

# **AC 2010-928: FIVE YEARS OF SHORT-TERM STUDY ABROAD PROGRAMS: ENGINEERING IN A GLOBAL AND SOCIETAL CONTEXT**

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# **Five Years of Short-Term Study Abroad Programs: Engineering in a Global and Societal Context**

## **Abstract**

A 3-week study abroad program for Bucknell University engineering students was offered five times between 2004 and 2009. The intent of the program was to provide an alternative for students who could not spend a semester or year abroad, enabling more of our students to gain some international experience before they graduate. Students receive one course credit (4 credit hours) for the program, which counts for a free elective or an engineering elective, depending on department. The program was delivered in the United Kingdom in 2004 and 2006; Argentina in 2007; Switzerland, Germany and France in 2008; and Norway and Sweden in 2009. Over 100 students and six different faculty members have participated.

This study abroad program was originally designed to address the specific educational objectives of the Civil Engineering Program which state “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 originally adopted for civil engineering students, it is applicable to all engineering students regardless of discipline. Specific educational outcomes for the program include: 1) The broad education necessary to understand the impact of engineering solutions in a global and societal context, 2) Recognition of the need for, and an ability to engage in, life-long learning, and 3) Knowledge of contemporary issues.

To meet the educational outcomes, the programs were planned thematically around issues in Transportation and Environment in the UK; Water Resources in Argentina; Energy Production, Utilization, and Policy in Switzerland, Germany and France; and Energy and Sustainability in Norway and Sweden. For example, in the most recent program, students heard a series of presentations on topics such as innovative energy generation and carbon sequestration and traveled on field trips to sites such as waste-to-energy, hydroelectric, and nuclear power plants. The students were in Stockholm, Gothenburg, Trondheim, Bergen and Oslo as the three-week program progressed. Assessment was based upon required class and field trip attendance, a daily journal and a term paper written and submitted after the students returned to the US. Self-assessment data have been gathered for all programs. The data show that the students attain a high degree of achievement of specific learning outcomes. Faculty also assessed student achievement directly through the end-of-course term papers which require students to make explicit connections between the course activities (presentations and field trips) and the learning outcomes. This direct assessment also demonstrated a high level of outcome achievement.

## **Introduction**

This paper describes a short-term international 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<sup>1</sup>, this program provides an

unique opportunity for students who are not able to spend a semester abroad to gain international experience before they graduate.<sup>2</sup> The program was delivered five times including twice in the United Kingdom (UK) in 2004 and 2006, Argentina in 2007, Switzerland/France/Germany in 2008 and Sweden/Norway in 2009. A total of 100 engineering students have earned one course credit (four credit hours) for the program, "Engineering in a Global and Societal Context," which counted as a free elective or an engineering elective, depending on department, and fulfills the "global and societal perspectives" course requirement within the Engineering College.<sup>3</sup> The program dates (e.g., mid-May to early-June) are selected so that the program begins shortly after final examinations and ends in time for students to return home for summer internships. All engineering students who have completed their sophomore year by the time of departure are eligible to apply.

A study abroad experience helps prepare engineering students to meet the changing demands of the profession and better prepare them for a career in the global economy.<sup>4</sup> To that end, the activities of the program are 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; however, the role of engineers in society is often understated. 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 21<sup>st</sup> century must be more than a skilled technician. This course uses technical issues such as transportation, energy, sustainability and the environment to call into focus the many historical, societal, legal, ethical, economic, environmental, and cultural issues associated with engineering projects.

### **Educational Mission and Objectives**

The University's mission statement describes a Bucknell University education as one "...in which students develop intellectual maturity, personal conviction and strength of character, informed by a deep understanding of different cultures and diverse perspectives." This mission has greater specificity in some departments such as civil engineering which includes a program educational objective stating "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."

The ABET Outcomes addressed in this course include: 1) the broad education necessary to understand the impact of engineering solutions in a global and societal context, 2) recognition of the need for, and an ability to engage in life-long learning, and 3) knowledge of contemporary issues. To support these outcomes, approximately ten specific course learning objectives and outcomes were developed, some of which were country specific. To meet the educational objectives, a series of lectures, site visits and guest speakers were arranged using underlying technical themes appropriate to the host country (e.g., transportation, environment, water resources). Assessment of the students was based on class and field trip attendance, a daily journal, and a term paper written and submitted after the students returned to the USA. The program provides an opportunity for students who are not able to spend a semester abroad to gain international experience before they graduate.

