2006-2232: SHORT-TERM STUDY ABROAD: ENGINEERING IN A GLOBAL AND SOCIETAL CONTEXT

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Short-Term Study-Abroad Program: Engineering in a Global and Societal Context

Abstract

A 3-week study-abroad program for Bucknell University engineering students was offered for the first time in May, 2004. One purpose of the program is to provide an opportunity for students who are not able to spend a semester or year abroad to gain international experience before they graduate. The program was delivered in the United Kingdom where both co-authors have taught and lived. Students received one course credit (4 credit hours) for the program, "Engineering in a Global and Societal Context," which counted as a free elective or an engineering elective.

This study-abroad program was designed to address a specific educational objective adopted as part of Bucknell's Civil Engineering program's accreditation process: "Graduates of the Civil Engineering program will demonstrate professional responsibility and a sensitivity to a broad range of societal concerns such as ethical, environmental, economic, regulatory and global issues." While this educational objective was adopted for civil engineering students, it is applicable to all engineering students regardless of specialty. Specific educational outcomes for the study-abroad program included:

- The broad education necessary to understand the impact of engineering solutions in a global and societal context,
- Recognition of the need for, and an ability to engage in life-long learning, and
- Knowledge of contemporary issues.

To meet the educational outcomes, a series of lectures, site visits and guest speakers were arranged using transportation and environmental issues as the underlying themes. The students were in London for the first and third weeks, and during the second week the group traveled to York, Nottingham, Oxford and Bath. While in London, the students were generally in the classroom in the morning and in the field in the afternoon. University faculty conducted the classroom activities to provide context and background for guest speakers and field trips. Assessment was based upon class and field trip attendance, a daily journal, and a term paper written and submitted after the students returned to the US.

The dates of the program were selected such that the program began immediately after the end of final examinations and ended during the first week in June so that students could return home in time for summer jobs. A total of 18 students participated in the first offering of the course, and the second offering will be in May 2006.

Introduction

This paper describes a short-term overseas program for engineering students interested in developing their professional responsibility and sensitivity to a broad range of topics impacting engineering including ethical, environmental, economic, regulatory and global issues. While there are a number of semester and year-long study abroad programs[1], this program provides an unique opportunity for students who are not able to spend a semester abroad to gain international experience before they graduate.[2] The program is based in the United Kingdom (UK) where the

instructors both have taught and lived. Students earn one course credit (four credit hours) for the program, "Engineering in a Global and Societal Context," which can count as a free elective or an engineering elective. Since faculty of the home institution teach the course and assess student performance, credit transfer complications are avoided.[3]

The program is centered in London with excursions throughout England. The program dates (e.g., May 17 to June 9, 2004) are selected so that the program begins shortly after final examinations and ends in time for students to return home for summer jobs. All engineering students who have completed their sophomore year by the time of departure are eligible to apply although the program as it has been executed to date is best-suited for civil engineering students.

It is established that study abroad can help prepared engineering students to meet the changing demands of the profession and prepare them better for a career in the global economy.[4,5] To that end, at a fundamental level the activities of the program were designed to stimulate the students' awareness and thinking about the many non-engineering issues that both affect and are affected by engineering decisions. Historically, engineering education has focused on the technical aspects of engineering (stress, strain, etc.) and, many would argue, virtually ignored the role of engineering in society. While technical aspects of engineering will and should remain at the core of an engineering education, it is widely recognized that the engineer of the 21st century must be more than a skilled technician. This course uses transportation and environmental engineering projects to bring into focus the many historical, societal, legal, ethical, business, environmental, and cultural issues that impact engineering projects.

Educational Objectives

Bucknell's civil engineering ABET accredited program includes a program educational objective which states:

> Graduates of the Civil Engineering program will demonstrate professional responsibility and sensitivity to a broad range of societal concerns such as ethical, environmental, economic, regulatory and global issues.

