AC 2011-1975: INTERNATIONAL RESEARCH AND EDUCATION IN ENGINEERING (IREE) 2010 CHINA: DEVELOPING GLOBALLY COMPETENT ENGINEERING RESEARCHERS

Brent K Jesiek, Purdue University, West Lafayette

Brent K. Jesiek is assistant professor in Engineering Education and Electrical and Computer Engineering at Purdue University. He holds a B.S. in Electrical Engineering from Michigan Tech and M.S. and Ph.D. degrees in Science and Technology Studies from Virginia Tech. His research examines the social, historical, global, and epistemological dimensions of engineering and computing, with particular emphasis on topics related to engineering education, computer engineering, and educational technology.

Yating Chang, Purdue University, West Lafayette

Chang started her professional career as the Study Abroad Director at Western Kentucky University from 2001-2006, where she drove a 3X increase in overseas educational experiences, working with a predominately local/in-state student population that does not have a natural inclination for study abroad (many being the first in their family to attend college). This work experience has become her focus and engagement of under-represented population in Education Abroad, focusing on students in science and engineering disciplines. Her main responsibilities include engagement of both students and faculty members at Purdue University to embrace global engineering mindsets and practice.

During the first 2 years at Purdue University, she drove a 2X increase in the number of engineering major participating in both short-term and long-term overseas study. At her current position as the assistant director of the Purdue Office of Professional Program, Chang expands her expertise area to concentrate on developing global professional and research internships for students in the Engineering, Technology and Business disciplines. In 2010, she became the Program Director of International Research and Education in Engineering (IREE), a NSF funded program that sent 58 U.S. engineering researchers to conduct research in China. Chang has been an active NAFSA member for over 10 years. Currently, she serves as the 2009 network leader of the International Education Leadership Development network of NAFSA. She has organized numerous workshops and conferences with National Science Foundation, American Society of Engineering Education, and the Colloquium of International Engineering Education. In the past, she served on the Board of Trustees (2002-06) of the Cooperative Center for Study Abroad, as Fulbright Advisor, and as a Selection Panelist for the national-level scholarship program for International Institute of Education. Chang research interest is a derivative from her professional experience in global engineering education, with an emphasis on global engineering competencies and the impact of internationalization on the engineering profession.

Born in Taiwan, grew up in Singapore, Chang has traveled to over 30 different countries. Chang has an MS Cross-Cultural Psychology and an Ed. D. degree in Higher Education Leadership and Policy at the Peabody College at Vanderbilt University in 2007.

Yi Shen, Purdue University

Yi Shen is a Postdoctoral Researcher in Engineering Education at Purdue University. She holds a Ph.D. degree in Information Studies from the University of Wisconsin-Madison. Her research examines cyberinfrastructure for interdisciplinary scientific research, global engineering education and global competency, and social informatics. Having expertise in mixed quantitative-qualitative methods, she applies factor analysis, multivariate statistics, and nonparametric statistical techniques as well as qualitative analysis to measurement development and model construction for assessing learning and evaluating innovations in intercultural educational practice and global engineering programs.

Joe J.J. Lin, Purdue University, West Lafayette

Joe J.J. Lin is a Ph.D. student in the School of Engineering Education at Purdue University. His research interest includes: student success models in engineering, global engineering education, teamwork and team effectiveness, and production systems control and optimization. He worked as a production control engineer in Taiwan, and has taught laboratory classes in manufacturing engineering and freshmen engineering in the U.S. He earned his Bachelor and Master degrees in Industrial Engineering from National Tsing Hua University (Taiwan) and Purdue University (U.S.A). His ultimate career goal is to help cultivate world-class engineering graduates that can compete globally, as well as collaborate with the best engineers across different cultures.

