AC 2008-492: SUMMER RESEARCH PROGRAM FOR MEANINGFUL INTERNATIONAL EXPERIENCE

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Summer Research Program for Meaningful International Experience

Abstract

An important aspect of engineering education in the 21st century must include the building of international awareness. A practical and highly impactful way for engineering institutions to foster this awareness is to provide international research programs and encourage students to take part in them, for experiences that are meaningful both academically and socially, and that will prove to be invaluable to them as working professionals. With the "flattening" of the world – or the increased competition in the global marketplace due to advancements in web technology – it is of great value for engineering students to learn about other cultures through collaborative educational interactions. One program to provide such an opportunity to engineering students is the summer research program. In such a program, students from universities in the United States can spend significant time working in research groups at foreign universities and students from other countries can spend time doing the same at a university in the U.S. An appropriate time for this activity would be in the summer after the junior year of study. With modest funding from industry and/or foundations, a summer research program can be established to provide meaningful international experience to a number of students.

Introduction

The explosive growth in computing and communication has revolutionized the way we work and live. Increasingly, the engineering work force is becoming more diverse as teams perform with a focus on the world economy. The influences of globalization, advances in technology and evolving demographics are changing the role of engineers in society[1]. Engineers of the 21st century will face new challenges and a different professional environment than those of their predecessors. The National Academy of Engineering study, *"The Engineer of 2020: Visions of Engineering in the New Century,"*[2,3] reports on the critical issues facing engineering education, including the importance of education in the global context. The importance of global engineering excellence is presented in a *Continental AG* report[4], where it is expected that future engineers will be globally-connected professionals with a broad understanding of different cultures and the issues that influence contemporary society. The relevance of a more international engineering education in the changing global context of engineering is also discussed in a recent National Science Board study[5].

With expanded opportunity for commerce across nations[6], companies and supply chains are becoming more international; globalization is here to stay. Increasingly, engineers native to and educated in the United States will go to work in countries such as India or China and will be immersed in those cultures. Conversely, graduates native to and educated in countries outside the U.S. will work in the U.S. or for U.S.-based

companies. In this worldwide context, future engineers will collaborate on teams comprised of individuals with different cultural and ethnic backgrounds. Therefore, an opportunity for a meaningful international experience for engineering students around the world, particularly for students in developing countries, will be an important part of their education. The culturally-interactive team experience provided by the "global immersion" of an international exchange program during the summer will give future engineers valuable insight into what they will face in the real world. In many universities, students are offered course credit for service training or the opportunity to join local chapters of Engineers Without Borders. Through these avenues, they work in communities outside their own familiar territory and experience global immersion.

Summer Research Program for Global Immersion

Global immersion would take place in a summer research program where students from top international engineering schools can spend eight to ten weeks in internships at a U.S. institution. In such a program, students at the junior level from an Indian Institute of Technology (IIT) in India or from a top Chinese university can be invited to spend two or three months during the summer at a North American university, and American students are invited to spend the summer months at top partnering institutions in India or China. In the program, students are assigned to work one-on-one with faculty members and conduct research in a chosen area at the host and guest institutions. Such a collaborative summer research program provides significant exposure and useful academic and social benefits for participating students. China and India are noted frequently here, as many multinational corporations have major operations in either country; such operations will naturally include engineers from India and China. An understanding of how engineers from these countries are educated, perform their work and solve technical problems will be valuable to engineering students heretofore educated in the U.S.

Most universities, including University of Southern California (USC), offer summer overseas study programs. At USC, students often travel to Europe and learn about that continent's history and languages. Although this is also a great cultural experience, the day-to-day immersion into Indian and Chinese communities and the study of engineering disciplines in either of those countries provides a more pragmatic experience for engineering students at this time, given the concentration of technical innovation and commercial expansion mentioned in previous paragraphs. Therefore, we consider the summer research program to be a primary vehicle for such interactions with partner institutions in China and India.

