

Overseas Immersion Program: Solid-State Lighting in Two Weeks

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Abstract

A two-week course on solid state lighting was developed as part of a summer overseas immersion programme (OIP) offered at the University of Glasgow to students from the Glasgow College, UESTC (formerly known as the UoG-UESTC Joint School) and the University of Electronic Science and Technology. The aim of the OIP is to provide students with an international academic and cultural experience while building stronger ties to the University of Glasgow and becoming acquainted with Scotland. The cohort of students was composed of 27 Year 1 students and 5 Year 2 students, all of whom were Chinese nationals for whom English was a second language. The process of designing the OIP will be described, tying the decisions on topics covered in lectures and labs, the sites of tours, and the course schedule with the aims of the OIP. Assessment of the OIP from the perspective of the staff and the students will be discussed.

Background

In September 2013, the University of Glasgow (UoG) and the University of Electronic Science and Technology (UESTC) opened the doors of the Glasgow College, UESTC (formerly known as the UoG-UESTC Joint School) and enrolled the first cohort of undergraduate students in a joint educational programme (JEP) on Electronic and Electrical Engineering (EEE). All science, technology, engineering, and mathematics courses have been taught in English with half of these courses taught by UoG staff and the other half taught by staff from UESTC. In 2014, UESTC set as a goal that all of the students in the Glasgow College, UESTC (GCU) and at least 20% of the UESTC students should have an international experience before graduating with a bachelor's degree. To support this, UoG offered a one-week cultural experience during the summer of 2014 to a group of 17 GCU students. At the request of UESTC staff, the summer offering was expanded to two week summer overseas immersion programme (OIP) and revised to include an engineering educational component with academic credit. In accordance to the policy of the School of Engineering, the engineering educational component had to be an official course with a minimum of 10 credits. The topic chosen was solid-state lighting, which dove-tailed with the internationally recognized expertise in optoelectronics at the University of Glasgow.

Course Design

A group of academic and administrative staff met several times during the 2014-2015 academic year to plan the course that would be offered during the summer 2015 OIP. The deadline for new course approvals was the middle of Semester 2 and there were concerns that it would be difficult to justify awarding 10 credits (100 hours of learning of which about a quarter are contact hours for lectures, laboratory exercises, other structured learning activities, and assessment of student learning) for a course that was only two-weeks in length. Thus, the group came to a rapid agreement that most, if not all, of the cultural and industrial visits had to contribute to the course aims in order to achieve the expected amount of student learning in a 10 credit course. Thus, the course objectives had to be outlined before the sites for the trips could be identified.

Aims of the OIP

The academic members of the committee developed the following engineering-related educational aims of the 10 credit course, which were to:

- introduce the phenomena responsible for incandescent, fluorescent, and solid state lights,
- discuss issues in product design, explain the engineering concepts and associated technologies that are applied in the design of solid state lighting in lectures and hands-on experiments,
- demonstrate applications of solid state lighting during industrial and cultural visits, and
- integrate the concepts into practice via a brief design activity.

Table I: Topics of Solid-State Lighting Lectures and Hands-on Activities

Lecture Topics	Hands-On Activities
Introduction to Solid State Lighting	
Visible Spectrum and Eye Response	Experiment 2: Humans vs. Machines Experiment 3: Properties of Red, Green, and Blue LEDs
History of Lighting	
Product Design	
What is an Led?	Experiment 1: Properties of Narrow and Wide Angle LEDs
Effect of Temperature on LEDs	
Power Electronics	
Efficiency and Cost of Lighting	
Applications of Solid State Lighting	Design Project: Wearable LEDs

The additional aims of the OIP, which were not formalized in the course specification, were to introduce students to Scotland and its history through a series of cultural tours, to support the development of oral English skills and technical English vocabulary, and to build student awareness of the academic life of the undergraduate engineering students and post-graduate research opportunities at the University of Glasgow. The informal aims would help guide how the lectures and laboratories were conducted, the selection of guest lecturers and chaperones for the visits, and the location of some of the lectures.

