Preparing Engineering Students for the Challenges of Globalization and Sustainability: Experiences in China

Matthew M. Mehalik
Visiting Assistant Professor, Industrial Engineering, University of Pittsburgh, Pittsburgh, PA 15261 mmehalik@pitt.edu

Abstract - This paper describes the learning goals, activities, achievements, and brief evaluation of a class of 20 freshmen who spent two weeks visiting companies, participating in classes, and experiencing cultural differences in Beijing, China in the early summer of 2005. In cooperation, the Study Abroad Program, the School of Engineering and the Undergraduate College of Business Administration at the University of Pittsburgh created a two-week summer experience for freshmen in engineering and business in several countries. The overall objectives of the course were to provide an opportunity for engineering students early in their careers to become aware of global challenges they will face. Specifically, the two challenges most emphasized were: 1. Global competition within the engineering field from highly qualified engineering students in other countries, such as China; and 2. Issues of sustainable development as the world’s most populous countries shape the demand for what engineers design, build, and make. Students focused on issues of how companies use a global strategy for their supply chains and customers.

Index Terms - China, study abroad, sustainable development, global challenges.

CONTEXT

Because global producers continue to shift their focus to the approximately 4 billion people who live in what has been termed tier-4 markets (i.e., characterized by a per capita income of less than $1500 per year), there exists a tremendous pull for innovation in technological and economic solutions that meet the needs of the aspiring poor while managing the environmental implications for this shift [6]. As things now stand, those at the bottom of the world’s economic pyramid live in high-cost, local economies. In terms of water access, people in poor urban areas without access to municipal water pay 4 to 100 times the cost as people at higher economic tiers. For example, in Lima, Peru, a poor family pays 20 times the cost as middle-income people [5].

China is no exception to these challenges. Firms from around the world have been and continue to race to China as its population of over 1.3 billion people increasingly are becoming integrated into the world’s economy, with greater demands for and availability of goods and services. The changes in China are driving the largest rural to urban migration in human history, with high levels of growth and change occurring at a tremendous pace. There have been corresponding large increases in the quality and quantity of Chinese engineers to meet the demands and needs of these changes. Chinese institutions are increasingly capable of creating skilled engineers and business leaders [4].

Engineering and business students at U.S. institutions necessarily need to be aware of these trends. Students will need to understand that they will soon be competing in this global arena. They will also need to embrace the perspective of sustainable development in order that this process of tremendous growth be done in smarter ways [7] so that limited resources and environmental conditions can be managed in the most intelligent and rational ways possible [1, 2, 3]. This situation provided the need and the stage for creating an experience for freshman engineering and business students at the University of Pittsburgh.

This experience consisted of having a group of undergraduate engineering and business students from the University of Pittsburgh visit China and reflect upon the roles of Chinese engineers at various companies after having met with them while touring and discussing the operations of these companies. Students visited six companies in the areas of computer manufacturing, air-cylinder products manufacturing, biotechnology, software engineering, media and broadcasting, and construction. For example, for the computer manufacturing company, the students visited and observed manufacturing operations where computer equipment was being assembled; logistics planning where manufacturing scheduling and planning were conducted; and design activities where new product lines were planned.

STRUCTURE OF THE COURSE

The course consisted of three main parts: a pre-departure portion, the visit to China, and the post-trip portion. In general, these three parts were geared to support the sequence of preparation, training, and building expectations before the visit; experiential learning during the visit, with some embedded reflection; and more in-depth reflection, evaluation,
and transformation of the experience into a presentation and written document after students returned.

I. Pre-Departure Activities

The pre-departure portion consisted of preparation sessions that focused on orienting students to China. Several guest speakers who were experts in various aspects of Chinese society were recruited to help students learn these dimensions. Students studied the history of China beginning over 4000 years ago and traced the sequence/cycles of China’s dynasties. Throughout this historical orientation, experts helped students understand how the China of today is the result of many different Chinese philosophical traditions, such as Confucianism, Daoism, Legalism, and in the 20th century, republicanism and communism. Students learned about how China was a conquered nation by the West at the beginning of the 20th century, how it endured a war with Japan, and how civil war ensued after the end of World War II, which led to the rise of Mao Zedong. The Cultural Revolution was covered during the Mao period, and the events that led to the Tian an men protest/crackdown in 1989. Finally, students learned about the trends towards a greater openness and Westernization of business in China, with the expansion of trade, increasing freedoms and privacy of Chinese individuals, especially in business.