E. Daniel Hirleman, University of California, Merced

E. Daniel Hirleman joined UC Merced as dean of the School of Engineering in 2010. He received the BSME with Highest Distinction, the MSME, and the Ph.D. from Purdue University, following which he joined the Arizona State University faculty in Mech/Aero Engineering. He eventually served in administrative positions culminating in Associate Dean for Research at ASU. In 1999 he returned to Purdue as William E. and Florence E. Perry Head of ME. Hirleman received the Pi Tau Sigma Award for Teaching Excellence and the College of Engineering Award for Significant Accomplishment in Research at ASU. He also received: the International Network for Engineering Education and Research (INEER) Achievement Award in 2006; the Hon. George Brown Award for International Scientific Cooperation from the U.S. Civilian Research & Development Foundation (CRDF) in 2008, and the 2009 Charles Russ Richards Memorial Award from Pi Tau Sigma/ASME. He chaired the International Congress on Optical Particle Sizing, served as Topical Editor for Applied Optics, is a Fellow of ASME, and Chairs the Advisory Board of Engineers for a Sustainable World. His research involves optical sensors for surface characterization, semiconductor manufacturing, particle and flow diagnostics, bio-hazard detection, food safety, as well as global engineering education.

Eckhard A. Groll, Purdue University, West Lafayette

Dr. Eckhard A. Groll is a Professor of Mechanical Engineering and the Director of the Office of Professional Practice at Purdue University. He joined Purdue University as an Assistant Professor in 1994 and was promoted to Associate Professor in 2000 and to Full Professor in 2005. He received his Diploma in Mechanical Engineering from the University of the Ruhr in Bochum, Germany, in 1989 and a Doctorate in Mechanical Engineering from the University of Hannover, Germany, in 1994. Professor Groll teaches Thermodynamics and his research focuses on the fundamental thermal sciences as applied to advanced HVAC&R systems, components, and their working fluids. Since joining Purdue, he has been the principal investigator (PI) or Co-PI on 77 research grants and 40 educational grants with a total budget of $7.16 million. Dr. Groll has authored or co-authored 71 archival journal articles and 125 conference papers. He has been the co-author of two handbook chapters and the editor or co-editor of seven conference proceedings. He has given 45 invited lectures or seminars and four keynote lectures. He serves as the Regional Editor for the Americas for the International Journal of Refrigeration and is a Fellow of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). Dr. Groll has been recognized for his academic leadership in higher education. He is a 2010-2011 Fellow of the American Council on Education (ACE) and participated in the Academic Leadership Program of the Committee on Institutional Collaboration (CIC-ALP) during 2009-2010. He has received numerous awards for his research and teaching excellence including the 2010 E. K. Campbell Award from ASHRAE, his induction into the Book of Great Teachers at Purdue University in 2008, and the 2007 Purdue University Faculty Scholar Award.

International Research and Education in Engineering (IREE) 2010 China: Developing Globally Competent Engineering Researchers

Abstract

The International Research and Education in Engineering (IREE) program supports the development of globally competent engineering researchers, while also encouraging cross-national research collaborations. Funded by the National Science Foundation (NSF) and administered by Purdue University, the IREE 2010 China program sent 58 U.S. undergraduate and graduate engineering students to China for intensive 10-week research experiences in university and industry laboratories. The program also featured extensive pre-departure and onsite orientation activities, a new Engineering Cultures China curriculum, a two-day re-entry meeting, and extensive use of the GlobalHUB cybercommunity. This paper offers a description of the IREE program, along with select results from our comprehensive program evaluation efforts. Our findings are based on a series of surveys conducted during various phases of the program, coupled with observations of the program team. By presenting this report on the IREE program, from the initial idea to end results, audience members will learn about the unique opportunities and challenges faced when executing overseas program for engineering students, including some recommendations and best practices.

Introduction

Many influential stakeholders argue that global competency is increasingly an imperative for a new generation of "global engineers" who must be ready to practice in a diverse, interconnected, and rapidly changing world.[1,2,3,4,5] Yet as many of these same reports acknowledge, most degree courses and programs fail to produce engineers with global competence and mobility, leading the authors to make passionate calls for reform. Even the most optimistic estimates indicate that just 7.5% of engineering students study abroad, while Shulman estimates that only 10-15% of engineering schools are taking global education seriously.[6,7]

In addition to the relatively modest number of schools that are working to thoroughly internationalize engineering education, many National Science Foundation (NSF) initiatives also provide crucial support for global education and research, such as through the East Asia and Pacific Summer Institutes (EAPSI) program. In this paper we focus on another such program, International Research and Education in Engineering (IREE). Initiated by NSF (ENG/EEC) in 2006, IREE objectives include developing collaborations with engineering researchers abroad and enhancing the global competency of future engineering professionals.[8] It provides U.S. engineering students and/or faculty with opportunities to experience the life and culture of another country, while gaining international research experience and perspectives. The IREE program also seeks to enhance U.S. innovation in global research and education, and promote connections between the research programs of NSF's divisions with the education of students.