In addition to on-campus activities used to enable our students to meet this objective, the department recognized that a study-abroad experience could have a tremendous impact on students' perceptions and attitudes regarding societal concerns. Further, we recognized that many students cannot or will not study abroad for a full semester or full year for a variety of excellent reasons such as participation in team sports and campus organizations. As a result, this three-week, study-abroad opportunity was developed to accommodate these students and to enhance our graduates' professional responsibility and sensitivity to the broad range of societal concerns identified in the above program educational objective.

To meet this educational objective, departmental outcomes include:

- The broad education necessary to understand the impact of engineering solutions in a global and societal context,
- A recognition of the need for, and an ability to engage in life-long learning, and
- A knowledge of contemporary issues.

To support these departmental outcomes, specific course learning objectives and outcomes were developed for the study-abroad program. Both the three-week time abroad and the six-week summer school period during which the student prepare their paper (see Instruction Methods below) are used by the students to meet the following learning objectives:

1. Develop a historic perspective on the evolution of engineering from prehistoric times, through Roman times and the Industrial Revolution, into modern times;
2. Understand the limitations of technology and how today's engineering solutions can become tomorrow's societal problems;
3. Develop a historic perspective on the development of the United Kingdom;
4. Understand how traditions, customs, and culture impact engineering projects;
5. Understand how projects in one country can be affected by policies, laws, and customs of other countries;
6. Understand how political, financial, and environmental constraints affect the planning, design, construction, and operation of large engineering projects;
7. Understand why personal property rights that are so important in the US are less important in European countries and how these differences affect land use policies;
8. Understand how and why environmental and social policies in Europe are different from those in the US;
9. Learn some of the risks and opportunities of working abroad; and
10. Understand how higher education in Europe is different from the US.

To meet these learning objectives students completing the program are expected to be able to:

1. Identify different categories of waste generated and differences between US and European practices on the management of the wastes;
2. Describe the technological, social and political considerations for the supply of potable water in the context of US and UK climatological, population and geologic differences;
3. Identify remedial technologies suitable for site-contaminated land needed to permit brownfield redevelopment and to describe social and political drivers that influence the application of these technologies;
4. Describe land use practices in the US and UK in the context of the historical development, social structure and political systems of each country;
5. Describe the historical evolution of transportation in London;
6. Describe the current and future issues facing transportation in the Greater London area;
7. Describe how transportation is organized and regulated in the UK at the national and local levels;
8. Describe privatization, its bases (economic, political, and social), its application, its positive attributes, and its potential shortcomings;
9. Identify impacts (economic, social, political, environmental, and geographic) of the London Underground system; and
10. Identify differences in university teaching modes and assessment activities between the UK and US systems of higher education.

The assignments and activities used to enable students to meet these course objectives are described in the next section.

Instructional methods

To achieve the educational outcomes, a series of lectures, site visits and guest speakers were arranged using transportation and environmental issues as the underlying themes. The students were in London for the first and third weeks, and during the second week the group traveled to York, Nottingham, Oxford and Bath. While in London, the students were generally in the classroom in the morning and in the field in the afternoon. Bucknell faculty conducted the classroom activities to provide context and background for guest speakers and field trips. Tables 1, 2, and 3 provide detailed activities lists for the three weeks. A few of these activities are discussed in detail to give the readers a sense of our approach to the program activities.

One of the first activities was entitled "Exploring London" and was designed to get the students out and about in London. Students were divided into groups of three to four and asked to complete the tasks described below and record their observations in their journals (more on journals later in the paper). The purposes of this assignment were (1) to get students familiar with using the London Underground, (2) to sharpen their observation skills, (3) to visit some of the standard landmarks of London, and (4) to get them started on their journals.

From the options shown in Table 4, each group was to choose in advance which places it planned to visit (e.g., which train station, which park, and which of the places in Part III of the list). Using a street map of central London students devised a route to get from one place to the next using the London Underground system. This activity succeeded in getting the students out and about while requiring them to record specific observations.

Another essential part of students' learning for programs of this type is the keeping of a journal to record and process their observations. Journals are a tool to increase self-awareness, perceptive examination, and memory retention of the study-abroad experience. Journals are an old practice. Authors, artists, poets, political leaders, scientists, and ordinary people in all walks of life have kept journals. Some, such as those of Leonardo Da Vinci and Charles Darwin, have become key documents for understanding the minds of their authors. A journal is a proven way to induce students to observe closely, to think about what they are encountering, to draw insightful conclusions, and to remember in detail what has been experienced. Without a journal, it is hard for the student to rise above the level of a tourist, gathering vignettes and impressions filtered through the distortions of one's home culture.

