AC 2011-2917: ENGINEERING EDUCATION IN CHINA

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Engineering Education in China –
A Summary of a Focused Visit in 2010

Abstract

A group of ten delegates, all members of the American Society for Engineering Education, formed an Engineering Education Delegation for a trip to China organized by the People to People Ambassadors organization from October 26 through November 6, 2010. While visiting three Chinese cities, Beijing, Xi'an, and Shanghai, the delegates visited four Chinese universities with strong engineering and engineering technician programs. A separate meeting was held at the start of the trip with five representatives of the Chinese Society for Engineering Education who provided useful information on the status, plans, and larger issues facing engineering education in China. This paper provides a summary of that trip and offers observations that may be useful to engineering educators in the United States and other parts of North America. It was found that, in the last decade, the number of students in engineering and technician education programs in China has grown dramatically. Simultaneously, modern educational facilities have been added to the core infrastructure of Chinese higher education, often in the form of entirely new campuses on the outskirts of already crowded major cities.

Background

Chinese history spans several thousand years, with evidence of strong dynasties dating to at least 1750 B.C. with the Shang dynasty. Many others followed, such as Zhou, Qin, Han, Tang, Song, Khan, Ming, and Manchu (17^{th} and 18^{th} centuries A.D.). For many centuries, emperors ruled large portions of the far-flung country. International interactions and trade occurred in later years through naval shipping at China's eastern port cities and the legendary Silk Road to and from the west, for which the Chinese terminus was centered in the region around Xi'an, one of the cities visited during the trip being described in this paper.[1]

Unification of China occurred around the 19^{th} century with simultaneous foreign influences, primarily from Europe. A Chinese republic was founded in 1912 and the 20^{th} century became a time of growth in international influence along with political and cultural turmoil. Under leaders such as Sun Yatsen, Yuan Shikai, and Chiang Kaishek, the country moved toward a nationalist form of government. Communism emerged in the 1920s and later its leader, Mao Zedong, established the communist People's Republic of China that persists today, although with continuously evolving structure, policies, and practices.

The times before, during, and after World War II were tumultuous with civil strife along with military actions involving Japan, Russia, North Korea, and South Korea. In 1966, Mao Zedong launched the Cultural Revolution with its Red Guards leading to a time of terror, anarchy, and repression. Following Mao's death in 1976, leadership passed to Deng Xiaoping who promoted a more pragmatic form of communism and broad economic reform, setting the stage for the emergence of China as a major player in international commerce and production of goods traded throughout the world.

Thus began the path toward modern China and in the 34 years following the death of Mao, the world has seen the huge growth that today strongly affects the balance of global economies. The type of government in the country today was described to our delegation as *socialist communism with a Chinese character*. One result is that huge resources can be directed quickly to developments that are critical to the overall plan of the central government.

Observations of the Engineering Education Delegation

During the time from October 26 through November 6, 2010, a group of ten delegates, all members of the American Society for Engineering Education, formed an ***Engineering Education Delegation*** for a trip to China organized by the People to People Ambassadors organization. The People to People Ambassador Programs' mission is to "bridge cultural and political boarders through education and exchange, making the world a better place for future generations."[6] While visiting three Chinese cities, Beijing, Xi'an, and Shanghai, the delegates visited four Chinese universities with strong engineering and engineering technician programs. A separate meeting was held at the start of the trip with five representatives of the Chinese Society for Engineering Education who provided useful information on the status, plans, and larger issues facing engineering education in China. The ten delegates were joined by six guests for a total of 16 travelers. However, only delegates participated in the professional visits and meetings.

During the travels of the Engineering Education Delegation, it became evident that the unique form of government in China at this time has developed ways and means of promoting growth, encouraging the development of entrepreneurial businesses and industries, and transforming large parts of the country into centers of commerce. Massive movement of populations from predominantly rural areas to the growing urban regions occurred and continues at a rapid pace to provide workers for the industries.

Our delegation was able to observe closely how the history and the current governmental structure has enabled China to rapidly expand engineering education, with the most dramatic growth occurring since about 1996, just 20 years after Mao's death when the country moved away from a repressive culture to a more open, growth oriented culture having major interactions and trade with countries throughout the world.

Production of large quantities of consumer goods and their worldwide distribution has long been a strength of Chinese industry and that trend has accelerated rapidly in recent decades. Emerging from periods of internal strife that dominated the country from the 1930s to the mid-1970s, the Chinese government made major changes to methods of creation and management of its product-producing industries, encouraging private capitalization within overall control of the central government. Centralized governmental control has allowed the country to rapidly direct resources to targeted needs resulting in major advances in the already-strong consumer products area while adding much more capability in high technology areas of electronics, automotive, energy, large machinery, aerospace, and other fields. Infrastructure improvements, particularly in the eastern portion of the country, have aided growth through more efficient transportation, shipping, urban housing, and manufacturing plant siting.