To support the College of Engineering's mission and educational objectives, 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 students prepare their papers (see Instruction Methods below) are employed for the students to meet the course learning objectives. The overall educational objectives are appropriate for any engineering discipline, and the specific educational objectives were modified each time the course was taught to fit the program's venue and the faculty leading the course. For example, in the most recent version of the course taught in Norway and Sweden, the objectives were:

1. Develop an understanding of how sustainable engineering can be applied to solve modern problems related to energy supply, residential construction, and transportation.
2. Understand the limitations of technology and how today's engineering solutions can become tomorrow's societal problems;
3. Develop an historic perspective on the development of Scandinavia;
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. Understand how European higher education differs from US education.
10. Learn some of the risks and opportunities of working abroad.

### **Course Organization and Instructional Methods**

To facilitate the participation of multiple faculty members from different engineering departments, a faculty workshop was held during the summer of 2007. During this workshop the participants discussed primarily the educational goals, logistics, and financial considerations of the course. Part of this time was also used to plan for future offerings of the course (i.e., locations, themes, and instructors). A key component of organizing such an intensive study abroad experience is to have a rigorous daily schedule (preparatory lectures from faculty; field trips; technical and cultural presentations or tours delivered by representatives from industry, government, and academia; and planned activities for evenings to help students get the most out of their experiences in the specific locations). With two or three faculty instructors per course, each instructor is responsible for approximately one week of programming (scheduling, travel, accommodations, events, etc.)

To achieve the educational objectives, a series of lectures, site visits and guest speakers are arranged based upon the course themes. For the most recent version of the course, the activities are shown in Table 1. Notice that the itinerary shows a mixture of technical lectures and field trips dealing with sustainability and energy interwoven with lectures and field trips dealing with the social and historical context of the host country.

**Table 1. Itinerary 2009, Sweden and Norway**

Day, Date	Activity
Saturday, May 16	Bus departs University at 9:00 a.m. Arrive at airport
Sunday, May 17	Arrive in Stockholm, Sweden; Cab transport to hostel; Briefing to review safety and security; Explore Stockholm
Monday, May 18	Introductory Lectures (Morning) <i>1. History and Culture of the Scandinavian Peoples</i> <i>2. Economic and Political Systems of Sweden</i> Free Time Seminars (Afternoon) <i>1. Energy Policy in Sweden</i> <i>2. Transportation Policy in Sweden</i> Welcome Dinner
Tuesday, May 19	Skanska: Global contracting and Green Building Design and Construction Waste Management field trip to Högbytorp (Ragnsells)
Wednesday, May 20	Vattenfall presentations Nuclear power plant tour
Thursday, May 21	Class Discussion; Boat tour of Stockholm Harbor; Vasa Museum: guided tour & film Museums
Friday, May 22	The Royal Castle guided tour; US Embassy <i>1. Role of US Embassies</i> <i>2. Swedish Alternative Energy and Sustainability</i> <i>3. Economic and Social Policies in Sweden</i>
Saturday, May 23	Train to Gothenburg, Sweden; Walking tour
Sunday, May 24	Exploring Gothenburg (free time)
Monday, May 25	Chalmers University <i>1. Internationalization</i> <i>2. Sustainable Development</i> <i>3. Campus and Laboratory tours</i>
Tuesday, May 26	Field Trip to Volvo Group Headquarters, Gothenburg <i>1. Efficient transport systems</i> <i>2. Safety &amp; Environment</i> Volvo truck factory tour in Tuve
Wednesday, May 27	Train to Oslo; Free time in Oslo; Train to Trondheim
Thursday, May 28	Field trip to TEV Energivek; Trondheim Energi – Statkraft Field trip to Leirfossen Hydroelectric Energy Plant Norwegian University of Science and Technology (NTNU) <i>1. Carbon Sequestration</i> <i>2. Renewable Energy Center</i> <i>3. Master of Science in Sustainable Energy</i>
Friday, May 29	Field trip to TEV-Statkraft, BioMass Incinerator for Central Heating SINTEF's Oil Spill Research Center Field trip Statoil's Rotvoll Energy Center <i>1. Offshore and onshore Wind Energy Projects</i> <i>2. Green Technologies</i> <i>3. Tours of research facilities and laboratories</i> Optional hike (3 miles) back to hostel