The topics that would be covered in the lectures were identified with several companion hands-on activities, listed in Table I. The technical depth of the lectures and the selection of the hands-on activities were limited by a number of constraints; the most significant was the uncertainty about the students' educational background. Much of the Year 1 curriculum at the Glasgow College, UESTC was devoted to science and mathematics; the only engineering and technology instruction was C programming and an introduction to microprocessors. The engineering content in Year 2 was fairly high and included a course with a challenging mixed signal design project. It was clear that students from both Year 1 and Year 2 of the Glasgow College, UESTC would be eligible to participate in the summer OIP. However, it was not

known how many students and from which years would select this particular OIP as this was one of four OIPs organized by the Glasgow College, UESTC. Another unknown was whether any UESTC students would attend the OIP – let alone information on their year(s) of study in which degree programme(s). While the majority of UESTC students were enrolled in engineering, the students could possibly have been non-engineering majors. Thus, it was decided to tailor the course materials for a student who has completed two semesters of calculus and one semester of physics, has been exposed to programming and has had experience using a basic microcontroller (i.e., our Year 1 students). This meant that it was assumed that students had little to no knowledge of electromagnetics and the principles upon which electronic devices operate and limited experience with electronic design.

Educational and Cultural Tours

At this point, the focus of the course development shifted and the discussion turned to the industrial and cultural tours. As mentioned, the intention was to integrate these visits as much as possible with the engineering educational aims of the course while also addressing the informal aims. Six tours were selected – the Kelpies and the Falkirk Wheel, Stirling Castle, the SSE Hydro, the Intelligent Lighting Centre at the University of Strathclyde, Black Light, and STV.

The Kelpies are two 30 meter-high steel sculptures of horse heads that are lit within by several large multi-colour LEDs lamps¹. These lamps can be programmed to wash the sculptures with a solid colour or multi-colour swaths, which can, of course, be changed with time^{2,3}. The Scottish Canals, the engineering body that oversees the operation of the five major canals in Scotland, maintains the Kelpies, which are located along a new extension to the Forth and Clyde Canal. This extension is minutes away from the Falkirk Wheel⁴, the world's only rotating boat lift, which transports boats between the Forth and Clyde Canal and the Union Canal. A request was made to Scottish Canal for a special tour of the Kelpies and the Falkirk Wheel by one of the engineering staff members who could discuss the design and operation of the solid-state lighting of the Kelpies.

A self-guided tour of Stirling Castle, which dates back to at least 1100 and a royal residence for several centuries⁵, was planned for the same day as the tours of the Kelpies and Falkirk Wheel, given their close proximity. Stirling Castle was chosen as it is one of the most visited sites managed by Historic Scotland. Thus, a tour of the Stirling Castle addressed the cultural portion of the OIP.

The SSE Hydro is a large entertainment arena in Glasgow City Centre. Its facade is composed of ethylene tetrafluorethylene, which is translucent. The facade acts as a diffuser to enable a continuous colour of light to shine through the material, allowing the colour of the facade to change as the thousands of LED lamps are switched on and off^{6,7}. It also allows light into the arena during daylight hours, reducing the reliance on interior lighting. A request was submitted to SSE Hydro for a special tour hosted by one of their lighting engineers.

The Intelligent Lighting Centre is a research consortium that is housed at the University of Strathclyde in Glasgow City Centre. The University of Glasgow is a member of the consortium and several of the School of Engineering staff are involved in projects funded through this research centre. Arrangements were made to tour the research centre on the same afternoon as the tour of the SSE Hydro, again because of their close proximity. Because of travel commitments of the Intelligent Lighting Centre's staff and a desire on the part of the academics involved in the OIP to introduce students to some of the concepts in solid-state

lighting before visiting the research centre, scheduling of this tour drove some of the decisions on the timing of lectures and labs and the other tours. It was decided that this tour would be the Monday of the second week of the OIP.

During the month of August, the city of Edinburgh is host to the Edinburgh International Festival and the Festival Fringe, a month-long arts festival with theatrical events scheduled all over the city in theatres, assembly halls, and in the street. Black Light is a theatrical and architectural lighting company. The company had been involved in the lighting design of the SSE Hydro and was currently responsible for the lighting of several of the theatrical events during the Fringe. The company was asked to give the students a tour through its location in Edinburgh where the engineering staff were in the midst of assembling stage lighting, which would then be transported to the location of the event. The lighting fixtures were LED lamps. The engineering staff agreed to explain how the lamps were selected and wired together.

Also in Edinburgh are the studios for the television company STV. Much of the lighting used in the studio was LED based. A tour was arranged with one of the broadcast engineers who could discuss aspects of lighting in the studio and at other locations as well as other issues related to broadcast engineering. The tours of STV and Black Light were scheduled for the same day. Given the distance between Glasgow and Edinburgh, the fact that the Festival Fringe was on, and there were other cultural sites in Edinburgh available to visit, it was agreed to give the students a free afternoon to investigate Edinburgh on their own.