One key element in this rapid growth of industrial production in China was the recognition that a large number of highly educated and trained people with skills and knowledge in science, engineering, and technology were needed to staff and manage the industries. Preparation of children and young people has been strengthened through elementary and high school years with strong incentives to succeed in their studies in order to be able to enroll in post-secondary training programs and in the universities of their choice. Apparently recognizing that English is the language of international business, virtually all young students in the industrialized eastern part of China study English; many from pre-school age. Testing is done for all students at the end of their secondary school education and the results have strong influence on future opportunities. While we were told that students and their families are free to choose the paths the students take, major emphasis is placed on science, technology and engineering fields. Others who have dealings with Chinese universities have said that government practices do, indeed, exert control over the collegiate majors students pursue.

Enrollment in Engineering and Technician Education in China

Education throughout the country has been improved to provide a highly educated workforce, not only for factory jobs, but also for management and product development. According to the director of the Chinese Society for Engineering Education, the Ministry of Education of the Chinese central government decided in 1997 that the quantity and quality of engineering and technology education should be increased dramatically.[2] One result is that:

> ***Enrollment in all forms of technical and engineering fields grew from slightly over 1.0 million in 1998 to over 7.0 million in 2007, as reported by the Chinese Society for Engineering Education.*** [2] ***[Figure 1]***

Similar changes occurred in graduate education:

> ***Enrollment in graduate programs grew from approximately 80,000 in 1998 to 450,000 in 2008.*** [2] ***[Figure 2]***

Among the approximately 700 Chinese engineering universities, entirely new engineering education programs were started within some universities and others were expanded so rapidly that entirely new campuses were created outside the traditional city limits of major cities such as Shanghai, Beijing, and Xi'an because the inner-city campuses were essentially land-locked.

Figure 3 shows how the distribution of technical and engineering enrollments by type of program changed over the period from 1990 to 2007. [2] *Short-cycle Courses* is a term used to include degree programs of two years or less and other technician training programs. The percentage of students in technician-type programs grew over the period while the percentage in undergraduate engineering programs decreased. But note that the total number of students grew dramatically in that period as shown in Figure 1. In 2007 the approximate distribution was:

- 45% technician programs and other short-cycle education
- 47% undergraduate engineering
- 6% M.S. graduate engineering
- 2% Ph.D. and Doctorate

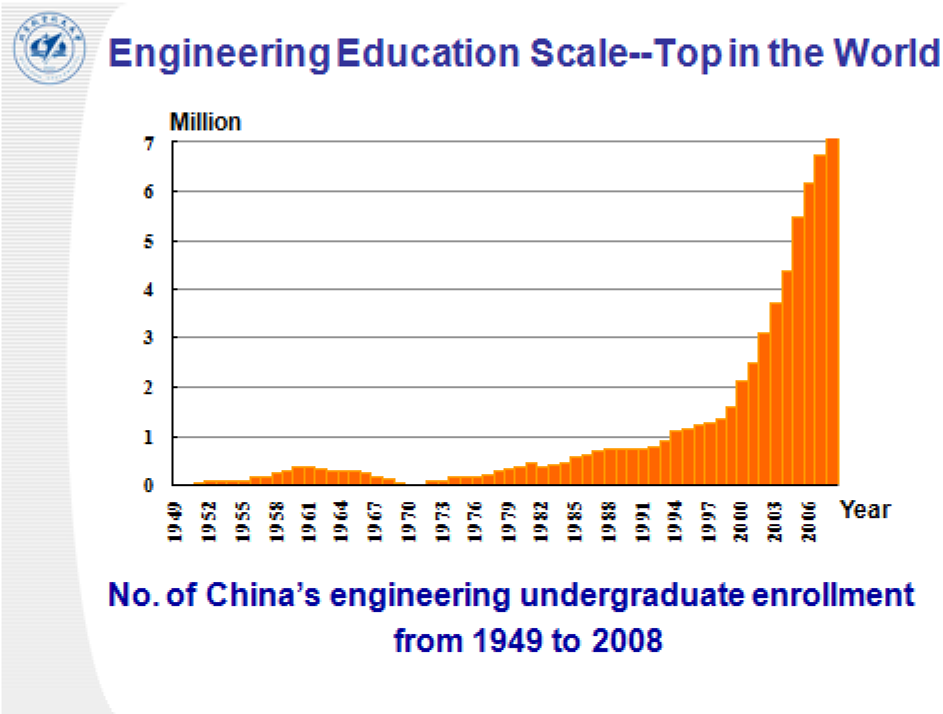

Figure 1 China's engineering undergraduate enrollment from 1949 to 2008

Source: Chinese Society for Engineering Education [2]