Keeping a journal is not easy and is not necessarily fun. A journal requires time that the student would probably prefer to spend doing something else or doing nothing. But the discipline of keeping a journal, of making time for it every day regardless of how busy the day is, puts this tool to use and keeps the student's perceptive powers sharp. The journal's first intended reader is the student. It is a tool for one's own exploration. If it is written simply to satisfy the professors, the student is turning a highly beneficial tool into simply another burden. The professors are the second intended readers.

Table 1 Schedule of Activities: Week One

Date	Day	Location	Activity
18-May	Tuesday	Newark, NJ	Arrive at Airport/ Depart for London
19-May	Wednesday	London	Arrive London - Immigrations clearance, visit
		Heathrow	ATM for cash
		London	Transfer to London housing Check into housing & get lunch (on own)
		Flats	Orientation, obtain transit pass
20-May	Thursday	Classroom	Introduction to Program
		Classroom	Overview of London Transport
		Classroom	Environmental Systems overview
		London	Exploring London - ends at the London Transport Museum
		Transport Museum	Unguided tour of the London Transport Museum
		Brown's Restaurant	Welcome dinner
21-May	Friday	Classroom	History and Architecture of London
		London	Walking tour: City of London Architecture
		London	Lunch on own
		London	Museum of London (unguided)
22-May	Saturday	London	Depart for Wiltshire
		Wiltshire	Stonehenge, Avebury, Old Sarum, Salisbury Catheral, Silbury Hill
		London	Submit journal for assessment
23-May	Sunday		Free Time
24-May	Monday	Classroom	Overview of British Transport
		Classroom	Richard Bate - British Planning
		London	Lunch on own
		Classroom	Strategic Rail Authority - Chris Austin
		Classroom	Steve Atkins - Land use and the case for rail
25-May	Tuesday	Classroom	England's Garden Cities
		Classroom	US and UK Planning
			History of Agatha Christie's Mousetrap - Miranda McGinnis
		London	Docklands, Canary Wharf & Greenwich
		London	London Theatre - Agatha Christie's Mousetrap
26-May	Wednesday	Classroom	The Underground Environment
		London	London Walk: Subterranean London
		London	Lunch on own, prepare for travel
		Kings Cross	Leave for Nottingham
		Nottingham	Arrive and check into Nottingham Youth Hotel

Table 2 Schedule of Activities: Week Two

Date	Day	Location	Activity
27-May	Thursday	Nottingham	Ride out of the city on the NET (tram)
		Council offices	Andy Holdstock - Nottingham Express Tramway
		Council offices	Lunch on own, Caves of Nottingham, public transport to Nottingham University
		Nottingham campus	Major Taylor - Infrastructure support for post-conflict and disaster
		Nottingham campus	Lloyd Bennett - Nottingham City's policy on congestion charging
		Nottingham campus	Hugh MacIntock - Cycling, an increasingly viable option for regular transport
28-May	Friday	Nottingham Campus	Paul Nathanial - Contaminated Land
		Leicester	Leave campus for Abbey Pumping Station
		Leicester	Lunch on own
		Leicester	Abbey Pumping Station
		Leicester	Museum of Roman Civilisation
		Nottingham	Quiz Night: Nottingham versus Bucknell
29-May	Saturday	Nottingham	Depart Nottingham to Peak District
		Cromford	Walking tour: Arkwright's Mill's and Cromford
		Carsington	Severn-Trent Engineer and Andrew Dawson
			Depart Carsington, stop at Edensor/Chatsworth
			Mam Tor
			Arrive at York by coach
30-May	Sunday	York	Jorvic Viking Center
			York walking tour
			York Minster including structural tour
31-May	Monday	Oxford	Morning travel to Oxford by train
			Arrive Oxford, tour of engineering
			Lunch at the University
			Tour and conversation with Prof. Gilliane Sills
			Free Time to explore Oxford
			Evening travel to Bath by train
01-June	Tuesday	Bath	Andrew Heath: Influence of Geology on the Development of Bath
			Roman Baths
			Walking tour: Bath Architecture/History
02-June	Wednesday	Bath/London	Morning travel by train
		Classroom	Discussion of week of travel/ journals due