The remaining tours were distributed more heavily towards the latter part of the OIP. This allowed time for the hands-on laboratories to be completed on Tuesday, Wednesday and Thursday afternoons of the first week of the OIP. The tour of the Kelpies and Falkirk Wheel and of Stirling Castle was scheduled for the Friday of the first week. As mentioned, the tour of the SSE Hydro and the Intelligent Lighting Centre was scheduled for the Monday afternoon of the second week of the OIP. The staff at Black Light and STV were both available on the Wednesday morning of the second week so the students spent that entire day in Edinburgh.

Lectures, Labs, and Design Project

It was decided that the first five lecture topics listed in Table I and all three laboratory experiments would be scheduled in the first week, before the industrial and cultural tours were begun. This would give the students some technical background on solid state lighting, which was thought would give the students more confidence to discuss issues with the engineers on the tours. The lab experiments, for instance, would give the students hands-on experience with several of the parameters that lighting engineers have to consider in their designs: far-field patterns of the packaged LEDs, optical interferences, frequency response of the components as well as the human observers, and colour mixing using discrete LEDs.

The design project would be introduced during the first week to allow the students some time to consider how to complete their design. A guest speaker was suggested to provide students with a better understanding of some of the issues other than the ones related to electrical engineering that are considered when developing a product. The person identified was a graduate of the Product Design Engineering degree programme offered jointly by the UoG School of Engineering and the Glasgow School of Art. In the following lecture period, students were assigned the task of finding articles on an application for solid state lighting and writing a brief summary about it. It was anticipated that the students would apply some of the knowledge gained during the lecture on product design and be stimulated to develop

their own ideas on wearable electronics after reading and seeing some of the solid state lighting designs developed by others. The formal launch of the design project was the Tuesday of the second week of the OIP. The designs were not expected to be very complex, given the level of the students and the limited time in which they had on campus. The students would have all day on Thursday of the second week to finish their project and prepare a short oral presentation about their design. The presentations were scheduled for Friday after which a farewell gathering would be held.

Activities to Address Informal Aims

A boat trip on Loch Lomond, a tour of Stirling Castle, and the free afternoon in Edinburgh, as well as the visit to the SSE Hydro, were thought to be sufficient to meet the aim of introducing the students to Scotland and its history and culture. Several writing assignments, discussions during the lectures, and the oral presentations were designed to help stimulate the development of the students' English language skills. To further develop these skills, it was decided to select students who did not speak Mandarin as the undergraduate laboratory teaching assistants. As the course instructor and the lead electronic laboratory staff member also did not speak Mandarin, students would have to speak English during the lecture and laboratory sessions. An invitation was also issued to the English specialist in Student Learning Services who supports the School of Engineering to talk with the students about techniques for writing and making oral presentations during one of the lectures early in the second week of the OIP.

The undergraduate laboratory teaching assistants also attended the tours with the GCU and UESTC students and provided a lot of commentary about life in Scotland and as students at the University of Glasgow. Representatives from the UoG Recruitment and International Office were also asked to speak to the students about how to apply for post-graduate studies. Two UoG students who had been students at UESTC were asked if they would discuss their experiences adapting to Scotland and the educational opportunities that they have had since joining UoG.

Assessment of the OIP

Formal assessment of student learning about solid state lighting was based upon two written reports, a short essay about a commercial application for LEDs, an oral presentation about the design project, and an evaluation of the design during a fashion show of wearable optoelectronic 'bling'. In addition, each student was asked to complete an evaluation of instruction. All of the assessed materials were submitted by student teams; there was no assessment of individual work.

The quality of the lab reports, which were due within 24 hours of the laboratory sessions, was variable. There were 3 submission for the first report and 4 submission for the second report that contained data with minimal or no written text and another 4 submission for each of the two reports that contained data and text with major issues with grammar and sentence structure. The deadline for submission of the short essays was in the middle of the second week of the course and was after the students received feedback on the written reports. Overall, the quality of the essays was considerable better than that of the written reports with the grades of three essays negatively impacted because of poor written English. While it is likely that students didn't fully realize the standard for grading of the written reports was similar in the summer course as it was during the academic year, there was not a significantly different from that noted earlier during the academic year. The revision to the teaching of

technical writing at the Glasgow College, UESTC is underway and better guidance specifically on the expectation for report writing will be provided before the next offering of the summer OIP.