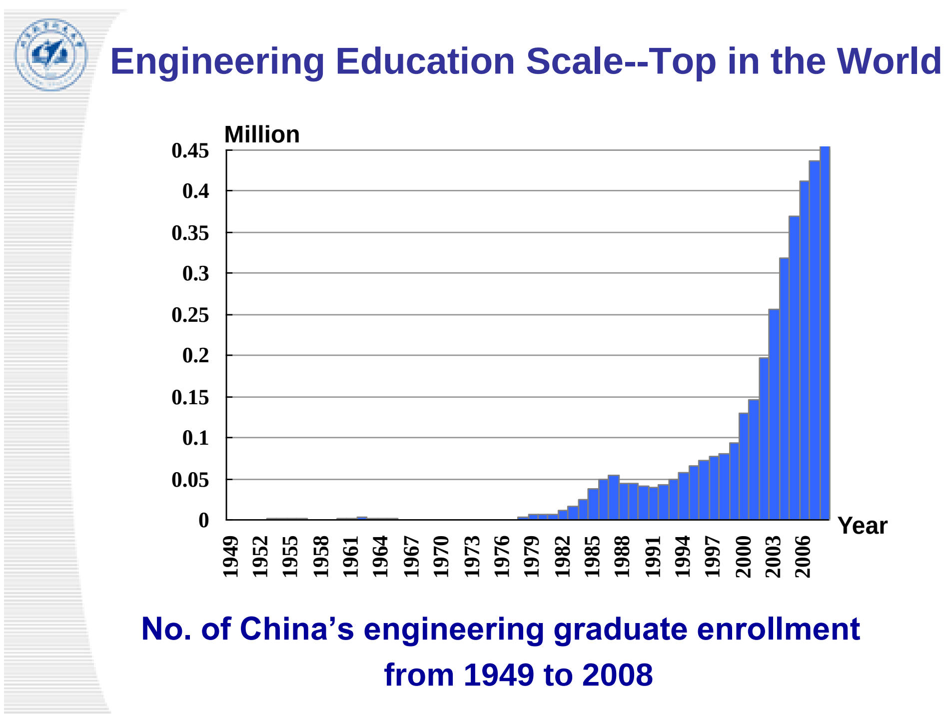

Figure 2: China's engineering graduate enrollment from 1949 to 2008

Source: Chinese Society for Engineering Education [2]

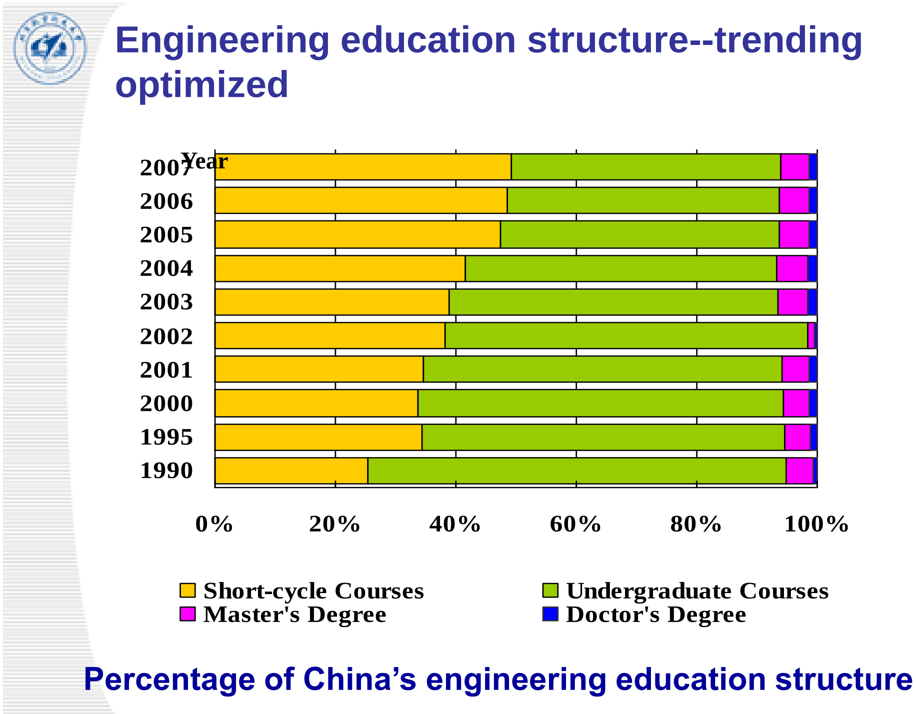

Figure 3: Distribution of undergraduate students by types of programs in China over the period from 1990 to 2007

Source: Chinese Society for Engineering Education [2]

Another dramatic comparison is shown in Table A dealing with the percentage of the entire undergraduate student population who are majoring in engineering for 23 countries on four continents. [2]

