Exploring the Human Dimension of Engineering Through the Built Environment

Dr. Jeffrey C. Evans P.E., Bucknell University

Jeffrey C. Evans, Ph.D., P.E., F. ASCE is Professor of Civil and Environmental Engineering at Bucknell University in Lewisburg, PA.
Exploring the Human Dimension of Engineering through the Built Environment

Abstract

Humanities and social sciences along with mathematics and natural sciences are at the core of liberal learning. Further, the proposed ABET student outcome five requires students to have: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

A new course has been developed (and is a work in progress at the time of this paper) for both engineering and non-engineering students studying abroad entitled “London’s Built Environment.” The course was designed primarily to foster students’ understanding of the relationship between the built environment that surrounds them, the natural environment in which it is built and the human and social environment for which it was designed and built. Since the first offering of the course is in London, the course is entitled “London’s Built Environment.” This course explores the relationships between Londoners, and more broadly Britons, and their built environment. The course included classroom lectures, guest lecturers and, most importantly, field trips. Lecture topics included a history of the development of the British Isles (e.g. Stone age through the present), London geology and natural subsurface environment and their role in shaping the historic and modern city; the role of clean water and waste management from ancient through modern times including the historic development of modern indoor plumbing and the unintended consequences thereof; the role of transportation infrastructure in urban development; and sustainable urban development. Lectures were also delivered in the field during walking tours led either by the course instructor or by those with local expertise. Site visits included walking tours with specific themes, thematic museums such as the Museum of London and the London Mithrium, and site visits to Greenwich and the Tower of London. Also included were trips outside of London to the UK’s best examples of the built environment including Stonehenge, Salisbury, York, Bath and Cambridge. The built environment was explored generally in a chronological manner beginning with Neolithic settlements capitalizing on the natural environment and progressing through various ages with particular emphasis on Roman, Medieval, Elizabethan, Georgian, Victorian, and modern time periods.

Throughout the course, a recurring theme was for the students to consider how and why the built environment is as it is and to compare and contrast that with their own experiences in the US and elsewhere. The course was designed as an active learning course with discussion, field trips and student presentations. In addition to ABET student outcome five above, two other goals of the course were:

- prepare students for meaningful involvement with a rapidly changing world characterized by diverse individual perspectives, globalization and multi-cultural interactions, and scientific/technological innovation; and
- provide students with opportunities to build and enhance their abilities to understand the social and natural worlds around them; to analyze, evaluate, and
integrate the information available to them; and to synthesize and communicate thought effectively.

While the paper describes the course as it is being delivered in London and more broadly the United Kingdom, it is believed that this course can be adapted to any environment in which the course is delivered, whether that be in the US or abroad. Note that as this final paper is submitted, it is at the end of the first half of the course so this is a work in progress paper.

Introduction

Educators recognize the role of humanities and social sciences in engineering educations but students may not always see the connection (Evans et al 2007). The value of study abroad has also been long recognized by engineering educators. In this paper, a new course entitled “London’s Built Environment” is described. The course was developed to foster students’ understanding of the relationship between the built environment that surrounds them, the natural environment in which it is built and the human and social environment for which it was designed. Engineering education, by necessity, stresses the underlying mathematics and science in the solution of engineering problems. Students may not fully appreciate the human and social constraints of their engineering problems and resulting solutions may fail to adequately incorporate these constraints. The built environment is the result of past engineering solutions developed under a certain set of social, economic, political and human constraints. Examination of the built environment in light of these human and social constraints provides an excellent way for students to learn how the social, economic, political and human conditions of the time led to the built environment they are witnessing.

The theoretical underpinnings for this course are well articulated (Crowe 1995). In his book, Nature and the Idea of a Man-made World, Norman Crowe draws on lessons learned from artifacts of the built environment of the past (buildings, works of civil engineering, etc.) to explore the ideas of harmony between ourselves, nature and what we make. Crowe examines the connections between the natural and the manmade world. Similarly, a series of essays (ed. King 2003) asks two forms of the same question: What can we learn about a society by examining its buildings and physical environment and what can we learn about buildings and environments by examining the society in which they exist? In this work, it is argued that the entire built environment is essentially a social and cultural product. The built environment results from the need to accommodate economic, social, political, religious and cultural factors. It is around this premise that this course is built.

