An Engineering Field Trip
… to the United Kingdom

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Introduction

During the spring 2014 semester, the author taught a new course entitled "Engineering in an International Context." This course was the result of a long-standing desire to provide a study-abroad experience for engineering students at Ohio Northern University. Immediately after the end of the semester, the students and instructor embarked on a two-week tour of England and Wales, with an emphasis on sites of engineering significance.

It is widely recognized that international experience can be valuable for both the personal and professional growth of future engineers, and many different approaches have been taken to incorporate such experience into the undergraduate curriculum [1, 2]. Of the long-term stay options (1-2 semesters), there seem to be two categories: those that require significant investment by the home institution or those that require significant motivation on the part of the student. In the first category, many US universities have developed satellite campuses in foreign locations, or joint programs with foreign institutions. In the second category, a number of consortia have been formed to allow individual students to enroll in courses at member institutions around the world. In spite of these efforts, relatively few engineering students are either able or willing to participate [2, 3]. While any student must overcome concerns about costs, language, culture shock, etc. in order to participate in a study-abroad experience, engineering students are also faced with a rigid curriculum and limited technical offerings, making it difficult to study in a foreign country without falling behind, unless they attend one of the few institutions with a satellite program designed specifically for engineers.

The program described here falls into a popular alternative category – the short-term, faculty-led international experience. Among the advantages of this approach are that it does not require a major investment by the university, can be flexibly redesigned from year to year, allows students to "ease into" their foreign experience with the help of the instructor, and does not significantly affect the students' academic or work schedules.

In this specific instance, the United Kingdom was selected as the destination for three reasons. First, it was the location of many significant technological advancements. Second, due to unique geographical and historical conditions, many artifacts related to these advancements can still be seen. Finally, the instructor has travelled to the UK numerous times and could serve as a guide and tour facilitator.

Educational Context

During the spring semester immediately prior to the trip, all participants enrolled in one of two courses: ENGR-1211 or ENGR-1221. The first was a three-credit graded course which students could apply towards satisfying the university general education requirements. The second was a one-credit pass/fail course for students who wished to participate but did not need the academic credit. No additional credit was applied to the tour – it was considered part of the course. Students in both courses attended class meetings, although only those in the graded course were required to turn in assignments.

The course met once per week, and covered a variety of topics. The goals of the course for all students (whether enrolled for graded credit or not) included:

1. Providing a broad context for understanding what they would encounter.
2. Providing an introduction to British technological history, with an emphasis on the Industrial Revolution.
3. Providing practical skills and information to prepare for the trip.

To meet the first goal, the class discussed geography (e.g. "What is the difference between England, Great Britain, and the United Kingdom?") and history, including a chronology of the various eras and major events in British history (e.g. the Bronze Age, the Norman Conquest) and the peoples who have contributed to the makeup of the modern Briton (Celts, Romans, Normans, Asians, etc.).

To meet the second goal, the class discussed major advancements and people from British history, many of which would later be encountered on the tour. For example, the development of transport in Britain was reviewed, from the Duke of Bridgewater's canal to the iron-hulled steamships created by Isambard Kingdom Brunel. During the tour, the students were able to explore one of these ships, the *SS Great Britain* (Figure 1), which was launched in 1843. Similarly, innovations in the iron industry were discussed in class, and then encountered by touring Abraham Darby's original iron smelting furnace and the world's first iron bridge.

Figure 1: SS Great Britain

Finally, the third goal was met in a number of ways. Lectures covered the itinerary of the tour to prepare students for what they would see. Map exercises provided familiarity with some of the locations. Class discussions and Q&A sessions addressed concerns ranging from airport security etiquette to the available of hair dryers in British hotels.

In addition, as part of the university general education program, the course also addressed the topic of aesthetics in engineering. Given the wide range of engineering and architectural objects encountered during the course and on the tour, students had the opportunity to gain a greater appreciation for how the designers of these objects may or may not have considered the aesthetical impact of their designs.

Tour Overview

A total of eleven students and one faculty member participated in the tour, in addition to the author who served as guide. Excluding flight time, the group spent twelve days in England and Wales, staying in the following locations: Cambridge (2 nights), Shrewsbury, Bangor (3 nights), Bristol (2 nights), and London (3 nights). These locations are shown in Figure 2

Figure 2: Major tour locations

While a detailed itinerary of the trip is beyond the scope of this paper, some of the highlights (in historical order) included:

- **Stonehenge, England**: an ancient stone circle built around 3000-2000BC and an amazing feat of prehistoric engineering.
- **Wroxeter, England**: founded in the 1st-century AD, once the fourth-largest city in Roman Britain. Excavations have uncovered a number of structures, including a hypocaust – a sophisticated central heating system for the public baths (Figure 3).
- **Conwy, Wales**: built in the 13th century AD by the English to subdue the Welsh, both the castle and the medieval walled town are well-preserved. The castle overlooks two historically significant bridges as well: Telford's 1826 suspension bridge and Stephenson's 1848 tubular railway bridge.
- **Ironbridge Gorge, England**: Often referred to as the "Birthplace of the Industrial Revolution," this was the location where Abraham Darby first used coal to replace charcoal in the smelting of iron – resulting in a vast increase in production (c. 1710). The world's first iron bridge crosses the Severn River nearby, and is still open to pedestrians (Figure 4).
- **Menai Bridge, Wales**: Designed by Thomas Telford and opened in 1826, this was the first large suspension bridge in the world.
- **SS Great Britain, Bristol, England**: One of three great steamships built by I. K. Brunel, the SS Great Britain was the largest ship in the world when launched in 1843, and incorporated many innovations or recent advances such as an iron hull, screw propeller, and pivoting rudder.
- **Dinorwig Power Station, Llanberis, Wales**: Built inside the largest man-made cavern in Europe (c. 1984), Dinorwig is a pumped-storage facility that provides nearly instantaneous electricity on demand.
- **London Eye, London, England**: The largest observation wheel in the world when constructed for the millennium celebrations.