Table A: Percentage of all undergraduate students who are in engineering by country					
China	37%	Spain	17%	Denmark	11%
Korea	29%	Germany	16%	Australia	8%
Malaysia	23%	France	15%	Holland	8%
Finland	21%	Italy	15%	Norway	8%
Austria	20%	Switzerland	14%	United Kingdom	8%
Hong Kong	20%	Portugal	13%	South Africa	7%
Sweden	20%	Greece	12%	United States	7%
Japan	18%	Ireland	12%		

Source: Chinese Society for Engineering Education [2]

Enrollments in engineering-related majors in Chinese colleges and universities continue to rise. However, there is some evidence that the production of graduates has slightly outstripped employment opportunities in some fields in some geographic areas at the present time. Many Chinese firms are factories that produce products on export contracts according to prescribed specifications. Therefore the private sector does not demand college graduates for product development.[7] Engineering educators are faced with adjusting resources as the mix of industries changes over time and the changes happen rapidly.

Chinese engineering education schools and programs vary in scope and mission across the spectrum of:

- Training of repair, operations, and maintenance technicians
- Instruction in skilled trades fields
- Preparation of production associates for high technology manufacturing industries
- Higher education in undergraduate programs in traditional engineering disciplines of mechanical, electrical, industrial, chemical, civil, computer science and engineering, aeronautics and astronautics, marine engineering, and others
- Higher education in more focused and specialized undergraduate programs such as urban railway engineering, power and energy engineering, flight vehicle engineering, guidance and control technology, propulsion system design, automation, and others
- Post-BS education in master and doctorate programs in areas similar to those mentioned for undergraduate programs

Many Chinese universities have exchange and cooperative arrangements with U.S. universities as well as some in Europe, Australia, Russia, and other areas.

It appears that *manufacturing engineering* is typically not taught as a separate discipline in most Chinese universities. Rather, it is considered to be a part of mechanical engineering, electrical engineering, or specialized programs. Pertinent names of programs which contain significant content in manufacturing include:

- Automation
- Mechanical Design, Manufacturing, and Automation
- Aircraft Manufacturing Engineering
- Industrial Engineering
- Computer Integrated Manufacturing and Agile Manufacturing
- Mechatronics and Robotics
- Information Engineering
- Electrical Engineering and Automation
- Measurement & Control Technology and Apparatus
- Information Counterwork Technology
- Control Theory & Engineering
- Detecting Technology & Automatic Devices
- System Engineering
- Pattern Recognition & Intelligent Systems
- Mechatronical Engineering (sic)
- Management Systems Engineering

- Global Competition and Product Development Management
- Corporate Development and Strategy
- Plant Systems Engineering
- Logistic Management

Summary of Trip Itinerary

The time spent by the delegation and their guests in China covered ten days; four days in the Beijing area, three days in the Xi'an region, and three days in the city of Shanghai. The U.S. terminus for travel was San Francisco. Table B shows an outline of the schedule, listing both professional visits related to engineering education and cultural sites viewed. Additional information about the universities visited and the cultural sites are provided in other sections of the paper and in a report generated by the delegates. [2]

The delegates departed the United States from the gateway airport in San Francisco on Tuesday, 26 October 2010, and arrived in Beijing, China on Wednesday. The People to People team met engineering education delegates in the arrival hall and transferred them by motor coach to the Beijing Kunlun Hotel. One People to People guide, referred to as the *national representative*, accompanied the team throughout the trip and provided information about the Beijing area. Additional *city guides* joined the group to provide focused commentary for the Xi'an and Shanghai portions of the trip.

Thursday was the first professional day with an in-country morning briefing by the national representative and the delegation leader, Dr. James Melsa, recent past ASEE president. An afternoon meeting followed with representatives from the China Society for Engineering Education. The Kung Fu Show at the Red Theater was optional evening entertainment. Friday was the second professional day with a visit to Peking University School of Engineering to meet with administrators and engineering faculty. Dinner was at the Qianmen Quanjude Peking Duck restaurant. Saturday was the first cultural day for the delegates with visits to Tiananmen Square, the Forbidden City, and the Great Wall of China via the Badaling gate northwest of Beijing.

Sunday was a travel day with a two-hour flight from Beijing to Xi'an. The second cultural day was Monday, 01 November 2010 with visits to the Big Wild Goose Pagoda, the Xi'an Jade Carving Center, and the Terra Cotta Warriors Museum. The Tang Dynasty Theater was optional evening entertainment. Tuesday was the third professional day with a visit to Northwestern Polytechnical University in the morning and to Xi'an Polytechnic University in the afternoon. Lunch was dumplings at the famous Defachang restaurant.

