses for engineer students in BJTU, like Calculus, Linear Algebra, Physics, Engineering Mechanics, Principle of Mechanic and System Analysis. 4 courses have 80% weight in the final examination and the other 2 courses have 70% weight in the final examination.

The methods of assessment in WPI may vary according to professors' preference. We took Calculus (MA1021), Linear Algebra (MA2071), Physics (PH1101), Introduction to Engineering (ES1020), Design of Machine Elements (ME3320) and Industrial Robotics (ME4815) for comparison. It's obvious that methods of grading are quite different among the courses. For the course with design projects, the projects always play a significant role for the whole course content. Exams are still important, but not that vital. This is because students are expected to be more involved into the process of learning, everyday performance are encouraged. By accomplishing projects, students can solve practical problems instead of theoretical ones only, through which participants may learn more about the real world, therefore have better understanding and abilities for their future.

This reflects that test papers are put into a more important position in China. With too many teaching files, test papers, and graduating paper, students' professional abilities and experiences are neglected in engineering education. We conclude the Chinese engineering education assessment is a process-oriented process. In other words, they think what students have mastered is most important.

Emphasizing the practical experiences and professional abilities, USA has the outcome-oriented assessment, which pays more attention to students' careers, like the employment rate after graduation, students' income, and the reputation of alumnus. In their points of view, the engineering education is served for what students can do after graduation.

In this part, we compared data from MyCOS Ltd. The data from annual reports include the graduation distribution, rate of employment and income survey. These can reflect the current situation of engineering education in China in some aspects, but they are not strong enough. We did not put them in our final presentation. However, we have listed some graphs and data in the appendix of this report.

Chapter 5 Analysis and Perspectives

This section presents the analysis about curriculums, educating models and methods of assessment.

5.1 Summary

About curriculums and course contents: The curriculums in Chinese engineering education are subject/knowledge oriented. Emphasizing understanding of knowledge, theoretical examination is the basic evaluation method for engineer students.

Based on the ability-oriented curriculums in USA, a variety of methods of assessment are used to focus on the necessary abilities as a qualified engineer.

About educating and teaching models: Current educating and teaching model in China is the kind that led by teachers, while in USA, the students act a very important role. Chinese students are more likely to accept knowledge, however, on the other hand, American Students tend to observe and discover their own recognize of the world, thus build their own knowledge system.

About assessment and evaluation methods: The assessment for the education system in China is process-assessment, which standardizes the engineering education process. The teaching materials, papers, and calendars are serialized and standardized.

The method of assessment in USA is outcome-oriented assessment, which helps assess students' abilities. In the words, the assessment is served for assessing the students' careers.

Current status in China and US: Since the Chinese education is subject-oriented and process-assessment, it has little connection with industrial society. China is the largest producer of engineering graduates in the world. However it is in short supply of qualified engineers.

Engineering education in USA is a strong and vibrant enterprise. The engineering education is employment-oriented, and quite a number of graduates are qualified engineers with professional abilities. The number of high school graduates who enroll in engineering programs in the USA has been declining significantly in recent years, despite a sustained and increasing demand for technical graduates by employers of engineers. Moreover, outsourcing leads to the reform of the professional abilities for globalization.

We would like to describe how engineering education and industrial need to be connected each other but we had no idea what kind of model should be adopted. However, the graph on my partners' textbooks inspired me: just like the following gears, the industry gear should be revolving with the globalization, while the education is being driven by them and corresponding to industrial requirements. This is exactly the ideal relationship between engineering education and industry need under the globalization circumstances we believe.

Now after previous analysis, we may now have an impression that the engineering education and industry in China is not closely related, while the US is on a stage of lacking of talents relatively. The purpose of education is to fulfill one's life-long need and to cultivate qualified talents to satisfy industry need at the same time. That's why we believed it is the time to reform the engineering education to keep on pace with the rapid-developing world

Here are some possible perspectives we proposed, hopefully they would be considered constructive. To strengthen the relationship and increase the interaction between industry and education, we advocate the cooperation between industry and universities. For example, the industry should participate more in the process of engineering education, and meanwhile colleges and universities could provide students more possibilities to touch the real world.

