



Exploring Engineering in China in a Global and Societal Context

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Abstract

Bucknell's College of Engineering established a course entitled *ENGR 290: Engineering in a Global and Societal Context* in 2004 to expose students to global and societal issues that they otherwise do not experience on campus. We share our experiences and thoughts in working through one particular offering of the course that took place in China in the summer of 2012. We discuss the logistics and academic goals in preparing the course, in conducting course activities in China, and in assessing outcomes.

1. Introduction

*To succeed and prosper in a global economy and interconnected world, U.S. students need international knowledge, intercultural communications skills, and global perspectives.*¹ The issues of which an engineering graduate should have knowledge include recognition of the existence of different cultures, engineering problems and solutions in a culture context, and the social impact that an engineering solution may have in a different cultural environment, among many others. The College of Engineering of Bucknell University established a course entitled *ENGR 290: Engineering in a Global and Societal Context* in 2004² aimed at giving our engineering students additional opportunities to be exposed to global and societal issues that they otherwise do not experience on campus. The course takes the format of a three-week long travel in a foreign country, typically at the beginning of the summer (mid-May through early June), so that the students can continue their scheduled summer activities after completing the course. Faculty members in groups of two or three take 20 to 30 engineering students to different countries to examine various aspects of engineering and to experience the culture and life in that country. In past years, ENGR 290 has taken students to Switzerland, England, Scandinavia, Argentina, and Brazil.

In the summer of 2012, three faculty members took a group of 22 engineering students of various majors to China for a session of ENGR 290 (called *ENGR 290 China* hereafter.) During the course we visited companies such as DuPont, Air Products, IBM, Lenovo, HP, AECOM, and GE, a local Chinese-owned company, Xin Tai Printing Company; well-known Chinese engineering sites such as the Three Gorges Dam; cultural attractions with significant engineering elements such as the Great Wall, Forbidden City, Beijing National Aquatics Center (Water Cube), Beijing National Stadium (Bird's Nest), National Center for the Performing Arts (China), and the Terracotta Warriors; and two Chinese universities, Southeast University in Nanjing and the University of Electronic Science and Technology in China in Chengdu. Before each of these visits, a student team studied the cultural, engineering, and other important aspects of the site or company and reported to the entire group to give an overview of what would be visited. During the visit, students attended presentations made by the company or the university, many of which included a question-and-answer session, or listened to stories about a cultural attraction by a tour guide. After the visit, students debriefed the visit in group meetings and each wrote thoughts and reflections in their course journals. At the end of the course, each student was required to write a summary paper to discuss what they learned and to reflect on what they experienced during the course. In addition to the benefit of experiencing engineering in a different culture, students were

also able to make connections with Bucknell alumni who currently work in various parts of China. Assessment of student performance was based on each student's participation, daily journal entries, team presentations, and the individual final reflection paper. While not being able to include all the challenges³ for engineering students studying abroad, *ENGR 290 China* did give students a flavor of many global and societal issues that engineering students, and engineering professionals, are likely to face in their future. Our paper concentrates on our experiences with *ENGR 290 China*, for extensive reviews on the general subject of engineering students studying abroad, please see other articles in the literature^{3,4} and in-depth comparisons.⁵

The remainder of the paper will give details of our experiences and assessments. In Section 2 we discuss the student learning outcomes of the course ENGR 290 in general and *ENGR 290 China* in particular. We also present in that section the activities we planned which are linked to the outcomes. The next section highlights some of the activities in our course that helped achieve the learning outcomes. Section 4 discusses our assessment of the course. We share our experiences in logistics and preparation for the course in Section 5, followed by some concluding thoughts in Section 6.

2. Course objectives and expected student outcomes of ENGR 290

ENGR 290 in part addresses several ABET defined student outcomes related to global, societal, and contemporary issues. The related ABET student outcomes include the following:

- (f) an understanding of professional and ethical responsibility
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (j) a knowledge of contemporary issues

To achieve these outcomes, *ENGR 290 China* set out specific course objectives that focused on China specific content such as how engineering is practiced in China, what are some of the differences between engineering in China and that in the U.S., what are the political and environmental factors that may affect engineering design and practice in China, and the impact of engineering on China's environment.