Wednesday was a travel day with another two-hour flight from Xi'an to Shanghai. The Shanghai Acrobatic Show was the optional evening entertainment. Thursday was the fourth professional day with a full-day visit to Shanghai University of Engineering Science. Friday was the third cultural day with visits to the landmark Bund (comprised of a long promenade along one bank of the Huangpu River in the heart of colonial Shanghai), Shanghai Museum, Shanghai General Silk Rug Factory, Yu Garden, and Old Town. Lunch was at the Qiandao Mongolian BBQ restaurant, and dinner was at the riverside Seagull Restaurant opposite the Bund in the more recently developed Pudong district, now the commercial and financial center of Shanghai.

Saturday, 06 November 2010, was the final travel day with departure from China from Pudong International Airport to San Francisco International Airport in California.

Table B Summary of the itinerary for the trip

Day	Date	City	Type	Event
Tue Wed	26 Oct 27 Oct	San Francisco	Travel	United Airlines flight Beijing Kunlun Hotel
Thu	28 Oct	Beijing	Professional	In Country Briefing China Society for Engineering Education Kung Fu Show
Fri	29 Oct	Beijing	Professional	Peking University School of Engineering Qianmen Quanjude Peking Duck Restaurant
Sat	30 Oct	Beijing	Cultural	Tiananmen Square Forbidden City Badaling Great Wall
Sun	31 Oct		Travel	Air China flight Sofitel Xian Renmin Square Hotel
Mon	01 Nov	Xi’an	Cultural	Big Wild Goose Pagoda Jade Carving Center Terra Cotta Warriors Museum Tang Dynasty Theater
Tue	02 Nov	Xi’an	Professional	Northwestern Polytechnical University Defachang Dumpling Restaurant Bell & Drum Towers City Wall Xi’an Polytechnic University
Wed	03 Nov		Travel	China Eastern Airlines flight Swissotel Grand Shanghai Bund Riverfront Shanghai Acrobatic Show
Thu	04 Nov	Shanghai	Professional	Shanghai University of Engineering Science
Fri	05 Nov	Shanghai	Cultural	Shanghai Museum Shanghai General Silk Rug Factory Qiandao Mongolian BBQ Restaurant Yu Garden Old Town Seagull Restaurant
Sat	06 Nov	San Francisco	Travel	United Airlines flight

Descriptions of Each of the Four Visits to Universities

Following are brief summaries of the four universities visited by the delegates as listed in Table B. Additional commentary is available in the report prepared by the delegation. [2]

Peking University – Beijing (PKU) [www.coe.pku.edu.cn]

Starting with a history of engineering education dating to 1910, large changes within Peking University led to its decline and abandonment in the tumultuous post WWII years. The University's College of Engineering was re-established in 2005. Dr. Shiyi Chen, founding dean of the college, stated that his university is ranked highest in the country – "*the Harvard of China.*" They have 5,000 faculty members with about 400 in engineering. Close to 50% of their graduates will go to the U.S. to continue their education, although many will also likely complete graduate programs at Peking University. Many of the faculty members have received their education or significant experience in the United States. For example, Dean Chen taught in the U.S. for many years and served as a major research manager at Johns Hopkins University in Baltimore, MD.

Peking University is not a "typical" Chinese university and it is working to be more like those in the U.S. They are trying to emulate Stanford and MIT with emphasis on entrepreneurship and a strong focus on teaching. They have the most Ministry of Science (similar to the U.S. Department of Energy) technology grants and a research center with continuing funding. Regarding globalization, they collaborate with the University of Southern California for the *world classroom*, a global design project, while engaging in similar activities with other schools around the world. They have a joint Ph.D. dual degree program with Georgia Tech and Emory University. They are negotiating other arrangements with Ohio State, Delaware, Cornell, and Stanford.

Their strategic plan is to focus on three broad directions:

1. Energy resources and the environment
2. Nanotechnology, biomedical, and cutting edge technologies
3. Aerospace and ocean engineering

Strong collaboration by the relatively new College of Engineering programs with the more traditional parts of the University are actively being nurtured to develop synergy with specialists in law, medicine, natural sciences, social sciences, political science, philosophy, business administration and others. Engineering programs include humanities requirements and social science courses designed exclusively for Chinese audiences. Chinese universities traditionally require more credits than U.S. schools so it is not difficult to incorporate these courses.

Major units of the College of Engineering are the Department of Energy and Resources Engineering, the Department of Advanced Materials and Nanotechnology, the Department of Biomedical Engineering, the Department of Industrial Engineering and Management, and the Department of Mechanics.

Students are encouraged to do summer internships with industry and 70 to 80% of their students participate. They also have an industry advisory committee on which representatives from about 30 well-known companies serve.

Northwestern Polytechnical University (NPU) – Xi'an [www.nwpu.edu.cn]

NPU was founded in 1938 and is located in the city of Xi'an in central China. On its urban campus and a new suburban campus, the university has an enrollment of 25,000 students, including 14,000 undergraduates, 8500 master's students, and 2500 PhD students, with 1100 professors. It is described as China's only research-oriented, multi-disciplinary, and international university of science and technology, which simultaneously excels at Aeronautics, Astronautics, and Marine Engineering. It offers 52 undergraduate programs, 101 graduate programs, 57 doctoral programs and ten post-doctoral positions. There are at least eleven schools in science and engineering fields, plus a School of Management and a School of Humanities, Economics and Law. Eighty percent of the students are in engineering programs.