Guest lecturers provided basic-level training in Chinese language. The intent was to provide a basic functional capacity for students during their trip. Students also learned about Chinese architecture and art, the structure of the current government, current political trends, and trends in business.

The course provided basic travel guidelines to ensure the safety of the students. At least 10 of the 20 students who went on this trip to China had never traveled overseas before. Therefore, students were coached on such matters as obtaining and using currency, passports, visas, how to bargain and purchase items, what to do if they become separated from the group, appropriate cultural conduct as representatives of the University of Pittsburgh, what items to pack and bring along, and what to expect in terms of the range, style, taste, and availability of authentic Chinese cuisine.

Students were also presented with the names of the companies that they would visit during their trip so that they could do preparatory research before they visited. The students worked on teams of 3 or 4 people, with one team focusing on a particular company, usually a company in an area that interested students on that team. The companies that the students prepared to visit were:

- SMC, a mechanical engineering and manufacturing company that produced pneumatic products for manufacturing facilities
- Lenovo, a PC manufacturer which had recently purchased IBM’s computer manufacturing business
- Capital Bio, a biotechnology firm that commercialized products stemming from research at a national biotechnology laboratory
- China State Construction Engineering Company, China’s largest construction firm
- UFIDA, a software firm that specialized in corporate management software packages and systems
- CCTV, China’s national broadcast network

Students prepared preliminary briefings on the background of each company during the pre-departure class meetings. They also prepared pre-departure journal entries that stated their expectations for the trip.

Students provided several reasons as to why they chose to travel to China over other countries offered as part of this program (Brazil, Chile, France, and Germany). The most commonly reported reason was that they expected the contrast of Chinese culture to their own (American) culture to be greater than the contrast with the other countries. Students viewed this strong contrast as a positive dimension of the program—most students who ended up selecting China tended to be students who wanted to venture into a country that stretched their boundaries with the familiar. Out if the 20 students in the program, 10 had never traveled beyond the borders of the United States. Of the remaining 10 students who had traveled abroad before, none had traveled to Asia.

The second most commonly given reason for selecting China over the other program countries as their destination was that students believed that they would have the opportunity at other times during their lives to travel on their own to European and South American countries. They believed China to be more difficult of a trip to attempt on their own, and therefore saw the trip as providing access to what would otherwise be too difficult on their own. For example, one student stated, “Out of the countries offered in the +3 program, China is the country with which I am least familiar. I think that the cultures of China and America are perceived to be completely different, and I’d like to explore not only these differences, but the similarities.”

Students recorded their expectations about the differences they would encounter when they traveled to China. They responded to a series of questions and recorded answers in their electronic journals. Students were organized into web development teams so that they could prepare daily electronic journal entries during their visit to China and to record their pre-departure expectations of the trip. Table I shows the range and frequency of responses to the question, “I think the main differences [between home and China] will be...”. Students responded in short paragraphs, and the author coded and categorized the responses in order to create Table I.

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II. In-Country Portion of Course

The trip to China lasted for 2 weeks. Students were coordinated to meet at a common departure airport so that the entire class could arrive on the same flight to Beijing. The trip was organized in cooperation with the Department of International Studies at Tsinghua University in Beijing, which served as the host institution. Students stayed at the international student dormitories at Tsinghua, also where they gathered for breakfast and several dinner meals.

