



Undergraduate Students as Visiting Students in the UK

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WIP: International Research Experience in Power Engineering for U.S. Undergraduate Students as Visiting Students in the U.K.

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Abstract

In this work-in-progress paper, we discuss our NSF-supported program designed to select, mentor, and send U.S. undergraduate students in electrical power engineering to the University of Strathclyde in the U.K. during summer to engage in research projects and research-related activities. We discuss the program need, logistics, design, and evaluation results. Each year, six new students participate in the program; they are selected via a nation-wide competition. Our primary motivation for this program is to provide students with experience in international research and help prepare the next generation of U.S. competitive STEM workforce capable of innovation. Moreover, the students will develop soft skills such as teamwork, oral and written communication, and time management. Since the operating parameters of the electric grid (e.g., frequency and voltage levels) are different in Europe from those in North America, the students will also gain a firsthand experience of different practices in distribution and transmission systems. The research performed under this program helps achieve the smart grid vision through a combination of technological advances and workforce training. Ultimately, this research will increase the utilization of smart grid infrastructure by integrating distributed renewable energy resources. Our preliminary evaluation results show that overall student participants were very satisfied with how the program is set up, designed, and run, giving an average score of 4.7 out of 5: 100% of scholars said they would consider graduate school after attending this program, and pointed to its catalyzing role. Students appreciated the international experience; for all of them, it was their first time living in a foreign country for an extended time. For more than half, this was also the first time to Europe; 90% of scholars said knowing what they know now, they would participate in the program again, citing hands-on research experience, learning about the culture, learning how others solve their power needs, and availability of PhD students to help them as the highlights of the program. We have received applications from 17 states, and 8 of 16 scholars were female, providing evidence for the effectiveness of our advertisement and minority recruitment plans.

Introduction

Electrical power is critical to the U.S. economy. However, most of the current electric infrastructure is outdated. What exacerbates this problem is that this infrastructure still runs mainly on legacy control, monitoring, and protection systems that may not realize its full potential. Smart grid has emerged as a powerful promise for improving the reliability, efficiency, security, and sustainability of the next generation power system [1]. It has attracted interest from fields such as engineering, computer science, economics, sociology, and policy (see, among others, [2]–[8]). Despite this diverse interest, there are still critical gaps in the available technology for smart grid. For example, while environmental concerns and energy independence recommend utilizing renewable resources in the power system, one of the U.S. grand energy challenges remains to integrate large amounts of renewable energy, i.e., 80% at a competitive cost by 2050 [9]. This also adds to the difficulty of enforcing resiliency of the power system to major events, as required by Presidential Policy Directive 21 [10]. The students in this program seek to familiarize themselves with and help address challenges such as renewable energy integration, including distributed intelligence, resilience, control, management, planning, and operation. Workforce shortage is also a hurdle in successful implementation and operation of the smart grid. Many of the current power engineering workforce retire or are eligible for retirement in the next decade [11], [12].

Compared to the United States, many European countries have a more mature experience in utilization of renewable resources. The University of Strathclyde hosts one of the largest power programs in Europe and, as a prime example of an institution with proven track record in research and industry collaboration, is our partner in this project. This program, now in its fourth year, prepares and sends a group of 6 students per year to the University of Strathclyde for about 7 weeks. The specific objectives of this program are

Engage students in high-quality disciplinary research. The student engage in research topics of national and international significance. Specific examples are (i) controls for renewable energy resources and (ii) resiliency of renewables-rich distribution systems utilizing microgrids.

Prepare the next generation of workforce capable of innovation. This program strengthens students' science and technology training by offering a balanced experience, including living and working in a foreign country, research, visiting global world-class companies, and professional development workshops. These efforts increase their marketability in today world's global workforce as they will gain experience in working with both American and European electric power systems.

Increase representation of minorities in power engineering. This program has a carefully crafted plan to recruit underrepresented minorities by integrating with several national minority-oriented programs/groups as well as in-house programs.

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Program Description

We have designed several activities for students to foster a “community of scholars” for long-lasting relationships beyond conclusion of this program. Fig. 1 summarizes these activities.