Table 3 Schedule of Activities: Week Three

Date	Day	Location	Activity
03-June	Thursday	Classroom	Channel Tunnel Rail Link
		CTRL	CTRL- Jeff Waller
		CTRL	St. Pancras Chambers tour – Roy Stock
		CTRL	Channel Tunnel Rail Link Tour - J. Kahn
04-June	Friday	Classroom	Risk Assessment - Dr. Stephan Jefferis
		Classroom	Selection of Remedial Approaches - Dr. Paul Bardos
			Lunch on own
			Free Time
05-June	Saturday		Free time
06-June	Sunday		Free time
07-June	Monday	Classroom	David Barry - Brownfields redevelopment for the Millennium Dome
			Lunch on own
		London	British Museum
08-June	Tuesday	Classroom	Student discussions: Synthesis of Transport/Environmental Issues
		Classroom	Course evaluation
		Classroom	Globe Theatre/Shakespeare's Romeo & Juliet - Miranda McGinnis
			Lunch on own
		London	Romeo and Juliet at the Globe Theatre
09-June	Wednesday	London	Check out of housing and transfer to London Heathrow
		London Heathrow	Depart for Newark, NJ
		Newark, NJ	Arrive at Newark International, US Customs clearance
			Depart Newark for **home** (on own)

Six entries weekly, one each for Monday through Friday and one for the weekend were required. Daily entries averaged about 2 sides of a journal page, although many were longer, and some were shorter. The content of the journal is a conversation that notes what the student sees, what is encountered, and what the student thinks about the meaning of these observations. It includes small experiences as well as large ones. It includes not only items that are directly tied to the course, but also items that are only tangential. It includes many experiences outside what is discussed in the course. For example, if the student attended a play, saw an episode in a pub, walked in a new park, was puzzled by the wording of a sign, or saw something one wouldn't expect to see in normal U.S. life, the journal is where this experience was recorded. *A journal is not a diary*. While, like a diary, it contains comments about personal feelings, mostly the journal focuses on the process of encountering and coming to understand British society and London in

particular. It trains the student to be observant. It records what the student observes and what it means to him or her.

Table 4 Exploring London

Part I.
Visit a train station and record the following observations:
- Where do the trains go?
- Describe the station architecture.
- Describe the neighborhood around the station?
- What evidence do you see of privatization?
- Be sure to get your travel card validated

Part II.
Visit a London Park
- What are the activities of the patrons of the park?
- What sort of sections is the park divided into, that reflect intended uses of the park?
- Do the activities taking place in the park appear to match the intended uses?
- How might the time of day, and day of the week, affect what an observer sees?

Part III.
Visit any one from each of the following categories and note your observations and impressions in journal entries. Plan your route in advance to economize on time and travel:

(Districts and Places)
- Leiscester Square (theatre district) and note the half-price ticket booth and its rules of operation
- Soho (nightclub theatre district)
- Covent Garden (theatre, restaurant and market area)
- Trafalgar Square. including: Nelson's Column, National Gallery (free), Admiralty Arch
- Downing Street (prime minister's residence)

Churches
- Westminster Abbey
- St. Pauls Cathedral (note the free Organ concert series)
- St. Martin in the Fields (visit the Crypt Café, a good place for cheap food)
- Southwark Cathedral
- Westminster Cathedral

Other Notable Places
- Tower of London
- New Globe Theatre
- Houses of Parliament
- Hyde Park Speakers Corner
- Harrods Department Store
- Buckingham Palace

While in London the students visited a number of museums (London Transport Museum, Museum of London, Royal Observatory, and the British Museum), did walking tours (City of

London Architecture, Subterranean London, Docklands and Canary Wharf), and attended two plays (Agatha Christie's Mousetrap and Shakespeare's Romeo and Juliet at the Globe Theatre). Lectures, guest speakers (Strategic Rail Authority, planning consultant) and field trips (Channel Tunnel Rail Link project) were used to acquaint the students with the London transport system and the British planning process.