Timing and Housing Logistics

Students who have completed their junior year will have fulfilled enough engineering course requirements to participate in research projects abroad. That period is also ideally suited as students are not yet looking for post-college employment or preparing to go to graduate school. Logistically, the summer season makes foreign study

convenient for students and institutions, as both on- and off-campus housing is readily available during summer months at most schools.

Under these summer research programs, several undergraduate students are invited to USC as research interns and several of our students have the opportunity to visit our partner institutions. Each summer, research students from guest institutions are assigned to work closely with faculty members at the host institution, based on research interests, to conduct research in a chosen area. Likewise, students from our institution can visit an international university for a few months to conduct research with faculty at that institution. Such a collaborative summer research program provides meaningful exposure and benefits participating students with both academic and international experience.

By partnering with top institutions around the world, it is not difficult to interest faculty in program participation. They value the program as a way to recruit potential PhD students down the road. With students from several international institutions engaged in the program at the same time, a microcosm of the greater flat world and, therefore, a true immersive experience can result. The key drivers of the program's potential success lie in its funding by private donors or industries who share a vested interest with universities in engineering education, in its great potential for providing the kind of purposeful international experience needed by tomorrow's engineers, and in its ability to generate interest from faculty by creating a pipeline for the emergence of outstanding PhD candidates.

The summer research program would cost about $3,000 to $5,000 per student. Financing might come from the host institution, from corporations, or in the form of government scholarships. The National Science Foundation provides qualified students with its Research Experiences for Undergraduates grants. American students visiting India or China might also gain real-world work experience while engaged in industry rather than in the classroom laboratory. Increasingly, a number of companies are offering such opportunities in countries like India and China. This type of summer program can be scaled up through widespread promotion at many U.S. and top Indian universities.

Summer Programs at USC

USC Viterbi School of Engineering (VSoE) administers successful summer research internship programs with visiting students from India, China, and from other schools in the states. We send our students to partnering universities in India and China in turn. Financing for the program with IIT Kharagpur came from a donor who is an alumnus of that IIT. Funding for the summer research program with Tsinghua University in China came from a donor who is an alumnus of both USC and Tsinghua. Funds were raised by the Dean with help from the school's development team. In both cases, donors pledged to provide financial support for several years into the future.

The summer break at USC is from May 16 through August 15. Summer breaks at our partner institutions, IIT Kharagpur and Tsinghua University, occur at slightly different times; however, there is enough overlap in the timeframes to provide five to

eight weeks of internship experience here for students from India and China. The ideal time for students to participate in a summer research internship is during the summer after their junior year. At that time, they have enough engineering background to participate in team projects and research and are not looking for jobs or applying to graduate school. In fact, engineering curriculum at the top colleges in India requires students to spend eight weeks at a foreign institution or company. Students from these institutions in India can take full advantage of this opportunity to visit a U.S. university to gain excellent international experience.

USC VSoE has hosted international students every summer since the inception of the program three years ago. We are able to bring 10 to 15 students here each year from both India and China. The amount of interest in this program among junior class students is tremendous. Deans at IIT Kharagpur and Tsinghua have worked with us in selecting the top students to visit us. In addition, we bring domestic students from across the country to our campus at about the same time. During their stay, we have a number of meetings and activities which naturally allow for interaction between participants, which benefits both domestic and international summer interns. Furthermore, each student has sufficient opportunity to interact with his or her faculty mentor and to meet other students, including graduate students in that research group. Typically, senior graduate students from that research group mentor the summer students as well. Many students have said this experience has been invaluable to them at this stage of study.

Report on the Summer 2007 Research Program

The summer research program has been quite successful in the past few years. Financial support has been provided by donors who care deeply about students. In 2007, the stipend and visa fee cost per student was about $3,500. In addition to highlights from 2007, I will note a few of the activities from the 2006 program as they compare to 2007. In 2006, six students visited from India and spent eight weeks conducting research with several faculty members. We provided each student a stipend of $1500 per month and also travel cost. With the high quality of students visiting from IIT, more faculty expressed interest in participating in this program. In order to bring more students, in 2007 we provided only stipend and $250 visa fees to each student while the students bore their own travel and health insurance costs. This allowed us to bring 14 students with the same total budget. During that time, we had also invited 15 domestic students from various universities. There were ample interactive social and team project opportunities for all participants. These students gave summary presentations at the end of their program and were unanimous in praising the value of this internship. Of the six Indian students, five applied for our PhD program and received offers of admission with fellowships. Although only one eventually joined USC, the other four joined top U.S. institutions.