NPU encourages innovation and foreign language skills and students are encouraged to enter a variety of domestic and international competitions. They have won awards with unmanned aerial vehicles and autonomous underwater vehicles. About 5000 enter a math competition each year and computer skills also are emphasized for all.

International collaborations exist with several institutions abroad, including a wind energy program with Germany and pending collaboration with the University of Maryland. Although an industrial internship program is in place, the program is not as strong as desired with most internships being just a few weeks of job shadowing industry people and observing.

Xi'an Polytechnic University (XPU) – Xi'an [www.xpu.edu.cn]

XPU's President Gao Yong described XPU as an engineering university that nurtures Chinese engineers needed to support the rapid development of the Chinese economy, especially in its role as the "*Factory of the World."* XPU and other Chinese universities promote globalization through cooperation with several international universities such as Kettering University, Oklahoma Christian University, Minnesota State University, and Nebraska in the United States plus others in the United Kingdom, Germany, Australia, Japan, and Russia. Programs include student exchanges, faculty exchanges, research collaboration, and dual-degree programs (2+2 and 3+1). Currently 150 students are pursuing a 3+1 dual degree program at XPU and Canterbury Christ Church University in the UK, leading to the BS and MS degrees.

XPU was founded in 1912 as the machine weaving facility of the Beijing high school of industry. In 1978, it became the Northwest Textile Institute. In 1998, control was transferred to the Shaanxi Province Ministry of Education and in 2001 the name was changed to Xi'an Polytechnic University. Engineering is now the leading major chosen by its students. From the discussion, it appears that XPU maintains an applied engineering approach, similar to engineering technology programs in the U.S., to serve Chinese manufacturing industries.

The university has 22,000 students combined at the city campus, where we met, and a new large campus south of the city. There are 1,400 staff members at XPU including 140 professors and 400 associate professors. XPU has 42 undergraduate programs, 32 graduate programs, and one doctoral program. Engineering related examples of programs included machinery and electronics, automation, textiles and materials, electrical and information technology, mechanical design, industrial engineering, industrial design, machine control, management, civil and environmental engineering. Other disciplines include water resources, law, Chinese literature, English, fashion, art design, and computer science.

Shanghai University of Engineering Science (SUES) **[** http://www.sues.edu.cn]

The delegation visited the new (2003) Songjiang Campus of the 33-year old Shanghai University of Engineering Science (SUES), located in a "new city" within the jurisdiction of Shanghai. It is considered a *municipal university*, although Shanghai and other large cities are treated in a manner similar to provinces. SUES is described as a school that places much emphasis on integrating practice, theory and learning. Additionally, there is close cooperation between the university and industry partners, a point in sharp contrast with what other visited schools mentioned. The delegation was taken on a campus tour with visits to the architecturally significant library building and a modern, well equipped laboratory facility housing manufacturing, automotive service, urban railway, and aviation labs.

SUES collaborates with Shanghai enterprises connected with automotive, textile, electrical, urban railroad, and chemical industries. Seven universities merged to form SUES. It now consists of 19 schools and approximately 18,400 undergraduate and graduate students with approximately 1,600 students participating in adult continuing education courses. There are 83 majors including transportation, mechanics, electronics, material science, product design and fashion design. SUES graduates are recognized by society for their contributions to engineering.

The university collaborates with foreign partners by exchanging students and faculty to bridge theory and practice; programs exist with the United States, France, Japan, Korea, and Canada. Two of these universities include University of Michigan (Dearborn) and Lawrence Technical University (LTU-Detroit, MI). These programs are focused on automotive engineering. Students also receive hands-on experience by participating in international competitions, such as Honda fuel efficiency competitions and the SAE Formula design competition with students from LTU. LTU has traditionally developed a top placing entry each year. The SUES students and faculty will support the team from LTU during the design and build phase, then they will host the team during the actual competition which will take place in China. Practical experience at enterprises during undergraduate years leads to a high rate of employment for SUES graduates.

Observations and Impact on U.S. Engineering Education and U.S. Economy

The delegates of the Engineering Education Delegation conducted by the People to People Ambassadors organization who completed the trip described in this paper formulated the following observations from their professional visits.