The in-country portion of the course consisted of three main content-related activities: company visits, cultural site visits, and classroom lectures and discussions. For the company visits, students were coached to observe the way that work happens in Chinese companies and to compare and contrast these methods with their past experiences with how U.S. companies in those industries operated. At each company, students were permitted to tour the operational environments. For example, the class was able to observe the entire manufacturing process of air cylinder products, from the forging of parts from aluminum ingots to the final polishing, testing, and shipping of the final products. The same was true of PC manufacturing—the entire assembly, logistical, and shipping operations of the product were explained by the operations director of one of the Lenovo facilities in Beijing. The class toured a construction site—a 24 story condominium unit that was in the middle of the construction process. Students observed the operations of China’s central state-run TV station, including real-time control room activities. Students were able to ask questions and to request follow-up information.

Each day, students recorded their reflections on their experiences in on-line journals. Journals for the current year’s trip can be viewed at: http://www.engr.pitt.edu/study_abroad/china

Students commented on working conditions, such as meticulously clean work environments in manufacturing facilities. Other notable observations included the clear posting of managerial and decision-making processes and piece rate targets that were clearly visible, as has been adopted from Japanese quality management programs. A contrast was the working conditions of most construction workers, who often lived on the construction site in challenging conditions based on U.S. standards. For example, there were work sites with no marking for dangerous conditions, such as open shafts or holes that spanned many floors of high-rise buildings partly under construction. Students were shocked to learn that many construction workers went from job-to-job in order to survive. Most of these workers migrated to the city in order to find work from the countryside. Students also learned about the low cost of labor in China—wage rates for practicing engineers at each of the aforementioned firms were a fraction of the wage rates of U.S. engineers. What was perhaps not expected was the very high quality and efficiency of many of the operations that the class visited.

Students had the opportunity to ask questions and have discussions with engineers, plant managers, and operations directors at each of the company sites. Usually the question and answer sessions would occur while walking through the various plants/laboratories/sites while they were in operation. Students were able therefore to ask specific questions about the technical operation of what they were observing. The engineers and plant managers provided specific (non-proprietary) information for the student questions.

Students were able to learn about China from special session classes at Tsinghua University. Students attended four 4-hour classes on Chinese language, Chinese history, philosophical traditions throughout different periods in China, Chinese art, Chinese foreign policy strategy, and different approaches towards marketing in the different regions throughout China. Students also received additional language training in class. From their journals, students found the foreign policy and strategy lecture most informative. The most common reason they found this lecture most informative was that they recognized that the way media in the United States portrayed China in its news was very different than the way Chinese professors portrayed the interests of the country. The difference most commented upon was that China saw itself as wanting to be the dominant entity in the Eastern Asian region of the globe, but not a global superpower.

Students also experienced cultural sites in the Beijing region. During the two-week period, the class visited the Temple of Heaven a historic, religious site for harvest festivals; the Fragrant Hill, a site that features the natural beauty of the hills surrounding Beijing; the Forbidden City/Palace Museum, Beijing’s home to its emperors dating to the Ming and Qing dynasties and center of Beijing; Tian an men square and Tian an men gate; the Beijing Opera; Wanfujing street (famous for its shopping district); and the Great Wall at Badaling. Tsinghua university provided student tour guides for each of these visits so that students could navigate the sites in small groups and learn much about the significance of each of them. Students also began to learn more Chinese language and to learn more about what it is like being a student at Tsinghua university through their discussions with these student tour guides. Most of the students maintained contact with many of

TABLE I

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Social interaction differences</td>
<td>12</td>
</tr>
<tr>
<td>Standard of living differences</td>
<td>8</td>
</tr>
<tr>
<td>Differences in Food</td>
<td>5</td>
</tr>
<tr>
<td>Population differences/crowds/traffic</td>
<td>4</td>
</tr>
<tr>
<td>Other: architecture, fashion</td>
<td>4</td>
</tr>
</tbody>
</table>

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these guides subsequently, as they developed friendships through these bonding experiences.

III. Post-Trip Portion of Course

At the end of the trip, students used the information that they recorded in their electronic journals from their company visits, classes on China, and cultural site visits to prepare detailed reports and presentations. Students had the entire summer session months to compile this information and to do additional research. Their work products consisted of a 25-page report on their companies and a 15-minute oral presentation to the class based on their findings.