During its first years, the IREE program provided supplemental grants to support international activities undertaken by individual faculty members and/or their students. For the 2007 and 2008

IREE programs, NSF funded nearly 250 research teams from U.S. universities. Trip reports and other documentation from the first years of the IREE program are available online.[9-10]

IREE 2010 China: Program Description and Applicant Review Process

The IREE program took another evolutionary step forwarded in 2010. With support from NSF, a team from Purdue University developed and administered a new IREE program format that allowed U.S. engineering students to conduct engineering-related research in China. China's significant and growing investments in scientific and engineering research help ensure NSF's grantees are developing global competency and research partnerships in a country with rapidly increasing prominence and influence in almost every engineering field. Nonetheless, China's geographical vastness and cultural diversity pose unique challenges for many students, who often have little knowledge and understanding of differences between Eastern and Western cultures – much less the kinds of local and regional differences within and around China.

Intensive publication of IREE 2010 China was successful, leading to submission of more than 360 applications. A special team reviewed all 278 of the completed applications (i.e. not missing any materials) to develop a ranked list of prospective awardees using the rubric presented in Figure 1 below. Our rankings were used to make award offers until 50 total participants were confirmed. Supplemental funding allowed the addition of 8 more highly competitive awardees, for a final total of 58 participants. After completing orientation activities during May 2010, the participants traveled to China for 10-12 weeks during the summer to work on frontier engineering research projects in university, industry, and government labs in China. Each received a stipend (US$4,000 for graduate students and US$3,000 for undergraduate students) to help support their time spent doing research. All grantees also received allowances for expenses related to the required orientation program, travel to and from China, lodging/meals while in China, and a re-entry meeting. The total award amount was estimated at approximately $7,500 (undergraduate students) or $8,500 (graduate students) in reimbursable expenses, and $1,400 in additional expenses covered directly by the program.

This paper presents a description of IREE 2010 China, including select results from our comprehensive program evaluation. Our findings are based on a series of surveys conducted during various phases of the program, coupled with the program team's experiences and observations. We also build on preliminary results from previous presentations and publications.[11] Through this report on the IREE program, from initial idea to end results, we discuss the unique opportunities and challenges faced when executing overseas program for engineering students, including specific strategies for optimizing such global experiences.

The results of the program evaluation are presented in a number of major sections. We begin with a summary of our comprehensive evaluation and research plan, followed by an overview of applicant and participant demographics. We then discuss the two different approaches used to arrange research placements in China, including some benefits and drawbacks for each. The next series of sections focus on program evaluation, starting with overall program evaluation based on participant feedback, and ratings and evaluations of the participants by their host supervisors. We then turn to evaluation results for the major program components, including the orientation and re-entry programs. In the final sections of the paper we discuss strategies used to assess global competency, followed by a review of recommendations and best practices.

Evaluation

Poor	Fair	Good	Very Good	Excellent
1	2	3	4	5

	Rating 1	2	3	4	5	Rating Comments
Overall quality of the personal statement	○	○	○	○	○	
Evidence of maturity and motivation, including ability to adapt to a different cultural environment	○	○	○	○	○	
Expresses enthusiasm for working in China, including learning aspects of Chinese language and/or culture	○	○	○	○	○	
Expresses demonstrated interest in a relevant field or sub-field of engineering-related research	○	○	○	○	○	
Evidence of relevant engineering work and/or research experience (from statement or CV/ resume)	○	○	○	○	○	
Evaluation of impression applicant will make abroad as a citizen/student representing the U.S./ IREE	○	○	○	○	○	
Academic qualifications (coursework, GPA, etc.)	○	○	○	○	○	
Quality of recommendation letter #1	○	○	○	○	○	
Quality of recommendation letter #2	○	○	○	○	○	
Diversity (ethnic background, institutional type, geographical distribution)	○	○	○	○	○	

