IDA

SCIENCE & TECHNOLOGY POLICY INSTITUTE

Portfolio Evaluation of the National Science Foundation's Grants Program on "International Research and Education in Engineering" (IREE)

Pamela Ebert Flattau, Task Leader
Bhavya Lal
Allison Laskey
Joseph J. Ford, III

January 2009
Approved for public release;
distribution is unlimited.
IDA Document D-3727
Log: H 09-000464

INSTITUTE FOR DEFENSE ANALYSES
SCIENCE & TECHNOLOGY POLICY INSTITUTE
1899 Pennsylvania Ave., Suite 520
Washington, DC 20006-3602

This work was conducted under contract OIA-040-8601, Task OSTP 20-0002.37, for the National Science Foundation. The publication does not indicate an endorsement by the White House Office of Science and Technology Policy (OSTP), nor should the contents be construed as reflecting the official position of that office.

SCIENCE & TECHNOLOGY POLICY INSTITUTE

IDA Document D-3727

Portfolio Evaluation of the National Science Foundation's Grants Program on "International Research and Education in Engineering" (IREE)

Pamela Ebert Flattau, Task Leader
Bhavya Lal
Allison Laskey
Joseph J. Ford, III

This page intentionally left blank.

Preface

Each year, U.S. colleges and universities prepare tens of thousands of talented individuals who wish to pursue careers in engineering. In 2006 alone, over 68,000 students earned a bachelor's degree in engineering; another 33,000, a master's degree; and 7,100, a doctorate.[1] As in other technical professions, great care is taken by the engineering community to ensure that degree recipients receive their training at programs accredited by peers.[2] Nonetheless, educators have come to recognize that improvements are needed in engineering education to prepare future graduates for the opportunities and challenges facing the profession in the 21st Century – most notably, the emergence of the global marketplace and the attendant demand for well-trained high-technology workers who will ensure a continuing, strong U.S. presence.[3]

The cadre of scientists who conduct research in engineering education have responded to this concern over the future of engineering education by turning their attention to needed improvements in the curriculum as well as instructional issues involving such topics as cooperative learning and teamwork, the timing of student exposure to new technologies, and characteristics of student learning strategies and styles – especially given the greater diversity of students now pursuing careers in engineering.[4]

The National Science Foundation (NSF) represents a significant source of support for research in engineering education,[5] and recently renewed its commitment to this area following the release of a report by the National Science Board outlining steps that might be taken to improve engineering education.[6] To assure the efficient investment of public funds in the coming years, the NSF Engineering Education and Centers Division (EEC) of the Directorate for Engineering asked the IDA Science and Technology Policy Institute (STPI) to examine a sample of NSF grants programs in engineering education, while also developing a master plan for longer-term support for research in engineering education. STPI launched a six-month study in April 2008 to provide the NSF's Engineering Education program with a systematic review of the outcomes and impacts of active grants in three engineering education program areas:

---

1 National Science Foundation, Science and Engineering Degrees: 1966–2006, Detailed Statistical Tables, NSF 08-321, Arlington, VA.

2 ABET, Inc., is the recognized national accreditation body for colleges and universities providing training in applied science, computing, engineering, and technology. ABET currently accredits 2,800 programs at more than 600 U.S. colleges and universities. See: www.abet.org.

3 See, for example, the National Academy of Engineering, Educating the Engineer of 2020, Washington DC: National Academies Press, 2005.

4 J. Heywood, Engineering Education: Research and Development in Curriculum and Instruction, Hoboken, NJ: John Wiley & Sons, Inc., 2005, provides a useful overview of research in engineering education.

5 See, for example, program announcement NSF 08-610, "Innovations in Engineering Education, Curriculum and Infrastructure," available at www.nsf.gov/2008/pubs.

6 National Science Board, Moving Forward to Improve Engineering Education, NSB 07-122, Arlington, VA, 2007.

Subtask 1: How People Learn Engineering (HPLE)
Subtask 2: Department-Level Reform of Undergraduate Engineering Education (DLR)
Subtask 3: International Research and Education in Engineering (IREE)

This report presents the results of STPI's evaluation of the program that addresses "International Research and Education in Engineering" (subtask 3).

Pamela Ebert Flattau, PhD
Project Leader
IDA Science and Technology Policy Institute

Contents

This page intentionally left blank.