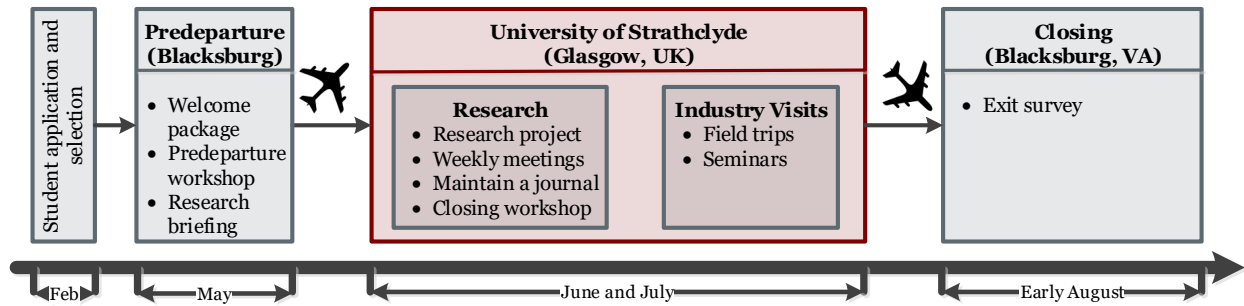


Figure 1. Summary of activities and timeline. Our activities promote both engineering and social aspects of the student development.

Student Selection

We advertised extensively in the national mailing lists reaching power professors in the United States, departmental mailing lists, and our classes. The primary criteria for student selection was (i) immigration/citizenship status as U.S. citizen or permanent resident (NSF requirement), (ii) background in power, (iii) GPA, and (iv) recommendation letters. The program was open to senior students and Master’s students. All except one of our participants were senior students. We strived to ensure students are paired with projects closest to their background and interest.

Activities in the United States Prior to Departure

Predeparture one-day workshop and professional development

The predeparture workshop provides and reiterates a host of information and is held the day before the students’ departure from the United States (which also facilitates departure arrangements). The workshop schedule includes program overview, research training, tours of labs (Fig. 2), and life in a foreign country. These different components, over years, have been delivered by different (yet relevant) speakers, including delegates from the Department of English, Office of Research, Office of International Programs, other faculty and the department chair.



Figure 2. Activities during the predeparture workshop include demos and discussion of the program requirements and expectations.

Professional Development Activities at the Foreign Site

On-site orientation

We also arrange an on-site orientation in the U.K. to complement the predeparture workshop in the US. The students are welcomed by the foreign site director and introduced to their mentors. They have a tour of the campus (labs, offices, and facilities) and the foreign site (local area, shops, local transportation, and banks). The foreign site director also provides a summary of the program activities (research projects and industry visits) and reiterates the reporting requirements.

Reporting

An important component of scientific research is documentation and reporting to summarize scholarly accomplishments. The students in this program are required to (i) maintain a daily journal, (ii) submit a final technical report, and (iii) orally present the results of their research. The students document their daily progress (data collection, experiment/simulation results, and interpretation) in a journal, signed by the mentor during the weekly meeting. Keeping a journal encourages students to maintain a steady progress. The final technical report is a narrative compilation, which is to include statement of problem, literature survey, solution and results, conclusions, future work, and references. The format of the report and resources on academic writing is provided to the students. Since the last few days of the students' time is busy with finalizing research, the deadline for submission of this report will be approximately a week after their return to the United States.

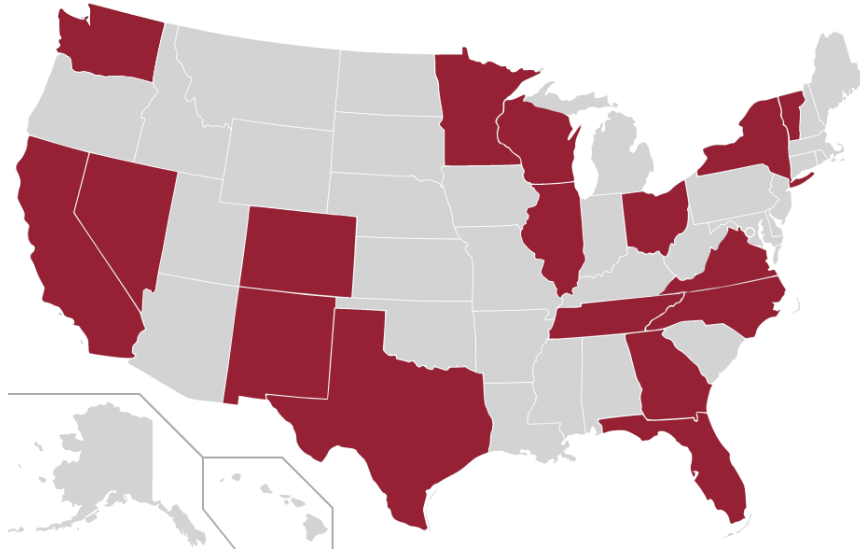


Figure 3. Our program has a wide reach and our applicants came from 17 states (AZ, CA, CO, FL, GA, IL, MA, MN, NC, NV, NY, OH, TN, TX, VA, WA, and WI).