- During the trip, four very different universities with different missions were visited as evidenced by the brief descriptions given earlier in this report and in the complete report of the delegation. [2] In summary:
  - PKU in Beijing is a very old, well established, highly regarded university ("*the Harvard of China*") with a rather newly re-established College of Engineering (2005). Its mission is clearly to become a world leader in broad technological areas such as energy, advanced materials, biomedical engineering, mechanics, and industrial engineering and management, with strong linkages between engineering and the traditional academic programs of the University.
  - NPU in Xi'an is positioned to offer a comprehensive set of undergraduate, master, and doctorate degree programs in many engineering disciplines with major emphases on aeronautics, astronautics, and marine engineering.
  - XPU in Xi'an offers a wide variety of undergraduate and master degree programs and one doctorate program. The greatest emphasis is on applied engineering to serve Chinese industries and to help to continue to excel as "*the Factory of the World*".
  - SUES in Shanghai offers a wide variety of training and practical, short-cycle programs for technicians, and technical workers in repair, operations, and maintenance positions in manufacturing industries, urban railway systems, airlines, and related industries, along with many baccalaureate degree programs in several engineering disciplines.
- All of the institutions visited have much less interaction with industry than is the case with most colleges of engineering in the United States. This was a topic of much interest to the Chinese administrators and faculty members.
- As compared with the United States, there appears to be more limited interaction among engineering college administrators and their faculty members in China.
- Accreditation of engineering programs is a topic of great interest in China, although it is not clear that all institutions have bought into its value. There is still much discussion regarding how it will be handled in China.
- In many ways, the problems facing Chinese engineering educators are quite similar to those facing U.S. engineering educators.
- Many of the Chinese students expressed interest in learning what is required to become students at an American university.

The theme of "*the Factory of the World*" seems to strongly characterize Chinese engineering education of the last few decades and it appears to have been successful in helping to fuel the country's rapid rise of industrial production in quantity, quality, breadth, and scope. Future-looking goals for higher education in engineering-related fields, however, seem to be directed toward innovation and enhanced competence in large-scale, highly technical systems in aeronautics, space exploration, energy resource development, environmental improvement, production of alternative energy systems, biomedicine, biomedical engineering, and entrepreneurship.

The impact of Chinese success in production and distribution of goods is well documented in public media on a regular basis. Newspapers, national magazines, television and cable news organizations, political commentary, financial news organizations, Internet-based news outlets, and books continue to address the "*China Situation*".

Coincidentally, in a mid-November 2010 week following the delegation's trip described in this paper, *ABC News with Diane Sawyer* spent three days reporting from China, allocating a majority of the broadcast time to special stories on this issue. Some of the reporting was actually conducted from sites in Shanghai visited by delegates just the previous week. In the authors' opinions, those stories tend to corroborate our own observations while adding additional detail. Of special significance were reports:

- Showing Chinese factories in full operation in new facilities, selling consumer products, solar panels, wind turbines, and many other products to the U.S. and around the world
- Describing the rapid rise in automobile ownership and in-country production of automobiles
- Visiting Chinese pre-schools, elementary schools, and secondary schools with comparisons to U.S. education
- Documenting the modern infrastructure in major Chinese cities and transportation systems (e.g. high speed intercity rail lines and the demonstration of the ultra-high speed "Maglev" train from downtown Shanghai to its airport).
- Observing that virtually all children in developed, urban areas of China learn English to enable them to engage in international commerce.

Of course, economic structures in the world change with time continuously. In the early years of independence of the United States, our economy was strongly tied to England and other European countries. Gradually, innovators and entrepreneurs in the U.S. developed products and production capabilities that allowed the economy to grow on its own foundations to meet its own needs and then to export to other nations. Particularly after WWII, the U.S. excelled in turning manufacturing facilities from war production to products for consumers, machinery for industry, electrical generation, infrastructure expansion and improvement, electronics and computer systems, and so on. This led to the U.S. economy becoming the largest in the world by a significant amount.

In the latter part of the 20th century, after recovery from the major destruction of WWII, many parts of the world emerged as major competitors within the world economy; most notably Japan, central Europe, southeast Asia, China, and India. Canada, Brazil, Mexico, Australia, and others are increasingly strong players in the world economy. Such changes are well documented in nationally syndicated columnist Thomas Friedman's columns and his books, *The World is Flat* and *Hot, Flat, and Crowded* and others. [3,4]

A far-reaching analysis of the changes in the world economy over many centuries and predictions of changes in the future are presented in a recent article by Niall Ferguson in the Wall Street Journal.[5] Ferguson argues that, after 500 years of Western predominance, the world is tilting back to the East. While noting that today China's per capita GDP is 19% that of the U.S., it is noteworthy that only 30 years ago (~1980) it was just 4%. He states that China recently overtook the U.S. as the world's biggest automobile market; 14 million Chinese sales per year, compared to 11 million in the U.S. Our delegation observed that problem first-hand as we navigated huge traffic volumes in all three major cities. We were told that in Beijing alone, approximately 2000 cars per day are sold.