Exactly how is this done? The course is organized around the examination of artifacts from the built environment. The course is presented in a somewhat chronological manner. Artifacts of the built environment are not only examined chronologically but also examined across a spectrum of categories of purpose. The principle categories were defense, religion, infrastructure, government, and daily life. These categories and
examples of some of the artifacts examined in this course for each category are shown on Table 1.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Representative Artifacts of the Built Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defense</td>
<td>Roman Walls, Iron Age Hill Forts, Norman and Tudor Castles</td>
</tr>
<tr>
<td>Religion</td>
<td>Stonehenge, Avebury stone circle, Temple of Mithras, Cathedrals (e.g. Salisbury, St. Paul’s), Minsters (e.g. Westminster)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Roads, bridges, water supply, waste management</td>
</tr>
<tr>
<td>Daily life</td>
<td>Homes, recreation (baths), villas</td>
</tr>
</tbody>
</table>

Some discussion of context, planning, organization and logistics is warranted although not the principle purpose of this paper. This course was developed by a single faculty member (the author). Academic content and expertise is added to the course through the participation of colleagues (e.g. Dr. Nicholas James, Professor of Urban Anthropology at Cambridge during our site visit to Cambridge and Dr. Andrew Heath, Professor of Civil Engineering at the University of Bath) and choice of local (paid) guides. This course is the core, or common course for our Spring 2018 Bucknell-in-London program and provides a common experience for all fourteen enrolled students. Recruiting efforts on the home campus were made during the previous year although one never knows the final number until the end of the recruiting period and some students tend to procrastinate these decisions. In addition to this core course for all students, four other 4-credit courses were on offer (History of London, Political Economy of the European Union, Art and Culture, and Theatre) of which students choose three of the four. Student housing was arranged through Acorn Estate Agents, classroom and office space was rented from Florida State University at their London Study Centre, and assistance with travel plans was provided by Academic Solutions, Inc.

Course Description and Learning Objectives

The course description is as follows:

This course will explore the relationships between Londoners and their built environment. By interweaving the human condition and social structure throughout the history of London with the resulting built environment, the course will provide students with opportunities to build and enhance their abilities to understand the social and natural worlds; to analyze, evaluate, and integrate the information available; and to synthesize and communicate thought effectively. The course will include classroom lectures, guest lecturers and field trips. Lecture topics would include the London geology and natural subsurface conditions, migrations and societal developments from the stone age through modern times and their role in shaping the historic and modern city. Technology topics interwoven with human and social structure development include the role of clean water, waste management from ancient through modern times including the
unintended consequences thereof; transportation infrastructure in urban
development; and sustainable urban development.

The overarching goals of the course are to:

- Prepare students for meaningful involvement with a rapidly changing world characterized by diverse individual perspectives, globalization and multi-cultural interactions, and scientific/technological innovation; and
- Provide students with opportunities to build and enhance their abilities to understand the social and natural worlds around them; to analyze, evaluate, and integrate the information available to them; and to synthesize and communicate thought effectively.

As noted, it is envisioned that this course could be taught in the US, using artifacts of the built environment in the US as a basis for the course content. However, if taught abroad as this version of the course, additional goals relating to the study abroad aspect of the course are appropriate.

Another goal of this course was to enhance students’ ability to analyze, evaluate, and synthesize complex interrelationships between humans and the natural world. Knowledge of the physical, cultural, or social connections between humans and the natural world is essential to understanding the built environment.

With all of the above objectives in mind, student outcomes were formulated. By the end of the course students are expected to:

- Be better prepared for meaningful involvement with a rapidly changing world characterized by diverse individual perspectives, globalization and multi-cultural interactions, and scientific/technological innovation.
- Have taken advantage of opportunities to build and enhance abilities to understand the social and natural worlds around them; to analyze, evaluate, and integrate the information available; and to synthesize and communicate thought effectively.
- Have enhanced their intellectual and academic development by exposure to knowledge, concepts, and/or experiences that reflect different cultural frames of reference.
- Have improved their personal growth, including the development of independence, flexibility and the ability to interact in unfamiliar situations.
- Have developed skills for relating to culturally different others.
- Have enhanced their awareness and understanding of their own culture by utilizing opportunities to compare and contrast host country customs, values, and traditions with their own.
- Upon their return, to contribute to internationalization efforts at Bucknell University by enriching classroom and campus discourse with new cultural perspectives and by seeking out opportunities to impact campus with their new experiences.
- Analyze, evaluate, and synthesize complex interrelationships between humans, the natural world and the built environment.
• Better understand the fundamental physical interconnections between humans, other species and the environment.
• Explain how some natural systems function and how human actions affect them.
• Distinguish between human impacts and natural changes.

Course Syllabus

The week by week course syllabus is presented as an attachment to this paper. Notice every other week involves a longer field visit outside of London. For each site visit, there were detailed additional planning documents and/or assignments. For example, during the first week (when students were largely still jet-lagged and finding their way around), students did a self-guided tour through the Museum of London. Prior to their departure to the museum, they were given the following assignment: In your journal, choose an artifact from each area, describe the artifact, and use it to describe what the artifact teaches us about life at the time of the artifact.