We planned the activities for *ENGR 290 China* so that students would have first-hand experiences with the issues mentioned above. These activities included engineering site visits, presentations and discussions led by the hosts, students' reflection in group discussions and students' individual journaling. The class visited four types of sites: engineering sites such as 2008 Beijing Olympic stadium (Bird's Nest), the Great Wall and Three Gorges Dam; major cultural sites with engineering significance including the Terra Cotta Warriors, the Forbidden City and Tiananmen Square; businesses including DuPont, GE, HP, AECOM, IBM, Lenovo, Air Products & Chemicals, and Shanghai Xin Tai Printing Company; and two universities -- Southeast University in Nanjing and the University of Electronic Science and Technology of China in Chengdu. When visiting a company, students often attended a presentation and a Q&A session led by the host to discuss what the business does, how the business works in a global environment, and what impact the business has on China and on the global market. Students reflected on what they saw during the visit in an evening session with the entire group, and wrote their thoughts in their personal daily journals. We incorporated these activities into our course

syllabus to maximize the effectiveness of learning when visiting the sites in China, because visiting a site without reflection would miss an important opportunity for learning.

3. Some highlights of the learning activities

The entire *ENGR 290 China* experience was fulfilling and successful. We will summarize specific aspects of its evaluation in a later section. Here we highlight a few events during the course that made the trip special. We divide these events into three categories, those involving company visits, those involving other site visits such as college campuses or cultural sites, and those that just happened serendipitously but presented important learning opportunities.

3.1 Learning how global businesses work in China

As mentioned in the *Introduction* section, *ENGR 290 China* visited many companies. On almost every such visit, someone, usually in a leadership role, gave a presentation about the company and how they do business in China, if it is a multi-national company, or how they work in the global market, if a local company.

When visiting HP Cloud Executive Briefing Center in Tianjin, we met a Bucknell engineering alumnus who was involved in the designing of the HP cloud computing center in China. He described his personal experience of coming from the U.S. to work in China when he had very little knowledge of China. He described how working in China for HP presented him with a tremendous career opportunity. Though he went through some initial culture shock and he had to learn many local laws and cultural elements, he found working in China very fulfilling. This discussion made our students realize that working in a foreign country is not something out of reach for them, as many had thought before the trip. A number of students reflected in the group discussions and in their journals that they would consider working in a foreign country after hearing the experiences of this engineering alumnus.

GE Shanghai presented students with an unusual example of how a global company can do business in China that benefits all. GE designed and marketed a product that considered the special needs of the Chinese market that worked remarkably well. Not surprisingly, the Chinese consumers liked a product tailored to their needs, while GE still made good financial returns on the product. The visit to AECOM Shanghai also led to a great learning opportunity, when students learned that customers in the Chinese market have very different business expectations compared to business expectations in the U.S. The competition is very fierce and employees often have to work overtime and during the weekends to meet market demands, or face the possibility of losing market share to competitors. But as in the case at HP and GE, students saw the potential for working for AECOM in China after graduation, even though they had never imagined this would be a possibility before.

3.2 Interacting with Chinese college students and learning from other cultural visits

We visited two Chinese universities, both with strong engineering programs. One is Southeast University in Nanjing (SEU), the other is the University of Electronic Science and Technology of China in Chengdu (UESTC). In both universities our students spent time with Chinese

students discussing topics of interest, ranging from college admissions processes, to academics, to student life outside academics and many others. We ate in the student cafeterias and visited students' dormitories. We also attended a graduation art performance (singing, dancing, performing skits, playing musical instruments, etc.) by the computer science and engineering students at SEU, which was completely unexpected from our students' point of view. Through these activities, both American and Chinese students understood much better the academic and live experiences of each other. Many of our students wrote in their summary paper and in their journal that the college campus visits were one of their favorite activities in *ENGR 290 China*.

We also visited cultural sites with engineering significance. For example, we toured historical sites such as the Great Wall and the Terracotta Warriors which demonstrated some of the amazing engineering accomplishments in ancient times. We additionally visited Chinese architecture wonders created in modern times. These included the National Center for the Performing Arts, Beijing National Stadium (the Bird's Nest), and Beijing National Aquatics Center (the Water Cube). Though many students had heard of these places or read about them before, learning them from images and books is very different from being physically at the site, which gives deep impressions that can not be achieved through other means.

3.3 Other learning opportunities present during the course

While the scheduled visits to the sites mentioned above were a critical part of the course, other learning opportunities, sometimes very valuable, took place outside of the planned activities. For example, students learned firsthand how severe the air pollution problem is in the Chinese big cities. The air pollution caused by industrialization was visible everywhere. We in fact rarely saw any blue skies. Another example that gave students an opportunity to examine opposite sides of one particular engineering project occurred on our way to visit the Three Gorge Dam. Students had heard mostly negative stories about the impact of the dam project on the lives of the residents in the area, although the students were aware of the benefit the dam is having on power generation and green energy. However when actually visiting the dam, the tour guide told a completely different story. The tour guide said people of his age in the area were very happy with the project because the dam project stimulated the local economy by bringing in many jobs that were unthinkable before the project. While both sides are correct from their own perspectives, the sharply contrasting views of an engineering project as seen from different perspectives taught students a very real lesson about the huge impact that engineering design can have on peoples' lives. Engineers should never take the impact of an engineering project on peoples' lives lightly.