All of the GCU students had participated in at least one open-ended design project during the academic year. The UESTC students who had more limited exposure to open-ended design did not demonstrate difficulties on the project once the concept of open-ended design was explained, though it is not known how much coaching these students received from the GCU students on this pedagogical approach. There was one team of GCU students who required some support and encouragement before the team proposed an idea for the design, which they ultimately developed. The other teams of GCU and UESTC students required minimum support as they created their projects. Informal reviews of the proposed designs were conducted at the end of the first week of the courses with all teams. The stated purpose was to collect bills of materials to ensure that parts were available for the construction of the projects during the next week. During the reviews, the course instructor and laboratory staff member discussed with each team safety issues related to the construction of the design including wiring and exposed connections and location of the battery to power the display. The staff also made suggestions on alternative circuits and components to some of the teams and with the intent to reduce the complexity of the projects. Three of the four student teams advised to reduce the scope of their designs elected to continue with their original projects. The designs produced were impressive, especially considering the limited time in which the students had to complete them. All of the teams demonstrated working prototypes on the day of the 'fashion show'⁸. Approximately a quarter of the teams did not finish the circuit construction and programming until early that Friday morning. There was noticeable pressure as well as encouragement from the two UESTC staff members who were the trip chaperones, which may have resulted in the 100 % success in project completion as well as the number of extra hours that the students spent on their designs. A more structured, but still open-ended design project will be assigned during the next offering of the OIP to limit the number of hours each team will spend to complete their project.

The quality of the oral presentations during the 'fashion show' was very good. Almost all of the student teams had prepared Powerpoint presentations. The organization and format of the information in the Powerpoint slides was excellent and of equivalent level to Powerpoint presentations written by native English-speaking students who attend the Glasgow campus of UoG. Two students (both Year 1 students from the Glasgow College, UESTC) had difficulties expressing themselves in spoken English, which limited their ability to communicate detailed information about their design during the oral presentations to the audience composed of fellow students, the undergraduate teaching assistants, and several staff from the Glasgow campus of UoG. No improvement in oral English of the cohort was noted during the two week OIP. Efforts to foster an environment that will support such improvements, such as increased interactions between staff and students based in Glasgow with the GCU and UESTC students during their two week stay in Scotland are under discussion.

The practical work during the lab exercises and on the projects was deemed to be very good and the assessment by the UoG staff was that the learning objectives from an engineering perspective were met. While many of the comments about the course from the students were positive, the comments on their evaluation of instruction about the project were more negative than positive. The students had not expected to spend a significant amount of time on academic studies while in Glasgow. A number of students said that they had spent a large

amount of time outside of the lecture and laboratory sessions working on the design project, which limited the time that they could spend sightseeing. The negative comments were unexpected as a summer OIP centered on a course with academic credit was strongly suggested by UESTC staff, which we had thought was also an element of the other three OIPs that were run that summer. Secondly, the students were encouraged to keep their designs simple by the course instructor and the lead electronic laboratory staff member. However, the open-endedness of the project, anything that was wearable with an optoelectronic component, did not present any constraints on students who created elaborate and time-consuming designs. Thus, the staff have decided to replace the design project with a more limited open-ended design project when the summer OIP is held again in the summer of 2016.

Assessment of the achievement of the programme goals related to the students' cultural experiences was obtained via a conversations with a student focus group, from a review of comments in the student evaluation of instruction, and informal conversations with the students during and after the OIP. The students, in general, were pleased with the amount of time that allocated for the tours; several students expressed an interest in exploring Scotland further. They enjoyed their conversations with the two undergraduate students. However, they would have liked to have interacted with more UoG students. The schedule of the summer OIP presents difficulties in addressing this as most of the UoG engineering students are either on internships or on holiday at the beginning of August. Efforts will be made to have the GCU and UESTC students meet more of the post-graduate students and the UoG staff during their visit.

In conclusion, a two-week summer overseas immersion programme with an academic component on solid-state lighting was designed and delivered during the summer of 2015. The integration of the engineering aims with the informal aims of the OIP was achieved through careful consideration of the industrial and cultural tours. The selection of student teaching assistants as well as guest speakers also supported the achievement of the informal aims of the OIP. The major change identified related to the engineering content of the OIP was to redesign the project to insure that students do not spent too much time completing their project at the expense of time spend gaining experience with the Scottish culture. Changes to the course and instructional materials as well as the inclusion of opportunities for the students to socialise with more native English speakers will be needed to meet the informal aim to support the development of oral English and technical English vocabulary. Revisions to the experimental procedures are planned to provide guidance on the expectations for the written reports. More opportunities to support the development of the students' oral English skills are planned and include additional extracurricular social activities with UoG students.

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