For example, the coverage of the 9 Billion (US$) Channel Tunnel Rail Link (CTRL) project, London's equivalent of Boston's Big Dig, included an introductory lecture by one of the Bucknell instructors at our London classroom, a project overview by a CTRL project manager at the CTRL project office, a guided tour of the Kings Cross-St. Pancras construction site (London terminus for the 68-mile high-speed rail line), and a guided tour of the St. Pancras Chambers (Renovation of the Midland Grand Hotel). Much of the discussion about the project focused on how political, financial, economic, social, archeological, and environmental issues constrained the planning, design and construction of the project.

A Wiltshire excursion lead by a knowledgeable local tour guide during the first weekend in England took the group to Stonehenge, Avebury, Old Sarum, Salisbury Catheral, and Silbury Hill. Similar types of tours were conducted as part of the program in York, Bath, Nottingham, and the Peaks District.

Other field trips included an excursion to Arkwright's Mill and Cromford (considered the starting place of the industrial revolution), Mam Tor (a major land slip area showing the constant conflict between engineers and the nature they often try to conquer), Abby Pumping station (a Victorian sewage pumping station with a museum of the history of waste treatment in England), and the Roman Baths in Bath. Guest speakers provided valuable UK perspective on a number of related topics including identification and properties of contaminated land sites, selection of remedial approaches for contaminated land sites, remediation of the brownfields site where the Millennium Dome was constructed, risk assessment, and the geology of Bath.

Assessment

Given the "immersion" nature of this three-week program, conventional means of student assessment though examinations were thought to be inappropriate. Instead, student assessment had three major components: 1) participation in all activities, 2) the journal, and 3) a "term" paper written after the students returned to the US. The importance of attendance in a venue-specific program of this type is self-explanatory. The journal, recording of factual information coupled with synthesis and interpretation in the context of UK, European and US practices, was a major daily component of the students' activities. Finally, within 5 weeks of the completion of the abroad experience the students were required to submit a 4,500-word minimum paper. Specifically, for each of the program's learning objectives the students had to identify and describe an experience (or collection of experiences) and examine how the experience(s) led them to accomplish the objective. For those learning objectives not met, the students described how their experiences fell short of enabling a meeting of the objective. In addition, students had to describe how the course is likely to impact their future and their professional careers.

Consideration was given to the use of quizzes on reading assignments, speakers and field trips, but it was decided that these were unnecessary. In hindsight, this was a correct decision as our

students were fully engaged in the program and little was to be gained by adding traditional quizzes to this non-traditional course.

In addition to the assessment of the students by the faculty, an assessment of the course by the students was undertaken. This assessment consisted of a student self-assessment rating their achievement in meeting the ten individual course outcomes. In addition, individual activities such as speakers, field trips, tours and the like were assessed by the students as to what extent the activity contributed to their meeting the learning objectives of the course. A 5-point scale was chosen and the students were asked "Using a rating scale of 1 to 5, with 5 being the highest, please rate your achievement of the following objectives:…" where the following words were assigned to the numbers:

- 5 – excellent
- 4 - very good
- 3 – moderate
- 2 – fair
- 1 - poor.

The learning objectives were restated in the active case for this survey. All of the students (100%) agreed the program was at least moderately successful in helping the students to meet the learning objectives and most 93% felt the program was very good in helping them achieve the learning objectives. While this is an indirect measure, the authors also recognize that the impact of this program can only be fully realized at some time in the future as students draw from this educational experience while working in their chosen profession. Of the activities, student ratings varied from 100% rating the activity as an excellent contribution towards their meeting the learning objective (the Channel Tunnel Rail Link Tour and the discussion of educational systems held at Oxford University) to 0% excellent for a couple of activities including a self-guided tour of Leicester. These data will be used to refine the course content and/or refocus the student's attention on the central purpose of a given activity.