Saturday, May 30	NTNU <i>1. Hazards and Joys of working and studying abroad</i> Tour of Trondheim Cathedral; Free time in Trondheim Evening Picnic at NTNU Professor's home
Sunday, May 31	Travel by Boat to Bergen; Scenic cruise of Norway's fjords
Monday, June 1	Travel by Hurtigruten Boat to Bergen; Class discussion on ship regarding journals Arrive in Bergen
Tuesday, June 2	Free time in Bergen; Travel by train to Oslo
Wednesday, June 3	US Embassy in Oslo <i>1. Welcome from the Deputy Chief of Mission</i> <i>2. Economic and energy policy (given by professor of <u>the Norwegian School of Management</u>)</i> <i>3. "Life as a Foreign Service Officer"</i> <i>4. "Cultural differences between the U.S. and Norway"</i> Statkraft <i>1. Osmotic Power</i> <i>2. Marine Energy</i> <i>3. Energy Efficiency in Industry</i> <i>4. Innovation processes</i> <i>5. Wind Power</i>
Thursday, June 4	Norwegian Public Roads Administration <i>1. Introduction to Norwegian Public Roads</i> <i>2. Bjørvika submerged</i> <i>3. National tourist routes program</i> <i>4. Safety Campaigns</i> <i>5. Sustainable building in Oslo area</i> <i>6. Public Construction and Property Management</i> <i>7. Statsbygg: New Opera House, Pilestredet Park, Fornebu Airport</i> Bus trip to places of interest
Friday, June 5	Skanska Norway Headquarters <i>1. Presentations regarding Tjuvholmen</i> <i>2. Visit to the Tjuvholmen project</i> Norwegian Folk Museum and Viking Ship Museum Free time Group Dinner
Saturday, June 6	Depart Oslo, Norway

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. A journal is an excellent way to induce students to observe closely, to think about what they are encountering, to draw insightful conclusions, to remember in detail what has been experienced, and to facilitate reflection later. 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.

Journaling was an important part of the course for both student learning and assessment of the students. For 2009 the instructions for the students were presented in Table 2.

**Table 2. Journal Instructions Provided to Students**

<p><b>Detailed Requirements for Journals</b></p> <p><b>Frequency:</b> Six entries weekly, one each for Monday through Friday and one for the weekend.</p> <p><b>Format:</b> Daily entries should average about 2 sides of a page of a journal notebook, although many will be longer, and some will be shorter.</p> <p><b>Content:</b> What you put in your journal is a conversation with yourself. It is notes about what you see, what you have encountered, and what you think it may mean. It should include small experiences as well as large ones. It should include not only items that are directly tied to the course, but also items that may be tangential. It should include many experiences outside what is discussed in the course: if you visit a restaurant, see an episode on the street, walk in a park, are puzzled by the wording of a sign, see something you wouldn't expect to see in your U.S. life, your journal is where you take note of it. <i>A journal is not a diary.</i> While, like a diary, it may contain comments about your personal feelings, mostly your journal will be focused on your process of encountering and coming to understand Norwegian and Swedish society and the role of energy and sustainability in their societies. It trains you to be observant. It records what you observed and what you think it means.</p> <p><b>Submittal and Review:</b> Journals will be collected and reviewed by your instructors as shown on the itinerary. Suggestions for improvement will be made as needed. Journals will be submitted along with the final term paper before the end of summer school and assessed as part of the faculty's assessment of the student's work for the course.</p>
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In addition, the instructors facilitate post-course reflection for the students by providing daily journal “prompts” in the form of a question or thematic statement. By having to reflect on the journal prompt for that day, students produce a fair amount of the material that will be incorporated into their final term papers. An example, from the 2008 course to Switzerland, Germany, and France, “How do attitudes about conservation differ in the United States and Switzerland?”, led to the response below. Note that this represents only one student’s impression, in some part based on the norm in the hostels in which we stayed as well as a conversation with a local while riding on a train, and is not meant to be taken as fact. However, the statement is evidence that students noticed more when asked to comment on specific topics.

The Europeans are much more concerned with minimizing energy use. Public transportation is readily available in all cities and even in most small towns. There are only...low water flow toilets and lights that turn off automatically in hallways and large rooms. In the United States, people are less aware and educated on the financial and environmental cost of wasting energy and therefore are less conscious about letting water run, leaving lights on, or driving a car two blocks to the store. Americans love air conditioning, while in Europe it is considered a waste of energy...

Other examples of journal prompts include, for the same 2008 trip, on the third day in Zurich “What have you seen in Switzerland that you would like the U.S. to adopt? What would you like the Swiss to adopt that we have in the U.S.?” and, from the day spent in Stuttgart, Germany (home to Mercedes and Porsche), after a visit to the Mercedes museum, “How has the automobile influenced energy policy worldwide?” Both of these prompts led to copious student journaling and reflection that was well-represented in their final term papers.

### **Administrative and Logistical Issues**

Engineering in a Global and Societal Context was designed so it could be offered by any faculty member in the University’s College of Engineering and in any location. As noted, the course has been offered in the UK (2004 and 2006), Argentina (2007), Switzerland, Germany and France (2008), and Norway and Sweden (2009). The cost of the program has been set at the tuition cost

for one 4 credit-hour course during the regular academic year. The program fee covered tuition, airfare, lodging, transport and all scheduled activities. Students needed additional funds for meals and non-program travel. The program is cost-neutral to the university.

Faculty are remunerated for teaching the course based upon the scale for teaching summer school courses but adjusted for the special nature of the course. The adjustment includes an additional 50% consistent with courses that have laboratories and therefore additional contact hours. Another 50% is added because the course is taught abroad. Faculty expenses including all travel, fees, meals and lodging are all reimbursed.