The paper consisted of four main parts: The first section provided an overview of the company, such as what were the company’s main products, strategy, unique operational features, and where the company was located. The students addressed the contextual environment of their companies in the second section of the paper. Features of this section included where this company fit within a broader industry and what some of its strategic issues for its success were, such as costs associated with production or factors associated with its relationships with suppliers. The third section of the report focused on each company’s competitive strategy—in terms of special intellectual property or technology that it possessed over its global competitors. In this section, students were able to highlight some of the differences that their company had with respect to other companies in the same industries in the United States or in other countries. In the final section the students listed the advantages and disadvantages that their companies had with respect to their competitors. They provided an evaluation of whether the company’s strategy was well-aligned with the current state of that company’s industry. Finally, they commented on the role that engineers played in that company and to what extent these roles were similar or different to their experiences here in the United States. Students presented their results to their classmates at the end of the summer.

Figure 1 shows an example of a slide from one of the student team’s briefings from their final projects. An interesting feature of this particular part of their project was this team’s finding that China needs to outsource some of its manufacturing in silicon chip technology to the U.S., a finding that the students found surprising because of the overwhelming publicity of how often manufacturing outsourcing is presented as mainly U.S. firms outsourcing manufacturing to Chinese firms. This insight provided young engineers a glimpse at the true complexities that companies must navigate in a global economy.

EVALUATION

At the end of the trip, students completed evaluation forms about the course. 18 of the 20 students returned their evaluations. Students were asked to rate their overall experience for the course on a scale of 5 (highest) to 1 (lowest). The class mean on this measure was \( \mu = 4.9 \), with a standard deviation of \( \sigma = 0.32 \). Students were also asked whether they would recommend this course to another student next year. For this question, the scale was 5 (definitely recommend) to 1 (definitely not recommend). For this measure, \( \mu = 4.7, \sigma = 0.6 \). Overall the students rated the program highly and expressed overall satisfaction with the quality of the program, which was surprising, because this was the first offering of this course with the partners at Tsinghua. Students rated their satisfaction with each company visit on a scale of 5 (excellent—definitely visit again next year) to 1 (poor—definitely do not visit again next year). Of the six companies on the itinerary, three received average ratings above 4.0, one received a rating above 3.5, and two received scores in the 2.5 – 3.0 range. In their explanations of their scores, the most cited reason for the companies that received the lowest scores was that they had fewer aspects of their operations to demonstrate that were visible, tangible, and concrete. The companies that had the highest scores were the companies that had the most visible operations to show and the most tangible products to present.

Students expressed their greatest dissatification with the university course lectures \( \mu = 2.9, \sigma = 0.9 \). The reasons most often given for these scores were that they thought the class time was too long and that there were communication issues at times during the lectures. On the positive side, students found the content of the lectures informative and the professors extremely knowledgeable. Differences in cultural expectations as to how classrooms operate likely also play a role in these scores.
Finally, students rated the cultural experiences positively. Students suggested eliminating a trip to a touristic restaurant near the Great Wall and suggested adding more time for shopping (the skill of bargaining with Chinese shopkeepers was of strong interest to many of the students).

**FUTURE STEPS**

The author has suggested several changes to the program for the summer of 2006. The number and style of classroom activities in China has been changed to place a greater emphasis on language lessons, which tend to produce a higher level of student engagement than the more passive lectures from the first year. Students will receive one hour of language training for every hour of content instruction when at Tsinghua. Several changes have been made to the company site visits. The class is scheduled to visit two internationally known state engineering laboratories: one for the creation of scientific instruments, and the other that consists of a model and simulation for the creation of the Three Gorges Dam project. Students have received additional preparation for learning how to keep separate journals for collecting information related to their projects and information from their personal experiences and reflections during the trip. The project has been modified to help students focus on technical product and production issues while visiting companies. Finally, students received additional background reading and coaching in the area of sustainable development issues, which the students will focus on more directly as they visit in the summer of 2006—issues such as air and water quality; healthcare; and overall sanitations systems, all of which have received emphasis in Beijing as the city prepares for the upcoming summer Olympic games in 2008.

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**REFERENCES**