While the focus of the course is on engineering, in many occasions students encountered and learned from other cultural issues. For example, one student was pleasantly surprised to find out that the ordinary Chinese people on the street were very trusting. One old lady, while chatting with her friends on the street, let one of our students taste her herb tea from her own drinking cup! On the other hand, students also found out that negotiating a sale price with street vendors can be a tough, but sometimes rewarding endeavor. Students also had plenty of opportunities for dining in Chinese restaurants, formal or informal; visiting local attractions; interacting with local people; among others. Each of these occasions presented students with the opportunity to learn

about some aspects of Chinese culture which many students were not aware of, nor had thought about, before.

4. Assessments

In this section we discuss two types of course assessment. The first is student assessment; that is, how students' performance was evaluated in the course. The second is learning outcomes assessment; that is, whether or not the course objectives were achieved.

4.1 Student learning assessment mechanism

ENGR 290 is a full credit course, just like any other Bucknell course, and students were evaluated with multiple assessment instruments. The course syllabus specified student performance evaluation as follows:

- Professionalism and Active Participation 25%
- Presentations 35%
- Journals 20%
- Term Paper 20%

Since the course takes place on the road, in a foreign country, professionalism is an extremely important element. The syllabus spelled out eight specific areas of “professionalism” a student had to follow in order to succeed in the course. These included being on-time, respecting others, being responsible, and contributing to the team and the course, among others. Students in teams of two or three were required to make a presentation on a subject related to a site visit, as well as a summary presentation at the end of the course. The 22 students were divided into ten teams. Each team was responsible for research and presenting their findings to the entire group. For example, one team investigated the topic of China and US business and industry collaboration. Another team researched the topic of high speed rail in China in comparison to the rest of the world. Each team presented their research findings to the class before visiting a site, typically in the evening before. Doing so allowed students to have some knowledge of what they were about to visit, which increased the effectiveness of the visit. Due to the logistic difficulty of finding adequate time for the final summary presentation by each team, the final presentation was replaced by a summary paper by each team (this is in addition to the individual term paper). Also as a part of “professionalism”, students were required to have a “buddy” throughout the course. These buddy pairs of students were required to stay and move about together. The buddy system achieved two goals, helping students bond with each other and making them less vulnerable in unexpected circumstances (though this fortunately was not an issue in our course.)

Students were required to write journals, six times a week. These journals were written with an app on an iPad, which each student had so that journal entries could be submitted electronically. We collected the journals four times during the course with pre-announced due dates. The journals were graded and returned to the students so they could revise or improve the next journal entries. Each student was also required to write a term paper, which covered broad experiences, learning objectives, and the potential impact of the course on the student's future and professional career, with a minimum of 4,500 words. The term paper was due after returning to the U.S. and the students were given an opportunity to revise the graded paper, before a final grade for it was assigned.

Overall our evaluation scheme worked very well. Especially with the help of the iPad technology, we were easily able to collect and return journal entries electronically. Student teams also shared their pre-visit presentations to the class using these devices.

4.2 Learning outcome assessment

The student course evaluations of *ENGR 290 China* were collected in the same way as in any other course at Bucknell. Course evaluation was made available on-line after the course was completed. Students had a fixed period of time to fill out the evaluations anonymously. The results were collected by a staff member in the college, other than the instructors. The instructors received the evaluation results only after all grades were submitted. The evaluation contains two major parts, a set of numerical ratings (1-5, 5 being most favorable) for various course elements and two free-format questions for students' direct feedback. Here are some of the numerical rating questions that are directly related to the course learning outcomes.

Table 1: Course Evaluation Rating Summary

Question	Average rating
The course achieved the educational objectives set by the instructors.	4.31 / 5
I would recommend this course to other students interested in this subject.	4.62 / 5
For me, the value of this course was high.	4.62 / 5
I would recommend future ENGR 290 courses return to China.	4.46 / 5

The two free-format questions asked in the evaluation were “What aspects of this course did you find particularly valuable?” and “What aspects of this course would you improve for future years?” Students found many things in *ENGR 290 China* particular valuable, including interacting with Chinese people and learning about the culture, experiencing Chinese college student life, seeing aspects of business models in China that are very different from those in the U.S., and writing journals and reflecting on what the students saw in the trip. Here are some sample quotes:

“Seeing, feeling, and observing Chinese people, their culture and its fast growing development. Also, visiting some well known companies in China was very valuable and learning about how business is done in China compared to the U.S.”

“I think that the best part of this ENGR 290 class was that we were really immersed in Chinese culture and got a very good sense of how business in China is run differently then (*sic*) business in the States.”