Executive Summary

In Fiscal Year (FY) 2006, the National Science Foundation, through the Directorate for Engineering, launched a program of supplemental grant support entitled the International Research and Education in Engineering (IREE) awards. Principal investigators with active NSF grants could apply for supplemental funding through the IREE program to allow early-career researchers "to gain international experience and perspective" and to promote the "closer research interaction between U.S. institutions and their foreign counterparts." The Foundation defined early career researchers to include undergraduate, graduate and postdoctoral engineers (including tenure-track junior faculty). In FY 2006, the Foundation awarded IREE awards to 114 travelers, at an average of $28,500 in supplemental support.

In 2008, the IREE program was "paused" to permit a systematic analysis of specific outcomes and accomplishments attained by IREE grantees. To that end, the Foundation's Division of Engineering Education and Research Centers asked the IDA Science and Technology Policy Institute (STPI) to assess the early outcomes of these IREE travel awards. The objective of the STPI analysis of the IREE program was three-fold:

1. To characterize the portfolio of IREE awards made in FY 2006,
2. To document selected outputs based on the trip reports filed by FY 2006 grantees, and
3. To specify the types of indicators that would be needed to gauge the longer-term outcomes and impacts of the IREE program.

To conduct its analysis, STPI analyzed budget information furnished by the National Science Foundation, as well as the trip reports filed by the FY 2006 grantees at the conclusion of their IREE experience. STPI also generated a set of "study questions" for purposes of analyzing the portfolio of IREE awards, and interviewed a sample of IREE "travelers" to gain further insights into the nature of their research and education experiences abroad, outputs, and anticipated outcomes and impacts.

Inputs

STPI defines "inputs" to the IREE program to include funding support provided by the National Science Foundation and project leadership and management, including U.S./non-U.S. institutional arrangements.

IREE program support in FY 2006 combined with Division program funds and NSF Office of International Science and Engineering (OISE) funding provided a total of about $3.3 million for these travel awards in FY 2006. When analyzed by NSF Engineering Divisions, the Division of Design and Manufacturing Innovation (DMI) provided a larger share of travel support than any other NSF Engineering Division in FY 2006. OISE

supported IREE travelers across all 5 NSF Engineering Divisions. The Bioengineering and Environmental Sciences (BES) and Electrical and Communication Systems (ECS) Divisions relied exclusively on a combination of OISE and IREE program support to fund travelers in FY 2006.

U.S. institutions participating in the IREE program in FY 2006 reflected a broad geographic distribution, but with greater participation evident for those travelers whose home institutions were located in the Midwest or on the East Coast. More than half the U.S. institutions sponsored just one traveler in FY 2006, while others sponsored multiple travelers.

The STPI analysis of available trip reports revealed that 41 of these 60 U.S. institutions sponsored the travel of early-career researchers to one institution in another country, while another 19 institutions sponsored IREE travelers to more than one "host" institution. By themselves, the IREE trip reports shed no light on the nature of these inter-institutional relationships. Other studies are needed to explore whether the IREE program strengthens the interaction between U.S. institutions and their counterparts, in line with the goals of the program.

Activities

STPI considers the "activities" of the IREE program to include key elements of the travel experience. This includes: trip duration, nature of the work and collaboration at "host" institutions, as well as involvement in the cultural activities of the host country.

Undergraduate Travelers: A total of 18 undergraduate engineering students participated in the IREE program in FY 2006. A total of 15 U.S. universities sponsored the travel of these IREE early-career researchers. The undergraduates traveled to 10 different countries: Germany (6), Australia (2), Denmark (2), China (2), and Hungary, France, Japan, Italy, Nigeria, and Canada (1 each). The average duration of the IREE trip at the undergraduate level was 87.9 days.

Graduate Student Travelers: A total of 84 graduate students in engineering participated in the IREE program in FY 2006. A total of 53 U.S. universities sponsored the travel of these IREE early-career researchers. They traveled to a total of 26 different countries, including: Germany (18), England (12), France (6), and Japan (6). The average duration of the IREE trip at the graduate student level was 90.9 days.

Postdoctoral IREE Travelers: A total of 12 postdoctoral travelers in engineering (including junior faculty) participated in the IREE program in FY 2006. A total of 12 U.S. universities sponsored the travel of these IREE early-career researchers. They sought early-career research training in 10 countries: Austria, Belgium, England, France, India, Italy, Japan, the Netherlands, Singapore, and Spain. The average duration of the IREE trip at the postdoctoral level was 79.3 days.