Overall Evaluation of Applicent

Poor	Fair	Good	Very Good	Excellent
1	2	3	4	5
○	○	○	○	○

Other Comments

Figure 1. Applicant Review Form for IREE 2010 China Program

Comprehensive Research and Evaluation Plan

We developed and used a comprehensive research and evaluation plan for IREE 2010 that represents an important step toward a more integrated model for assessing global engineering programs. Our goal is to bring together diverse yet complimentary data that provides robust evidence of the quality and impacts of a given program, including objectives at the program and participant levels. As summarized in Table 1, during every major program phase we used a variety of surveys and instruments to collect relevant data, including demographic information, self-assessment of readiness for an experience abroad, and general measures of cultural orientation (using the MGUDS-S survey[12]), and global engineering competency. Other surveys allowed the participants and their research hosts to evaluate all major program components. Finally, a series of exercises and assignments provided participants with reflective learning opportunities, while also giving the program team rich insights about student experiences.

In the remainder of the paper we present preliminary results of our program evaluation, including evidence of the quality and success of the program generally and a number of major program components more specifically. While our analysis of results related to the global competency of participants is still ongoing and will be presented in parallel and future work, below we describe the instruments and activities used to collect data in this area.

Table 1. Research and Evaluation Data Collection Plan

	Pre-Assess 1 (prior to orientation)	**Pre-Assess 2** (during orientation)	**Post-Assess 1** (after orientation)	**Post-Assess 2** (during experience)	**Post-Assess 3** (at re-entry meeting or later)
(a) Background demographic survey	✓				
(b) Readiness self-assessment	✓		✓		
(c) Diversity survey (MGUDS-S)	✓				✓
(d) Global competency assessment	✓		✓		✓
(e) Reflective exercises, assignments		✓		✓	✓
(f) Survey evaluation of orientation			✓		
(g) Survey evaluation of full program					✓
(h) Survey of hosts and sponsors					✓

Applicant and Grantee Characteristics

The IREE program attracted a diverse applicant pool. Of 278 complete applications, about 30% were submitted by undergraduates and the remaining 70% by graduate students. The program also attracted a large number of female applicants, who made up approximately 43% of this pool. Other underrepresented groups applied in much lower numbers, with Hispanics/Latinos and African Americans comprising just 7% and 4% of all applicants, respectively. Additionally, there was a disproportionately large number of Asian/Asian American applicants to the program, who made up more than 35% of the applicant pool. This is not surprising given the focus of the program on China, and many of these applicants were in fact Chinese nationals with visas.

Among the 58 final grantees, 27 (or 46%) were women, and 5 (or 9%) identified themselves as underrepresented minorities. A total of 26 awardees (or 45%) were undergraduate students at the time of application, and the remainder (32, or 55%) graduate students. Additionally, 55 grantees (or 95%) were U.S. citizens, 2 (or 3.5%) were U.S. permanent residents, and 1 (or 1.7%) was an international student. Awardees represented more than 40 different home universities in the U.S.

Placement: Site vs. Self

The IREE 2010 program offered applicants two options for research placements. In the "self placement" model, student applicants proposed placement in specific host institutions and research labs, often identified with the help of a faculty advisor or mentor. In the "site placement" model, the IREE team arranged placements for small groups of awardees at select partner sites. There were a total of 21 site-placement and 37 self-placement participants. Across all participants, the most common research sites were Shanghai Jiao Tong University, Tsinghua University, and Xi'an Jiao Tong University.

The self-placement model provides researchers with a somewhat expensive but high-quality research experience, while the site-placement model is thought to offer a research experience that is more affordable and scalable, but possibly not as relevant. While the research team is still evaluating quality of experiences across the two placement groups, we tentatively observe that many self-placement participants did benefit from a closer alignment with their own research and their work in China, while many in the site-placement cohort complained that their disciplinary background and research interests were not well-matched to their host lab. Additionally, 10 (or 18%) of 55 final evaluation respondents recommended that more information about research sites be made available to applicants and grantees, and one of these participants even alluded to his somewhat questionable site-placement in a microbiology lab. However, we also observe that many site-placement participants did benefit from having a "built-in" support network consisting of other IREE participants who were placed in the same labs and/or schools. Students who were unable to place themselves in Chinese labs also greatly appreciated the site-placement model. As one participant explained when asked about the most desirable characteristics of the program: "The fact that you DON'T need a host institution. This is IREE's biggest selling point." Still another noted the value of "having other people make the research connection for you."