“College trips to meet local students who are our age. It provided some of the best opportunities to make direct comparisons between our cultures.”

“I think the discussions we had during and after visiting the sites were extremely valuable. During the visitations I learned a great deal and formed my own opinions, but it was also nice to hear what others had noticed because often times I did not see it the same way. Also, writing the journals was a good way to help

me really delve into what we talked about each day and will be nice for the future when I want to look back to what I did in China.”

For the “future improvement” question, a couple of students mentioned they felt the course was a bit heavy on travel. One student also mentioned that being required to read more about China before the course would be helpful.

5. Logistical considerations and impact

As mentioned earlier, *ENGR 290 China* is one of the several versions of ENGR 290 that Bucknell’s College of Engineering has been offering over the last few years. With the increasing importance of global awareness for engineering students, and more recently the rapid growth and development of China and the Chinese economy, a group of faculty members conceived the idea of offering a version of ENGR 290 in China. We wanted to have as much engineering related content in the course as possible. We first came up two sets of activities, visiting companies and visiting sites with engineering significance. We wanted to visit companies whose businesses are closely related to the majors in the college. We also wanted to visit some universities. The connections to the chosen sites came from Bucknell alumni, the Asia Institute of China, and personal connections from the faculty in the college. The site visits also included cultural sites with engineering significance.

Traveling in a foreign country presents many challenges, particularly in a country where none of our students speak the language and few were familiar with the culture. Once the idea of *ENGR 290 China* was conceived, we sought professional help from the Asia Institute, an organization run by a Bucknell alumnus who has been working in China for a number of years. The Asia Institute took care of all logistic details including obtaining our visas to China, international air travel, domestic air travel, trains, buses, ship, hotel, meal, and tour guides. While the faculty members had the company and university contacts in China, it was the Asia Institute’s personnel who planned and executed such local details as arranging meeting times, determining the bus routes, parking locations, and lunch or dinner locations before or after the visit. The Asia Institute had two of their employees traveling with the group during the entire trip so they handled every logistical detail including purchasing train tickets, arranging restaurants for meals, local tour guide and bus arrangements, ticket purchasing for tourist attractions, among many others.

The work of the Asia Institute relieved the faculty members from these detailed responsibilities so they could concentrate on working with the students. One of the key components we designed into the course was to have the students write daily journals and to have daily group meetings to reflect on each day’s activities and to preview the visit the next day. Our syllabus stated that students had to write six journal entries per week, one for every weekday and one for each weekend. These journals were collected four times during the course with specific due dates. We required each student to have an iPad with specific software loaded so that the daily journals were written by each student using the same software. The students submitted their journals via email and the instructors graded the journals electronically and returned them to the students through email. The use of iPads (other tablets would work as well) greatly enhanced journal writing and sharing experiences. For example, with iPads students’ journals could include

images and videos that vividly described their experiences along with text. The use of iPads also made the sharing of student presentations much easier and more effective. Before visiting a site, the responsible team typically emailed the materials the night before the presentation so that the rest of the group would have a chance to read them before the presentation. The use of iPads again made this possible and relatively easy. Finding the time and proper space for such presentations, however, was a challenge. Most days, the group met during the evening hours. We used various kinds of space for this purpose, including hotel conference rooms, lobbies, and dining rooms, buses, trains, or onboard ship. One time we shared such a meeting with the SEU students in their classroom! The typical length of such a meeting was between 30 minutes and an hour.

Another issue to deal with when traveling in a foreign country is money. While most of the meals and all lodging and travel expenses were covered in a pre-paid fee, cash was still needed for gifts, meals on our own, and any other discretionary spending. We learned that major Chinese cities have ATM machines from which customers can withdraw cash directly with a credit or debit card, although with a fee. We therefore recommended that students find out from their own bank if their credit or debit card could be used in China, and if not, to obtain such a card from a financial institute that offers such a service.

6. Conclusions

We ran a very successful offering of Bucknell's *ENGR 290: Engineering in a Global and Societal Context* in the summer of 2012 (*ENGR 290 China*) by taking a group of 22 engineering students to China for a three-week academic trip. The course greatly enhanced students' knowledge about engineering in a different culture. Students visited engineering companies; explored Chinese culture, history, and engineering; met with Chinese college students and visited their campuses; saw engineering marvels, ancient and modern; and networked with Bucknell alumni in China. All indicators showed that the student learning outcomes for the course were achieved. The responses from students were very positive. We as faculty instructors learned a great deal from the course as well, even for the one who grew up in China. The logistics of arranging such a trip were challenging. With professional help (from the Asia Institute in our case) that took care of many logistical details, the faculty instructors were able to concentrate on student learning. We felt *ENGR 290 China* was indeed a very successful course.

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