Formative Feedback and Preliminary Results

Below, we share results from first three years (2017–2019) of evaluation of this program. Considering that this paper reports on a work-in-progress (WIP), we expect our final publication to include more analysis and data.

We have received applications from 17 states (Fig. 3) and 8 of 16 scholars were female—evidencing the effectiveness of our advertisement and minority recruitment plans. Some representative results of program evaluation (two surveys: one after the predeparture workshop and one after the end of cohort) are shown in Table I. Overall, the scholars were satisfied with the program and felt their time was well spent. We also had a number of open-ended questions whose answers are summarized below.

Are you considering graduate school after this program? 100% of scholars answered yes to this question citing its role. This is significant as many students initially did not have research experience.

How did the program contribute to your international experience? All students appreciated the international experience; for all of them, it was their first time living in a foreign country for an extended time. For more than half, this was the first time to Europe.

Knowing what you know now, would you participate in this program again? 90% of scholars answered yes, citing “hands-on research experience,” “learning about the Scottish culture,” “learning how the UK solves its power needs,” and “availability of PhD students to help

TABLE I. PRELIMINARY EVALUATION RESULTS

| Question (out of 5) | Score |
|------------------------------|-------|
| Predeparture Seminars | |
| Program introduction | 4.7 |
| Research methods | 4.5 |
| Communication skills | 4.7 |
| Ethics in research | 4.6 |
| Workshop duration | 4.2 |
| Program in Scotland | |
| Meetings with mentors | 4.1 |
| Nonresearch activities | 4.2 |
| Accommodation | 4.8 |

them” as the highlights of the program. One person said no and cited the short duration of the program (8 weeks).

We also asked the students to write any additional comments as they please. The following are examples of the comments we have received:

- I went into this workshop expecting it to be a little boring, but all day was very interesting! I learned a lot of new things, and all the speakers were very informative and personable. I felt like the length was good, and the day was worth it.
- I really enjoyed communicating with Dr. McArthur, he had a calming effect on my nerves and relived some tension about the environment we would be going to. Also, seeing how he wanted to expand our experience by taking us to seminars and including us with a trip with his PhD students showed that we are going to be supported in the U.K.
- This program has opened my eyes to Scotland and the European power industry. Before, I knew very little about how European countries tackle their issues with power, and now I understand the basics of ... how European countries’ power grids work. Also, I have never lived in a foreign country for an extend about of time before. This trip showed me how the Scottish people live and what life is like in Scotland. I gained a new perspective on life in the U.S after living in Scotland and seeing the differences in everything from driving to grocery shopping to using public transportation. This trip made me appreciate the U.S and Scotland each in their own unique way.
- This was only my second time leaving the country and being able to experience another culture I felt helped develop me as a person. This definitely has made me feel more open to other peoples opinions as well and has ignited my desire to travel to other countries.
- It was a wonderful experience. Ill never forget this opportunity. I thank you graciously for all their work into this. I really think this is a incredible experience for students with no international experience. Before this trip, I thought myself as an open minded person, after I feel that past person was far from it.

Discussion

Our evaluation plan includes formative and summative assessment tools. Formative evaluation provides feedback on the ongoing operation of the project. Summative evaluation provides feedback on the extent to which project outcomes are met. The evaluation plan provides the opportunity for the participants and mentors to report their satisfaction. Our evaluation goes beyond each year's cohort, as we will follow up with our alumni to track their performance (GPA, publications, and research experience) and their professional development and career after graduation (job, graduate school, or internships). Because the typical measures of research success occur in months and years following the conclusion of the actual work, we will instead use research presentations to evaluate the technical rigor of the program. Ultimately, we aim to answer the following educational research question: What is the measurable impact of our activities on the graduation rate, academic performance, attrition rate, professional competence, and workforce placement of a cohort of power students?

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