Additionally, nearly a quarter of the respondents (or 12 of 55) who completed the final program evaluation recommended that all research hosts in China be provided with more information about the IREE program, including goals and expectations for placements. There was a perception among participants that working conditions varied widely across host sites, and that more could be done to synchronize expectations program-wide.

Overall Program Evaluation

All research and evaluation data for IREE 2010 has been collected. While analysis of the data is ongoing, we can report a number of preliminary results. Overall, awardees were very satisfied with IREE. When asked to rank their overall experience on a scale of (1) Poor to (5) Excellent, the average response was 4.5. Of 55 respondents, 32 rated the experience Excellent, 20 Very Good, and one each Good, Fair, and Poor. There were no statistically significant differences in average evaluation scores between the placement groups (site vs. self), or between orientation groups (Purdue vs. Shanghai vs. cyber/online). When asked at the re-entry meeting to comment on the most desirable characteristic(s) of the program, the themes mentioned most often were: amount of compensation/funding, assistance with arranging research placements, and personal and/or professional benefits from an immersive international experience. When asked about least desirable characteristics of IREE 2010, participants most often noted: poor matching of student backgrounds/interests with site-placement positions, dissatisfaction with various aspects of the orientation and/or re-entry meetings, and difficulties related to language learning and use.

When surveyed after all IREE participants had returned to the US, the host supervisors had very favorable impressions of the awardees. When asked for an "Overall Evaluation" of the student(s) they hosted, 29 of 30 indicated "Above Average" or "Outstanding." Only one host reported "Satisfactory," while none reported "Below Average" or "Unsatisfactory." When asked "would you be willing to host more IREE students during Summer 2011," 25 of 30 hosts responded "Yes" and just 5 indicated "Maybe." When IREE participants were asked to evaluate the overall quality of their research host, on the other hand, they also responded positively, with an average rating of 7.6 (n=57) on a scale of 1 (low) to 10 (high).

Orientation Program

At a post-trip conference for the 2007 IREE program, many grantees strongly recommended that NSF provide pre-trip preparation or orientation to all participants. NSF and Purdue University responded to these recommendations for the 2008 IREE grantees by conducting the first IREE grantee's conference prior to travel abroad. This two-day pre-trip conference was attended by 184 grantees, 88% of whom had not previously traveled to their destination site. The conference provided each grantee a broad overview of the histories, cultures, technical practices, and languages of his or her respective host region. Grantees also had the opportunity to attend panel discussions and workshops hosted by select IREE 2007 grantees.

Building on this prior success, the IREE 2010 team developed and ran three types of orientation programs during May 2011, with the goal of studying the effectiveness of the orientations depending on format and location. Of the 58 grantees: (i) 19 students were hosted by the Purdue team for a two-week orientation session in Shanghai, China; (ii) 19 students were hosted by the IREE team for a two-week orientation session at Purdue's main campus in West Lafayette, Indiana; and (iii) 20 students participated in a flexible five-week cyber-based orientation program, with grantees participating from their own workplace or residence. All orientation programs offered extensive instruction in Chinese language (Mandarin), general history and culture, and Engineering Cultures® China content.[13] The Engineering Cultures China curriculum provided grantees with a wealth of information about the historical development and contemporary state of engineering education and the engineering profession in China, as well as specific participant observation methods and strategies to enhance their ability to work more effectively in diverse global contexts. Below we discuss our preliminary evaluation of the effectiveness of the different orientation formats and components.

A summary of the evaluation results for the orientation program and its major components is presented below in Table 2. When surveyed at the end of their orientation experience, the average overall evaluation of the orientation program was 3.8 (n=56) on a scale of (1) Poor to (5) Excellent. Evaluations were highest among face-to-face groups, with the Purdue (n=19) and Shanghai groups (n=19) giving average ratings of 4.1 and 4.0, respectively. Cyber/online orientation participants (n=18) gave an average rating of 3.3. As these findings suggest, participants viewed face-to-face orientations more favorably. In fact, only 3 of 18 cyber/online participants reported that they would opt for the same format again, while 12 indicated a preference for face-to-face orientation in China, and 3 for face-to-face orientation in the U.S.