Administrative and Logistical Issues

Engineering in a Global and Societal Context was designed so it could be offered by any faculty member in Bucknell's College of Engineering and in any location, not just the UK. The overall educational objectives are appropriate for any engineering discipline, and the specific educational objectives can be modified to fit the program's venue and the faculty leading it. In accordance with campus governance, the course was approved by the engineering curriculum committee, the university international education committee, and the university Committee on Instruction.

The cost of the program ($3490 in 2004) was set at the tuition cost for one 4 credit-hour course during the regular academic year. The program fee covered tuition, airfare, lodging, UK transport and all scheduled activities. Students needed additional funds for meals and non-program travel. The program is cost-neutral to the university. For the 2004 program, a total of 18 students participated. The students were all civil engineers and consisted of 4 sophomores, 13 juniors and one senior.

For all overseas programs the university requires that a crisis management plan be in place to cover any major emergencies. Some of the components of the crisis management plan are given below:

1. A photocopy of page one of the passport of each student is kept in the files to facilitate replacement in case of loss.
2. A system of rapid communication with students and staff of the program is devised and tested. This communication network may be used for communicating academic and social notices, but it should also enable the director to contact all students at short notice and assemble the group quickly. A list of student addresses and telephone numbers is maintained.
3. In the event of a crisis, it is the immediate responsibility of the program director to locate all students and to inform the home (US) campus office about their welfare. During a crisis students are instructed not to travel independently and to remain at a location where they can be reached.
4. An orientation for the students is conducted to inform students about the procedures to be followed in case of an emergency. The orientation also includes information and advice appropriate to the program's location for students' personal security and safety.
5. Cellular phones are provided to the faculty leading the program and to students as needed.

In addition, special measures are taken to minimize risks of anti-American threats or terrorism including:

1) Elimination of any signs on the outside of the premises where the students live and study that could identify them as American,
2) Review of State Department information regarding the program venue and advice on any special recommended precautions,
3) Implementation of a plan to contact all students in emergencies,
4) Control of entry to the classroom facilities and warning of students against giving passcodes to any unauthorized individuals, and
5) Advising of students to take the following precautions:
    a) Avoid congregating at American hangouts such as bars that might be targets for terrorists,
    b) Avoid speaking loudly in English when walking with groups of other Americans,
    c) Avoid dressing in ways that identify them readily as Americans (e.g., baseball caps on backwards, American college sweat shirts, etc.),
    d) Exercise care in whom they invite to visit them at their residence or how much information they give to strangers about their program and its location,
    e) Keep abreast of local news through TV, radio, and newspapers, and
    f) Stay in touch with their families so that they know their students are safe, and they know where to reach them in case of an emergency or if an incident causes them to worry about their student's safety.

Summary

A new course, entitled "Engineering in a Global and Societal Context" was delivered to 18 Bucknell University civil engineering students in England for the first time in the spring of 2004. The study-abroad experience was designed to be a three-week, intensive experience. The scheduling of the program, immediately after the end of finals, was timed to permit student to return home for the summer with adequate time remaining to have a summer internship. The course content was designed to enhance the participating students' awareness of global and societal issues impacting and impacted by engineering decisions.

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This program could not have been successful without the contributions of many people, particularly our British friends and colleagues who volunteered their time to interact with our students. These contributors and the nature of their participation in the course included:

Richard Bate: British planning
Chris Austin: Strategic Rail Authority
Steve Atkins: Land use and the case for rail
Andy Holdstock: Nottingham city tram system
Major Taylor: Infastructure support for post-conflict and disaster
Lloyd Bennett: Nottingham congestion charging
Hugh MacIntock: Cycling as a means of regular transport
Paul Nathaniel: Contaminated land
Andrew Heath: Geology of Bath
Glliane Sills: Oxford and UK educational systems
Jeff Waller: Channel Tunnel Rail Link
Jay Khan: Channel Tunnel Rail Link tour organizer
Roy Stock: St. pancreas Station tour
Stephan Jefferis: Risk assessment
Paul Bardos: Remedial Approaches
Dave Barry: Brownfields redevelopment for the Millenium Dome

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