Figure 3: Remnants of a Roman hypocaust at Wroxeter, England.

Figure 4: The Iron Bridge over the River Severn, Shropshire, England.

Logistics

All logistical arrangements – other than airfare - were made by AIFS (the American Institute for Foreign Study). This included ground transportation (including airport transfers), lodging, entrance fees to all scheduled attractions, and several tours by local guides. Students were billed directly by AIFS, and were able to add the cost of the trip to their financial aid package (i.e. student loans) if they wished. Airfare was purchased by the instructor directly from the airline, and billed to the students through their university accounts.

By far the greatest drawback of the tour, and the negative aspect mentioned most in student feedback, was the cost. Excluding airfare, the cost of the tour was approximately $316 per day. This covered accommodations (including breakfast), all ground transport in the UK, and all fees for entrances and guided tours included in the itinerary. This is comparable to other "small-group" tours, such as the 14-day Rick Steves "Best of England" tour, which is limited to 24-28 people and will cost approximately $325/day for May 2015 [4]. However, large-capacity package tours can be much less expensive. For example, Globus and Evan Evans, two well-known tour operators, offer tours in the UK for approximately $250/day [5, 6].

The most effective way to reduce costs would be to significantly increase the number of participants. Unfortunately, this is something of a "Catch-22" in that a number of students who initially showed an interest in the program ultimately decided that it was not affordable. Another potential cost-saving approach would be to use public transportation. Having visited most of the locations previously, the author's experience indicates that this could be done for a group of 10-15 participants. However, due to limited schedules it would take much longer to visit the same number of sites – perhaps as much as 50% more travel time. A more practical approach, and one that will be implemented the next time the course is offered, is to stay in one central location and make day trips. This removes the need to provide lodging for the coach driver, and also allows a smaller vehicle to be used, since luggage space is not required.

Assessment

Quantitative assessment data was collected through the usual end-of-term course evaluation process. Unfortunately, since the trip occurred after the end of the semester, the feedback provided by these evaluations relates only to the course. However, this feedback was consistently positive. Seven students completed the evaluation survey, which included 25 standard questions. The average responses were all 4.0 or higher on a 5.0 scale. There were no responses below Neutral (= 3).

Because the trip occurred after the end of the semester (and because the author was exhausted upon its completion!), no quantitative assessment data was collected. However, the qualitative feedback was uniformly positive. Anecdotal evidence also suggests that the objectives mentioned previously were achieved to some degree. For the next offering, it should be possible to collect quantitative data upon completion of the trip to verify these conclusions.

Lessons Learned

This program was in many ways a very personal venture for the author. As a result, the lessons learned are somewhat individualistic. However, it is to be hoped that the following reflections may be useful for others planning a similar program.

Use a professional travel agent. By far the most stressful aspect of this program for the author was purchasing airline tickets directly from the airline. While using a professional, education-oriented travel agency (AIFS) was almost certainly more expensive than making arrangements directly, there were a number of advantages. Perhaps the most important advantage (aside from maintaining the faculty coordinator's sanity), is the efficiency that can be achieved with professional planning. The final itinerary enabled the group to maximize the number of locations that could be visited in the limited time available, which was effectively a cost savings to offset the additional cost of the travel agency.

Schedule plenty of unscheduled time. Prior to the trip, one of the author's biggest concerns was that there might be too much "blank" time on the itinerary. Overall, the group spent perhaps 1/2 to 2/3 of each day together on scheduled activities (including travel). This proved to be a good balance, allowing time for individuals or small groups to explore on their own. Of course, this free time was often spent in small towns or other sites where the groups occasionally encountered each other, offering both a sense of freedom and connection.

Minimize the language barrier. While traveling to an English-speaking country might seem to lessen the students' encounter with "foreign" culture, in fact the opposite proved to be the case. Individual students provided a number of anecdotes about encountering locals which indicated that they gained significant insight because they were able to communicate (reasonably) fluently. For example, after spending time at the historic Darby Ironworks in Shropshire, students were given free time in nearby Shrewsbury. One group of students wandered into a church where the custodian showed them an antique safe produced by the same Darby Ironworks and gave them a brief lesson in local history. Another group learned quite a lot about the relationship between England and Wales from local university students in a pub in Bangor, Wales. While it is certainly possible to have a meaningful study-abroad experience without speaking the language fluently, this inevitably creates an added distance between the participants and the local people.

Remember the big picture. It was sometimes disappointing that the students were not always impressed with the same things the instructor was. In retrospect, this should not have been surprising. If one has never seen a well-preserved medieval castle before, it may be difficult to focus on the mundane-looking railway bridge immediately below the castle ramparts. For some, the appeal of historically-significant scientific instruments may pale beside the prospect of a pint of Real English Ale. But ultimately all of these can be meaningful, broadening experiences.

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