Table 2. Participant Evaluation of Orientation Program Components Before (Pre) and After (Post) Research Experiences in China

	Orientation Component								
	Overall Orientation Program		Mandarin Language Training		General History and Culture		Engineering Cultures China		Logistical Issues
Orientation Group	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Post only**
Shanghai Orientation (n=19)	4.0	4.1	3.0	2.9	3.7	4.1	4.3	4.4	3.9
Purdue Orientation (n=19)	4.1	4.0	3.5	2.9	4.0	4.1	4.1	4.2	3.9
Cyber Orientation (n=20)	3.3[1]	2.9[1]	3.3	2.1[1]	3.6	3.6	3.8	4.0	4.1
All Participants (n=58)	**3.8**	**3.7**	**3.3**[2]	**2.6**[2]	**3.8**	**3.9**	**4.0**	**4.2**	**4.0**

[1] Participants from the cyber/online orientation group gave statistically significant ($p<0.05$) lower scores to the (1) overall orientation program and (2) language training, as compared to scores on these same two components from the Shanghai and Purdue face-to-face orientation groups.

[2] Participants gave statistically significant ($p<0.05$) lower scores to the language training after they came back from China, as compared to their scores at the very end of their orientation session.

Preliminary results from our pilot Readiness Assessment instrument also suggest that the cyber/online orientation format was less effective for participants, especially as compared to face-to-face sessions. In fact, cyber/online participants showed no significant movement on 15 readiness questions administered before and after orientation. Yet responses from Shanghai and Purdue participants respectively showed significant movement on three and four of the readiness questions. For example, when asked to evaluate the statement "I wish I better understood the host country" on a scale of strongly disagree (1) to strongly agree (6), average pre/post-orientation scores from Purdue participants decreased by 1.1, while the average for Shanghai participants decreased by 1.4. Given these results, we infer that many face-to-face participants developed a significantly enhanced understanding of the host country.

Open-ended orientation evaluation questions reveal that many Purdue- and Shanghai-based orientation participants appreciated being able to interact and network with their IREE peers while simultaneously enriching their knowledge of Chinese history, culture, and engineering culture. Numerous Purdue-based participants, on the other hand, liked having multiple opportunities to interact with Chinese students at Purdue, and to hear from professionals with global engineering experience. Many Shanghai participants noted the value of experiencing orientation in an "immersive" environment that helped increase their motivation and provide opportunities for experiential learning (e.g. field trips). In fact, 9 (or 16%) of 55 program evaluation respondents explicitly recommended that all face-to-face orientation activities be conducted in the host country. Finally, many participants from across the groups suggested improvements for language training, including more emphasis on practical conversation skills. In addition, 11 (or 20%) of 55 participants recommended personalized or multi-level instruction options for those entering the program with varying levels of prior language expertise.

When asked to comment on the benefits/advantages of the online orientation, many participants appreciated the convenience and flexibility of the format, and the ability to skip or customize language training depending on their needs. They also reported a number of concerns, including: a lack of motivation/incentives to finish all assigned content and activities, the heavy workload and intense schedule, balancing participation with other commitments, a lack of opportunities to interact with the instructors and network with participants, and the quality of the language training materials (book and accompanying audio files). As we discuss in more detail below, we propose an optimized hybrid orientation model to strategically maximize the benefits – and reduce the drawbacks – of both online and face-to-face formats.

Among the major sub-components of the orientation program, the Engineering Cultures China modules received the most favorable evaluations, with an average rating of 4.0 (pre) and 4.2 (post) across all groups. The next most favorable element was general history and culture, with an average rating of 3.8 (pre) and 3.9 (post), followed by language training at 3.3 (pre) and 2.6 (post). Performing further analysis of the pre- and post-experience results reveals no significant differences between pre- and post-experience average ratings for overall evaluation, Engineering Cultures China, or general history and culture. However, the lower post-experience scores for language training does represent a statistically significant drop.

Our evaluation data leads us to identify a number of reasons for wide variations in satisfaction with the language training, including diversity in the Chinese language skills of participants and significant variability in the instructional models/formats used for language training across the three orientations. Participants from all groups suggested many improvements for the language training, including more opportunities for practice and better options for customized instruction.