For many of the site visits, local guides and speakers with particular expertise were arranged to speak with our students. For example, during our visit to Bath, our students went to the University of Bath and a local engineering professor explained the geologic origins of the warm springs and the development of the built environment associated with the Roman baths. Each local host was also informed of the course description and learning goals for the course so their field instruction could be tailored appropriately.

Student Learning Strategies

Student learning was first and foremost through field site visits with informal and formal instruction “in the field” by the course faculty member as well as guest instructors and guides. Active participation was required of all students.

Classroom time was used for two purposes: 1) provide an overview/context for field visits and 2) for discussion and exploration of concepts and observations from the field experience. During lectures/seminars students are invited to comment on, debate and discuss any aspects of the field trips.

Another aspect of student learning was the requirement for journaling throughout the semester. Journals are a tool to increase students’ self-awareness, perception, and memory retention. 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 they have experienced. For a field-based course such as this one, if a student does not keep a journal, they will generally not rise above the level of a tourist, gathering vignettes and impressions filtered through the distortions of their home culture. A journal is not a diary. While, like a diary, it may contain comments about students’ personal feelings, mostly the journal is focused on the
students process of encountering and coming to understand British society and London in particular.

Student learning was also enhanced through the required reading of three required texts. Steven Johnson’s *Where Good Ideas Come From* (Johnson 2010) provides the students with a global understanding of the key aspects of society and human interactions that foster creativity and innovation. Students also read *Longitude: The True Story of the Lone Genius Who Solved the Greatest Scientific Problem of the Time* (Sobel 1995). This reading is coupled with a site visit to the Royal Observatory and the National Maritime Museum at Greenwich. Finally, students read *The Ghost Map: The Story of London’s Most Terrifying Epidemic--And How It Changed Science, Cities, and the Modern World* (Johnson 2008). This reading is coupled with an exploration of the human condition in Victorian England and a walking tour of Soho. Additional recommended reading was *London: A Social History* (Porter 1995).

Another method of student learning was through student preparation of term papers and presentations. There were two papers and presentations for this course during the semester. For each paper, students were to discuss an artifact from the built environment of their choosing and discuss the chosen artifact in terms of its cultural, economic, societal, and political significance. Papers were a minimum of 1500 words to a maximum of 2500 words plus figures and references. Draft papers were due for peer review one week before the due date on the syllabus. Each student served as a peer reviewer for another paper and completed the peer review within three days of receiving the paper for peer review. All drafts, reviews and final papers were submitted electronically as MS Word documents to the instructor for assessment. Class presentations were between 8 and 10 minutes in length and were based upon the paper.

The final paper/exam is short answer/essay written in response to a series of prompts. The prompts are given out the last day of class and the paper was due one week later. The prompts were based upon the coupling of expected students’ outcomes with the students’ experiences throughout the semester. For example, using the first student outcome, the short answer prompt is as follows:

*Using an experience from this course, show how you are better prepared for meaningful involvement with a rapidly changing world characterized by diverse individual perspectives, globalization and multi-cultural interactions, and scientific/technological innovation.*

**Methods of Assessing Students’ Performance in the Course**

Students were assessed on the bases of their performance in five different aspects of the courses as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class/visit participation/discussion</td>
<td>20%</td>
</tr>
<tr>
<td>Presentation and Paper 1</td>
<td>20%</td>
</tr>
<tr>
<td>Presentation and Paper 2</td>
<td>20%</td>
</tr>
<tr>
<td>Journal</td>
<td>20%</td>
</tr>
<tr>
<td>Final paper</td>
<td>20%</td>
</tr>
</tbody>
</table>
Assessment of the Course and Student Learning

This paper describes a work in progress. As of the date of this draft, the entire course has been planned and about \( \frac{1}{2} \) of the course has been delivered. As of now, completed direct assessment includes two reviews of their journals, grading of the first term paper and presentation, and class participation.

From the two journal reviews, 100\% of the students were found to be meeting the journaling expectations for recording their observations. However, only about 85\% of the students have grasped the concept of reflection and analysis of the observations. Additional instruction has been provided in this area and a third round of direct assessment will be completed and the results included in this paper.

From the student work on term papers and presentation, it is clear the students have endeavored to make connections between the human, social, political, and economic environment and the built environment artifact for which they chose to write. As expected, some students were more insightful than others but all of the students have now modified their critical thinking processes to think more broadly about the built environment that surrounds them.

Finally, class participation and engagement varies. Some students continuously ask questions and think critically about concepts presented while others are more passive receptors. Students have a tendency to be distracted by texts and other smart phone interruptions despite efforts to minimize/eliminate these distractions. On the other hand, certain artifacts profoundly impact certain students so collectively, the student participation is having the desired effect.