Last summer, we increased the number of visiting students and hosted 14 from India. We also invited eight students from China and 17 students from across the U.S. Different groups of students came at different times; but there was, again, enough time for these students to meet and learn things about each other. Students were selected

competitively, with Deans and faculty actively involved at both institutions. All students had completed their junior year of study in different areas of engineering. Each student was matched with a faculty mentor who provided appropriate guidance and research opportunities. Several social functions were held off campus for the enjoyment and further multi-cultural enrichment of students. Students formed groups to take educational tours of the neighborhood surrounding the university. The program culminated with a brief presentation on research projects from each team. The work accomplished by each team was quite substantial and garnered more acknowledgement of the value of the experience. In 2008, we plan to host 14 students from India, 12 students from China, and about 20 domestic students. We are also planning to send 12 students form USC VSoE to Tsinghua University in China.

Selection of Students

Program announcements are sent to our partner institutions in late fall, requesting that students apply with their academic dean by January 15. Faculty interested in taking a summer intern were asked in late fall to provide project summaries that students can review on university websites and indicate which projects and faculty interest them.. All applicants were reviewed with the help of the academic dean at our partner institution to ensure selection of the top candidates. In addition to providing, their GPAs and academic scores in their application for the summer research program, students were asked to write briefly on their areas of research interests. Students were selected to cover several areas of engineering to meet our faculty interests. In some cases, two students worked with a faculty mentor so they could work on significantly larger projects. The selection of all students was completed in early spring and letters of invitations were sent to students then, so they had time to apply for their visas. Students organized themselves and traveled in groups from India and China. The arrival of all students from each country on the same day made it easier to set up housing, paperwork for payroll, library access and computer accounts. The summer internship program commenced with a welcome reception. At the end of the program, students briefly presented their work to their faculty mentors and other invited guests.

Sample Research Projects

Summer research students were matched with faculty working in different areas of engineering and worked on a variety of research projects. Some of these included but were not limited to the development of applications for hand-held devices, modeling of neural activities of hippocampal region of the brain, developing algorithms for reducing communication costs in wireless sensor networks through compressed sensing, fabrication of carbon nanotubes, ultrasound imaging of small animals and analyses of these images, and integrating information. During their involvement in such projects, students were exposed to cutting- edge research technology in our institution's lab as they worked with faculty and graduate students. In some cases, students participated in ongoing larger projects. For example, one student worked on the design of a model using Google Map API to handle large databases containing tens of thousands of borehole data and displacement vector data of earthquakes, to contribute to the study of liquefaction

modeling of earthquakes. In other cases, students worked on well-scoped projects. One student worked on accurate timing and power characterization of static single-track fell-buffers, which is an asynchronous circuit design. The faculty were unanimous in their assessment of the program that these summer students made useful research contributions. In most cases, these students continue to work with their faculty mentors after returning home. Some of the details of our summer research programs and testimonials from past students can be found at http://vsoe.usc.edu/summerinternship/.

Conclusions and Future Work

Our positive experience with the summer research program over the last three years has demonstrated the profound value in the exchange of ideas between students of many nations, and the need to continue providing a meaningful international experience for the global engineers of the future. With continued financial support from industry and foundations, it will be possible to maintain and enhance such a program that is of immense value to all participants and ultimately, we hope, to the engineering profession as a whole. In the future, we plan to increase the number of countries and partner institutions from which students can visit and contribute to an even more enriching academic and international endeavor. Likewise, our plan is to provide several destinations for our students to spend summers in nations abroad.

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