Re-Entry Meeting

All IREE grantees were required to participate in a re-entry meeting held approximately one month after they returned to the U.S. from China (September 25-26, 2010 in Chicago, IL). One major goal of the meeting was to support the cultural readjustment process. Returning home after a lengthy sojourn abroad can be challenging and frustrating. We think it should be a simple matter of getting resettled, resuming our everyday routines, and reconnecting with friends and family, but research has shown that re-entry requires social and psychological adjustments and these can be actively supported.[14] The other goals of the re-entry meeting were to promote networking and community building among this new group of global engineers with substantial knowledge of China, and to allow program staff to collect research and evaluation data.

All attendees (n=56) participated in a series of planned activities at the event, including: a) poster sessions, b) individual hour-long interviews with IREE staff, c) two hour thematic focus groups facilitated by IREE staff, d) a keynote address by Al Soyster, Director of NSF's Division of Engineering Education and Centers (EEC), e) a group activity (writing/performing skits), and f) informal networking and socializing. As indicated in Figure 2, participant evaluations of the re-entry meeting were very favorable. In terms of Overall Quality, the meeting received an average rating of 4.2 on a 5-point scale. The highest rated re-entry components were accommodations (average rating of 4.6), following by informal networking and socializing (4.5), the keynote lecture (4.1), and the poster sessions (3.9). The group skit activity had the lowest rating (3.1).

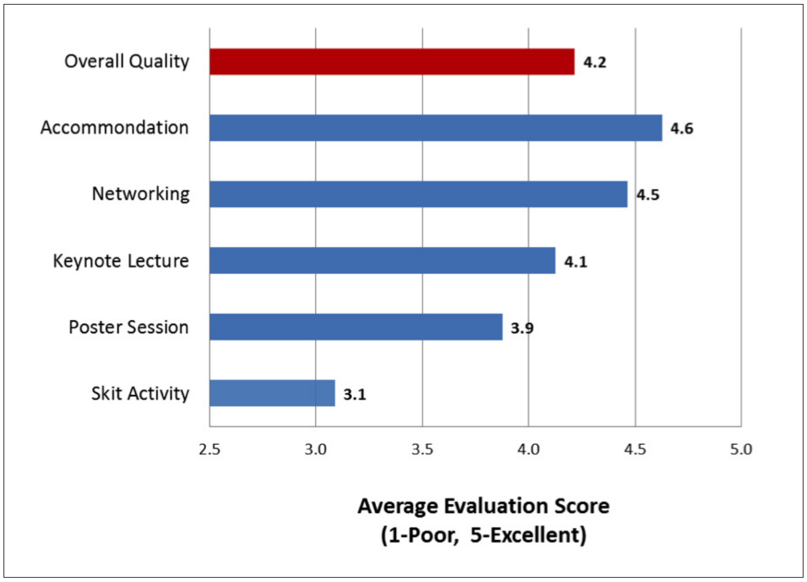

Figure 2. Participant Evaluation of IREE Re-entry Meeting

Assessing Global Competency

While there are many competing definitions of what counts as "global competency" for practicing engineers, our own research and evaluation efforts allow us to report results related to a number of dimensions that are frequently discussed in the literature, namely: foreign language competence, general cultural orientation and appreciation, and global engineering competency. For the current IREE program, our assessment of foreign language ability is limited to reports of self-efficacy using a five-level scale developed by McNeill, namely: no proficiency reported, "I know a few words and phrases," "I can engage in basic conversation," "I could take engineering courses in this language," and "This is my native language."[15]

To evaluate general cultural orientation and appreciation, we used the Miville-Guzman Universality-Diversity Scale - Short Form (MGUDS-S), a 15-item instrument that measures universal-diverse orientation (UDO), or "an attitude of awareness and acceptance of both similarities and differences that exist among people." MGUDS-S was administered to all participants prior to orientation and again at the re-entry meeting. Two preliminary findings are worth noting. First, pre-experience MGUDS-S scores were high compared to other, non-IREE populations, suggesting a self-selection factor at work among participants. Second, we found small but statistically significant increases in MGUDS-S scores after the IREE experience, suggesting that the program had a positive impact on the UDO of participants. These results will be presented in more detail in parallel and future publications.

Additionally, two global scenarios were developed and used to more specifically measure the global engineering competency of participants before and after the IREE experience, as shown in Figure 2 below. A scoring rubric is now being developed for these responses.