In conducting its interviews, STPI found that many IREE travelers were eager to convey to the National Science Foundation ways in which the IREE program might help travelers live and work in different cultures. Highlights from some of those interviews follow:

- The time needed to procure equipment from the host institution was the "worst part" of the IREE experience.
- Established research goals "took a different direction" half-way through at least one IREE project due to equipment problems.
- In the future it would be helpful if NSF established a network of former IREE travelers to contact before, during, or after travel.
- In the future, it might be better to offer multi-year funding to U.S. institutions to permit more effective inter-institutional planning and the recruitment of a stronger pool of travelers.
- The biggest challenge of the IREE program is that it "caters" only to U.S. institutions, making U.S. travelers guests rather than colleagues of the host institutions.

Based on its analysis, STPI concludes that the IREE trip reports represent a useful starting point for the documentation of the travel experience. However, more formal methods are needed to capture both the on-site research activities and cultural dimensions of the IREE experience. Formal data collection mechanisms, such as pre- and post-travel questionnaires to gather feedback from travelers might help the Foundation refine the program in the coming years.

STPI also observed that little is known about the experience of the "host" institutions in sponsoring the research and education activities of the U.S. travelers. The Foundation would most likely benefit from the development of mechanisms to gather such feedback. Such instruments are used by managers of other travel programs, including the Fulbright Fellowship Program, as well as the Erasmus and Marie Curie Fellowship programs as outlined in Appendix H of this report.

Outputs

STPI identified a set of variables that could be used to capture the outputs of IREE support. However, based on an initial tabulation using available IREE trip reports, STPI limited the set of output measures to six:

- Technical outputs
    - Publications accepted, submitted, or planned for submission
    - Conference papers, technical papers, or manuscripts
    - New tools, techniques, or methods learned or developed
- Professional outputs

    - Continuing/future collaborative research planned
    - Future exchange of researchers/students planned
- Global/Intercultural outputs
    - Language studied/learned

In general, most if not all IREE travelers reported gaining new research experiences and perspectives. However, postdoctoral travelers and graduate students were more likely than undergraduates to report specifically that an output of their travel included the acquisition of new tools, techniques or methods, and publications. Postdoctoral travelers and graduate students were also more likely to report plans for continuing collaborations following the completion of their IREE experience. Taken together, these observations suggest that investment in international research and education experiences for purposes of furthering the early careers of researchers is more effective at later stages of the educational process in engineering than at the undergraduate level.

Nonetheless, undergraduate engineering students participating in the IREE program in FY 2006 reported the benefit of IREE support in terms of language acquisition, and the communication of research and education results through conference presentations when compared to travelers at the graduate and postdoctoral level of education.

Outcomes and Impacts of the IREE Program

The National Science Foundation is interested, of course, in measuring the longer-term outcomes and impacts of the program relative to the preparation of a global research workforce in engineering. STPI concludes, however, that the pilot program launched by the Foundation in FY 2006 lacked focus, precluding the specification of longer-range measurement at this time. The outputs reported by IREE travelers vary significantly by the level of education of the traveler, suggesting more attention is needed on the formulation of program goals relative to the advancement of early careers of these researchers.

The IREE program is also ambiguous about the ways in which U.S. institutions might establish collaborations with “foreign host institutions” – or document the outcome of such collaborations. STPI found little evidence in the materials furnished by the Foundation that an effort was being made on the part of the agency to track developments in this area – whether as outputs or outcomes/impacts reported by the U.S. institutions receiving IREE support.

Background

In 2006, the National Science Foundation's (NSF) Directorate for Engineering initiated the "International Research and Education in Engineering" (IREE) award as a pilot program within the Division of Engineering Education and Centers (EEC). As the *"Dear Colleague"* letter[7] explained NSF grantees could apply for supplemental funding to allow early-career researchers *to gain international research experience and perspective, and to enable closer research interaction between U.S. institutions and their foreign counterparts.*

Applicants were expected to have *meaningful and productive contacts with their counterparts in other countries.*[8] For purposes of this award, the NSF defined "early-career researchers" to include:

- Undergraduates,
- Graduate students,
- Postdoctoral fellows, and tenure-track or tenured faculty members at the assistant or associate professorship level or its equivalent.

The funded time spent in foreign institutions/laboratories for each researcher was expected to be between 3 to 6 months. Upon the completion of their travel, NSF required each faculty advisor/researcher to prepare a trip report providing details of their research experience.