5.2 Innovation of Curriculum and Course Content

Content of courses are the most fundamental factors that should be taken into consideration. Based on the industrial need, curriculums should be framed. Theoretical and practical courses need be provided. There is no doubt that all the information should be updated and evaluated continually. The method of "learning by doing" adopted by WPI may help students clearly understand the concepts in the class.

5.3 Innovation of Assessment and Evaluation Methods

Various methods should be introduced to evaluate students and the system itself. What should be kept in mind all the time is that the aim of assessment is to provide a better education environment for students, not just for the benefits of schools or teachers. The graduation distribution or employment outcomes are more important for a student's fulfillment, therefore scores shouldn't be the only standard and the process may not be focused as it used to be.

5.4 Innovation of Teaching Model

As known to all, that educating is not just pumping facts, it requires the communication and interaction between instructors and students. Traditional teaching model in China is students played as listeners, taking notes, doing homework assignments and taking exams is all it about, which is really outdated and lack of practical stuff. In reverse, the more scientific scene should be like, that the students act as leading actors/actresses on their own education stage, while the instructors are aspirators or just guides or assistants. Which counts more is the spirit of learning by oneself and self-motivated practicing.

Now in China, we can hardly find an instructor with industrial background. However, the experience always plays a very important role in the process of teaching. Universities in China may invite some real world engineers to campus to give speech or even conduct courses if possible. And new teachers may receive some related industrial training before they start working, or may be sent to companies to learn their modern experience. They can also combine their research and teaching, and in that case the students can in truth deal with and solve industrial problems during their study.

5.5 Ideal Relationship between Industrial Need and Engineering Education

Just like tightly connected gears, under the globalization circumstance, the engineering education gear is driven by the industrial need one, and they are actually turning together, which we believe may be the expected ideal situation and relationship among the three aspects.

The above-mentioned are the perspectives we raised after comparison and analysis, and we believe that at least some of them will come true in the future, because the world is changing, so is education.

Chapter 6 Conclusion

6.1 Accomplishments

Although there are some organizations doing the related research, different engineering education systems have never been evaluated. The industrial world is continually evolving. Through this project, we have some understanding.

In order to recognize the current industrial and educational circumstances we collected data from engineering publications and official websites.

Via comparison, we’ve found the existing common part and differences.

Eventually, we analyzed and found the possible reasons to the problem, and gave out our evaluation and several constructive perspectives.

As is always true, no matter how much we achieved, there are still tasks we need to complete. We’re, as always, still on our way.

6.2 Future Work

As the limit of time and data resource, we were not able to work out a deep enough and thorough enough understanding and research into the two engineering education systems and general industrial background of the two countries. And if possible, we want to track what innovation or modification has taken in place, to analyze whether our perspectives are feasible or not. Some further improvement may show up also.

In conclusion, we have begun to be aware of the method of collecting useful information and how to organize them for clearly expressing our thinking.

What’s more, we have learned how to work and cooperate with a team, and how to act as a responsible team member, which all our group members will benefit throughout the life.

Chapter 7 References

Footnotes References

[1]<China’s looming talent shortage>, Mckinsey Quarterly, 2006

[2] http://www.boeing.com/

[3] http://www.abet.org

[4] Engineering Education in China,
http://www.law.gmu.edu/nctl/stpp/engineering_education.htm

[5] http://www.nsf.gov/pubs/2006/nsf06608/nsf06608.htm

[6] Journal of Xi’an University of Post and Telecommunications (Jan 2009),
http://yuanbao.xupt.edu.cn/

[7] Science of Science and Management of S. & T. (Mar, 2000)
http://www.scrtvu.net/thesis/files/lwk/lw0543.html
http://www.tjkxx.com/cn/qkjs.asp

Other Resources

Curriculum Catalogs from WPI and Beijing Jiaotong University

The Three Strategies to Reform Engineering Educations in China *by Jianzhong Cha*

Chinese College Graduates’ Employment Annual Report *by MyCOS Ltd*

http://www.cdio.org

http://www.abet.org

http://www.boeing.com

And some related information resources