Still other analyses related to global competency are ongoing. During their research placement, for example, all participants were twice asked to respond to a series of reflective prompts in "blog" entries they were required to post on the GlobalHUB site (http://globalhub.org). This data is now being analyzed using a "levels of reflection" framework.[16] In addition, individual hour-long interviews and two-hour thematic focus groups were conducted with 56 participants at the IREE re-entry meeting. The audio from these sessions is now being transcribed, and preliminary results from select focus groups are now being prepared for presentation and publication.

Global Competency Scenario 1: As an American engineer, you have been invited to General Electric's China Technology Center in Shanghai to help develop prototypes for a new medical imaging device. Your team includes engineers from GE's Research Centers in Shanghai, Beijing, and New York (USA). How prepared are you to enter this work situation? What knowledge and capabilities do you have and what do you lack?
Global Competency Scenario 2: As an employee in a large multinational corporation, you are temporarily assigned to your company's branch operations in Shanghai, China. Your work team consists of three Chinese engineers, all at about the same rank as you. Your team reports to an engineering manager, who is also Chinese. In a recent team meeting, your manager proposed a solution to a difficult quality control problem. However, you feel you have a much better solution to the problem. How would you deal with this situation?

Figure 2. Scenarios for Assessing the Global Engineering Competence

Conclusions and Recommendations

Based on our analysis, we present a number of recommendations relevant for those involved with developing, evaluating, and/or administering global engineering programs, including:

1. *Improved Site-Placement Matching* – The site-placement model is appealing because it can be scaled to large numbers of students, provides research opportunities to those who might otherwise have difficulty finding placements, and provides social supports for students located at the same labs and/or institutions. Yet to ensure that these individuals have the highest quality experience possible, we recommend that program administrators be very proactive in identifying specific research fields and topics at each host site. Then, students can indicate their preferred host sites/labs when applying, resulting in better matches.

2. *Research Host Preparation* – As recommended by numerous participants, program leaders should educate all research hosts about the sponsoring program, such as by providing information about program goals, the background and abilities of the students placed in their lab(s), and expectations about typical working hours, conditions, and tasks. Such preparation is especially important for site-placements, where students are often less likely to initiate contact and make detailed research plans with the host prior to arrival.

3. *Enhanced Hybrid Orientation Format* – Based on our evaluations and observations of the IREE 2010 program, we propose development of a "hybrid" orientation format for global engineering programs that optimizes quality and scalability by combining the best features of cyber/online and face-to-face interactions. Self-paced online orientations prior to departure

should provide essential program and travel information, basic introductions to language and culture, and opportunities to seed community development via member profiles and discussion forums. This would be followed by an intensive face-to-face orientation in the host country, where students continue to build community and networks, while deepening their knowledge of language, history, culture, and engineering culture in an immersive learning environment. Further, efforts should be made to extensively utilize experiential learning activities in-country to allow participants to improve their sensitivity to context and practice their language and cultural etiquette skills. This type of format would help address one participant's suggestion that the IREE program "[f]ind [a] happy medium between unregulated cyber orientation and overwhelmingly condensed Shanghai/Purdue orientation."

4. *Optimized Orientation Content:* Our experiences lead us to a number of recommendations for optimizing the content of program orientations. First, we maintain that there is great value in developing and using orientation materials that are specifically tuned to the context and practice of engineering, such as the Engineering Cultures modules that are now available for many different countries. The high ratings given to this component by IREE participants helps support this claim. Second, we propose a number of language training enhancements, including a greater emphasis on: conversation, vocabulary/terms often encountered in work settings, simulations that provide realistic opportunities for "survival' and conversational language practice, and customized instruction for those with varying levels of proficiency.

Ultimately, our goal is to provide techniques and strategies so participants in global engineering programs are more likely to have transformative learning experiences that enhance their global competency, which can in turn have profound impacts on their future effectiveness as engineering professionals and informed global citizens. Through systematic research and evaluation efforts, we are beginning to develop the tools and strategies needed to evaluate the quality and impacts of various types of global engineering programs, allowing us to optimize these experiences through a process of continuous improvement. We hope that what we have learned can serve as a source of inspiration and guidance for further research and development efforts. And ultimately, it is our students who serve as our greatest source of inspiration. As one participant explained, when asked about the program's best features: "Going to a totally new place and really being immersed into it. You live and work in China for 3 months; it's amazing."

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