While there are a number ways to provide engineering students an opportunity to study abroad, short-term programs such as this are an essential part of a variety of options made available to students. Consistent with identified Best Practices<sup>5</sup> for study abroad this program: 1) is part of a suite of opportunities, 2) has a clear set of outcomes, 3) is proactive in student recruiting, 4) rewards the faculty for participating, and 5) involves several faculty. Plans for each country/culture offering of the course are developed building upon the experiences of prior instructors but crafted to account for the unique aspects of the host country.

### **Assessment of the Students**

Given the “immersion” nature of this three-week program, conventional means of student assessment through 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, a recording of factual information coupled with synthesis and interpretation in the context of host country 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 programs’ 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 meeting the objective. In addition, students had to describe how the course is likely to impact their future and their professional careers.

### **Assessment of the Course**

In addition to the assessment of the students by the faculty, an assessment of the course by the students was undertaken. The exact assessment tools used varied from year to year given the numerous faculty involved and the varied venues for the course. In total, three different types of course assessments were conducted. One form of assessment consisted of a student self-assessment rating their achievement in meeting the ten individual course outcomes. At a more detailed level, individual activities such as speakers, field trips, and tours were assessed by the students as to what extent the activity contributed to their meeting the learning objectives of the course. During 2009, generic course assessment questions were asked as well.



Regardless of the type of assessment, a 5-point scale was chosen with 5 being the highest and 1 being the lowest. Representative results from each type of survey are discussed in the following paragraphs.

For the student self-assessment rating their achievement in meeting the ten individual course outcomes (such as those presented above) students were asked: “Using a rating scale of 1 to 5, with 5 being the highest, please rate your achievement of the following objectives:...” The following words were assigned to the rating numbers:

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

The learning objectives were restated in the active case for this survey. The results are shown on Table 3 for the UK (2004) and Argentina (2007) programs as examples. All of the students (100%) agreed both of the programs were at least moderately successful in helping them meet the learning objectives and on average felt the program was very good to excellent (4.0 or better average) 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.

**Table 3. Student Assessment of Outcome Achievement**

Outcome	UK (2004)	Argentina (2007)
1	4.17	4.00
2	4.11	4.50
3	4.56	4.40
4	4.56	4.50
5	4.06	4.60
6	4.67	NA
7	4.50	3.90
8	4.39	4.00
9	4.17	NA
10	4.50	NA

The second type of assessment, in which students ranked each and every activity, is too detailed for this paper but useful to faculty should it be decided to repeat the course in a given venue (e.g. UK in 2004 and again in 2006).

**Table 4. Course evaluations for 2009 program (Sweden and Norway)**

Evaluation Statement	Score (1-5)
The course achieved the learning objectives established by the instructors.	4.64
The course achieved my own personal learning objectives.	4.73
I would recommend this course (i.e., spending three weeks studying engineering in a global context, regardless of locations).	4.86
I would recommend future ENGR 290 courses be held in Sweden and Norway.	4.73
The course was helpful in developing new knowledge and perspectives.	4.86
The scheduled lectures were a valuable part of the course.	4.64
The journaling assignment was a valuable part of the course.	4.05

In 2009, the third type of generic assessment was conducted as shown in Table 4. For the seven questions asked regarding the value of the course, most students agreed strongly with the statements (with the exception of the value of journaling). Similarly, for all aspects of the course except journaling, the median score was between 4.5 and 5.0. Even though journaling was the lowest scored aspect of the course on average students agreed it was a valuable aspect of the course. Note that the evolving nature of the course and the personal preferences of individual instructors resulted in assessment data that varied in form and content for these first five offerings of the course. Efforts are underway to develop some standardization to track long term variations.

### **Summary**

Engineering in a Global and Societal Context was offered to engineering students a total of five times to date. The course has been offered in the UK (2004 and 2006), Argentina (2007), Switzerland, Germany and France (2008); and Norway and Sweden (2009). The various offerings of the course have been evaluated using surveys of several types but, regardless of the nature of the survey or the venue of the course, the assessments demonstrate the extraordinary success of the course. The authors believe and the assessment data show that this course provides a learning environment "...in which students develop intellectual maturity, personal conviction and strength of character, informed by a deep understanding of different cultures and diverse perspectives" consistent with our university's mission.

### **Acknowledgements**

The authors would like to thank co-instructors in ENGR 290 Engineering in a Global and Societal Context. From Bucknell University, Professor Michael Toole co-led the course in 2007 in Argentina and Professor Peter Stryker co-led the course in Norway and Sweden in 2009. From Lafayette College, Professor Polly Piergiovanni co-led the course in Norway and Sweden in 2009.

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