Ferguson adds, ". . . contrary to the view that China is condemned to remain an assembly line for products *designed in California*, the country is innovating more, aiming to become, for example, the world's leading manufacturer of wind turbines and photovoltaic panels." In fact, the ABC News broadcast in November 2010 showed a modern, highly automated factory in the Shanghai area producing solar panels, some of which are destined for an elementary school in California! Again Ferguson states, "This is part of a wider story of Eastern Ascendancy. In 2008, for the first time, the number of patent applications from China, India, Japan, and South Korea exceeded those from the West."

Overview of Cultural Sites Visited

When not engaged in visits to universities and meetings with Chinese engineering educators, the ten delegates had numerous opportunities to experience some of the exciting cultural treasures of China in all three cities visited. Furthermore, the six guests were able to visit other important sites. A brief summary is given here.

<u>Beijing Area</u>

The day began with a trip to the huge Tiananmen Square and the taking of a group photo. It was amazing to see the size of the square and to observe the vast numbers of Chinese people standing in line to view the tomb of Mao. From the square, the group walked to the Forbidden City and learned more about the lifestyle of the emperors. From the Forbidden City, the group traveled by bus through the Hutong area (an older style neighborhood) and the site of the 2008 Beijing Olympics where delegates were able see the *Bird's Nest* and the *Water Cube*, two prominent sites for the Olympic Games. In the afternoon the group visited the Badaling section of the Great Wall of China, about 50 miles northwest of Beijing. The delegates and their guests had an opportunity to walk/climb on the wall and get a feeling for its history and vastness.

Guests visited the Temple of Heaven and the Summer Palace, and experienced an in-depth look at the Hutong neighborhood, and a tea ceremony.

<u>Xi'an Area</u>

The day began with a visit to the Big Wild Goose Pagoda, one of the largest Buddhist temples in China, where the group learned about Buddhism and its influence on Chinese history and culture. The group then traveled to the Xi'an Jade Carving Center for a delightful lecture on the types and qualities of jade and jade carving and had a shopping opportunity. The group saw the Drum Tower and the Bell Tower and walked the Xi'an City Wall, a restored, complete, nine-mile long structure surrounding the old city. The afternoon was dedicated to a visit to the site of the *Terra-Cotta Warriors* near Xi'an where approximately 6000 life-size models of Chinese warriors were buried by the Emperor Qin in the 2^{nd} century BC and rediscovered in 1978. The opportunity to visit this commonly designated eighth wonder of the world was unbelievable.

Guests visited the Museum of Xi'an, the Muslim district, and a Muslim shrine.

Shanghai Area

This day was spent experiencing several cultural sites in Shanghai, including the spectacular Shanghai Museum with excellent exhibits of Chinese bronze, jade, ceramics, and Ming and Qing furniture. The group then visited the Shanghai General Silk Rug Factory where they were able to learn about the process of creating silk rugs, observe some wonderful examples of the process, and do some shopping. The afternoon was spent visiting the beautiful Yu Garden and Old Town. Another silk factory allowed the group to learn more about silk manufacturing. Old Town provided a shopping opportunity with a bazaar-type setting.

Guests visited the Shanghai Center for Urban Planning, a Buddhist shrine, and interesting city neighborhoods.

Conclusion

This paper has presented a brief overview of a busy ten-day trip by a small delegation of engineering educators to the huge, populous, rapidly growing country of China and visits to four of the robust array of 700 Chinese universities who prepare over seven million Chinese young people for careers in engineering, technology, and science-related positions within the Chinese economy. The authors hope that the information, observations, and impressions presented will help ASEE members relate to the large effects that recent developments in China have on the U.S. and on the entire world. Furthermore, it is hoped that this will impact the design of curricula and courses to better prepare our students for the increasingly global society in which we live and in which they will work throughout their careers.

References

1. Knowles, Christopher, *My China, Fodor's Exploring China,* New York: Fodor's Travel, a division of Random House, Inc., 2007
2. *Journal of the People to People Ambassadors Program – Engineering Education Delegation visit to China*, October 26 to November 6, 2010. http://www.peopletopeople.com/OurPrograms/CAP/Pages/Journals.aspx.
3. Friedman, Thomas, *The World is Flat,* New York: Farrar, Straus & Giroux, April 2005
4. Friedman, Thomas, *Hot, Flat, and Crowded,* New York: Farrar, Straus & Giroux, September 2008
5. Ferguson, Niall, *In China's Orbit,* Wall Street Journal/WSJ.com, November 18, 2010
6. "History and Mission of People to People Ambassador Programs" retrieved on 17 January 2011 from http://www.peopletopeople.com/AboutUs/Pages/default.aspx
7. Huang, Yasheng, "Reform the Private Sector" *The New York Times:The Opinion Pages: Room for Debate* "What is a College Degree Worth in China?" December 02, 2010. Retreived on 03 December 2010 from http://www.nytimes.com/roomfordebate/2010/12/02/what-is-a-college-degree-worth-in-china?hp