Shown on Table 2 is the course assessment instrument to be used at the end of the semester. These results will provide an indirect assessment of student learning that can be coupled with the direct assessment tools described.

Finally, the prompts provided for the final exam essay questions will provide direct assessment of each student’s learning progress on each of the learning goals.

<table>
<thead>
<tr>
<th>Question</th>
<th>Possible Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How much did you learn from this course?</td>
<td>A great deal, a lot, a moderate amount, a little, nothing</td>
</tr>
<tr>
<td>2. Overall, how would you describe the quality of the instruction in this class?</td>
<td>Very Effective, Effective, Ineffective, Very Ineffective</td>
</tr>
<tr>
<td>3. How well did you progress on this learning goal in this course?</td>
<td>Extremely well, very well, moderately well, slightly well, not well at all</td>
</tr>
<tr>
<td>Have taken advantage of opportunities to build and enhance abilities to understand the social and natural worlds around you: to analyze, evaluate, and integrate the information available; and to synthesize and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>How well did you progress on this learning goal in this course?</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Have enhanced your awareness and understanding of their own culture by utilizing opportunities to compare and contrast host country customs, values, and traditions with their own.</td>
</tr>
<tr>
<td>5</td>
<td>Have enhanced their intellectual and academic development by exposure to knowledge, concepts, and/or experiences that reflect different cultural frames of reference.</td>
</tr>
<tr>
<td>6</td>
<td>Tracing the fundamental physical interconnections between humans, other species and the environment.</td>
</tr>
<tr>
<td>7</td>
<td>Better understand the fundamental physical interconnections between humans, other species and the environment.</td>
</tr>
<tr>
<td>8</td>
<td>What elements of the course and instruction did you find most helpful for your learning in this course. Briefly explain for no more than three elements.</td>
</tr>
</tbody>
</table>

**Summary and Conclusions**

A new course has been developed, *London’s Built Environment*, that aims to encourage students to consider the human condition and social, political and economic structures in place at the time any given artifact of the built environment was made. Because this course is part of an international education experience delivered in the United Kingdom, students are able to see first-hand such artifacts as Stonehenge, the Roman Baths, Norman Castles, Tudor structures as well as many others. Site visits organized around questions of the human condition and social systems in place at the time of artifact construction, leads students to contemplate the observed structure in a much different manner than that of the usual tourist.

Since this course is being taught in the UK, artifacts from the UK were chosen for the syllabus. For international courses taught elsewhere, it is easily possible to keep the core approach unique to this course and adopt artifacts from the host country to deliver the course elsewhere. It is believed that the same principles could be adopted for a course in the US.
References


Attachment

TOPICS: UNIV287 London’s Built Environment

Week 1: Thursday, 18 January: Introduction – in class. Then we will go to the Museum of London for the entire history of the people of London since the beginning of history.

Week 2: Thursday, 25 January: Neolithic and Iron Age Britain – in class. Friday the 26th we will have a field trip to the following artifacts: Old Sarum, Salisbury Cathedral, Stonehenge, Avebury, Silbury Hill

Week 3: Thursday, 1 February: Roman Britain -in Class
Visit Roman Temple of Mithras

Week 4: Thursday and Friday, 8 & 9 February: Vikings
Field trip to York with York Minster including undercroft, Jorvic Center, city walking tour with wall walk and National Rail Museum

Week 5: Thursday 15 February: In class discussions and presentations:
Paper no. 1 due
Wednesday 14 February: Tower of London

Week 6 Thursday and Friday 22 & 23 February: Field trip to Bath Thur/Fri
Artifacts include Roman Baths and Royal Crescent along with Bath Walking Tour, University of Bath for lecture on geologic influences

Week 7 Thursday 1 March: Cambridge

Week 8: Thursday 8 March: Eurostar to Brussels, Utrecht, and Amsterdam

Week 9: -NO CLASS – SPRING BREAK

Week 10: Thursday 22 March: Environmental artifacts in class
Walking tour: Soho and Broad Street; the Embankment

Week 11: Thursday 29 March: Environmental Artifacts;
Kew Pumping Station; Kew Gardens
Friday 30 March: Hampton Court Palace

Week 12: Thursday 5 April: In class discussion:
Excursion to London Canal Museum, Canal boat, walk on the towpath

Week 13: Thursday 12 April: Transportation Artifacts: Greenwich
Wednesday 11 April: Churchill War Rooms

Week 14: Thursday 19 April: Tour of the Globe Theatre
In class discussions and presentations; Paper No. 2 due

Week 15: Thursday 26 April: Last Class
Field Excursion in London: Modern London Artifacts including London Eye, Thames River dinner tour

Week 16: 3 May: - Journals and Final Paper due 18:00 GMT