Intended Impact of the IREE Program

While the "Dear Colleague Letter" conveyed the Foundation's expectations regarding the IREE program and guidelines for applicants, it was the proceedings of the first grantees conference in 2007 that furthered stakeholder understanding of program goals. Based on a review of the IREE trip reports and interviews with stakeholders, the authors of the 2007 conference proceedings suggested that the IREE program was expected to have a "positive impact on both the research and on the researchers," in three dimensions: [9]

1. Technical Impact:
    a. Brings proximity to partners/end users
    b. Enhances research productivity
    c. Gains access to new research tools
    d. Improves quality and innovation in the research

---

[7] See, NSF, "Dear Colleague Letter: IREE," NSF 06-026, available at www.nsf.gov/funding, 2006.
[8] NSF, *ibid.*
[9] Chang, Y. and E. D. Hirleman, *Proceedings of the International Research and Education in Engineering (IREE) 2007 Grantees Conference*, April 2008. Available at: https://engineering.purdue.edu/GEP/IREE2007/ .

e. Widens scope and range of applications of ongoing research
f. Increases level of robustness in research questions and solutions

2. Professional Impact:
    a. Reinforces project management imperative
    b. Exercises a broad range of leadership options and styles
    c. Enhances transcultural teamwork and collaboration
    d. Expands range of communications capabilities
    e. Establishes global networks
    f. Encourages faculty-student interaction

3. Global/Transcultural Impact:
    a. Fuels emergence of "best practices" effective in sustaining transcultural collaborations
    b. Encourages the innovative development of "shared work space" to accommodate cultural difference
    c. Develops/extends research communities beyond the United States
    d. Increases non-English language proficiencies
    e. Affirms the centrality and power of language
    f. Contributes to solutions of global grand challenges

The 2007 proceedings document continues to guide stakeholder discussion of the IREE program as evidenced by its availability the subsequent year to FY 2007 IREE awardees.

Results of the FY 2006 IREE Competition

In response to the first announcement, over 170 grantees (out of a total of 4,500 eligible grantees)[10] applied for supplemental funding to travel abroad. By September 2006, NSF awarded approximately $3.3 million in supplemental funding to support the international travel of 114 undergraduate, graduate students, postdoctorals, and early-career faculty, at an average level of $28,500 in supplemental support per traveler.

By April 2008, 114 travelers had filed trip reports from the first round of IREE awards.[11] Appendix A presents the suggested template for preparing an IREE trip report.

[10] W. Aung, "IREE: Motivation and Implications," October 2007. Available at: https://engineering.purdue.edu/GEP/IREE2007/documents/Aung.pdf .

[11] Some trip reports address the international research and education experiences of two or more individuals. See: https://engineering.purdue.edu/GEP/IREE2007/documents/IREE_final.pdf .

Nature and Scope of the STPI Analysis

In 2008, the IREE program was "paused" to permit a systematic analysis of specific outcomes and accomplishments attained by IREE grantees.[12] To that end, the Foundation's Division of Engineering Education and Research Centers asked the IDA Science and Technology Policy Institute (STPI) to assess the early outcomes of these IREE travel awards. The report that follows summarizes the results of the analysis that took place between April and December 2008.

The objective of the STPI analysis of the IREE program was three-fold:

1. To characterize the portfolio of IREE awards made in FY 2006,
2. To document selected outputs based on the trip reports filed by FY 2006 grantees, and
3. To specify the types of indicators that would be needed to gauge the longer-term outcomes and impacts of the IREE program.

The overarching evaluation question asks whether the NSF IREE program is accomplishing its goal of enabling early-career researchers *to gain international research experience and perspective, and to enable closer research interaction between U.S. institutions and their foreign counterparts.*[13]

To establish a baseline understanding of the range and types of travel experiences supported through FY 2006 funding, STPI examined the IREE awards portfolio for evidence of those factors that could be evaluated at different points in this supplemental awards program life cycle. Such factors include:

- Inputs (funding from the National Science Foundation; project leadership and management, including U.S./non-U.S. institutional arrangements)
- Activities (length of travel; relationship of overseas research project to objectives of "current" NSF grant support)
- Outputs (technical outputs; professional outputs; and global/intercultural outputs)[14]
- Outcomes (technical outcomes; professional outcomes; global/intercultural outcomes)
- Impacts (in a larger sense, a strong global presence of these engineers)

STPI developed an IREE "Logic Model" to guide staff thinking about the relationship among these variables. (See Figure 1.)

---

[12] W. Aung, NSF, *personal communication*, April 2008.

[13] NSF, "Dear Colleague Letter: IREE," NSF 06-026, *op. cit.* 2006.

[14] For purposes of this analysis, STPI adapted the list of "intended impacts" articulated by the report authored by Y. Chang and E.D. Hirleman, *op.cit.* 2008.

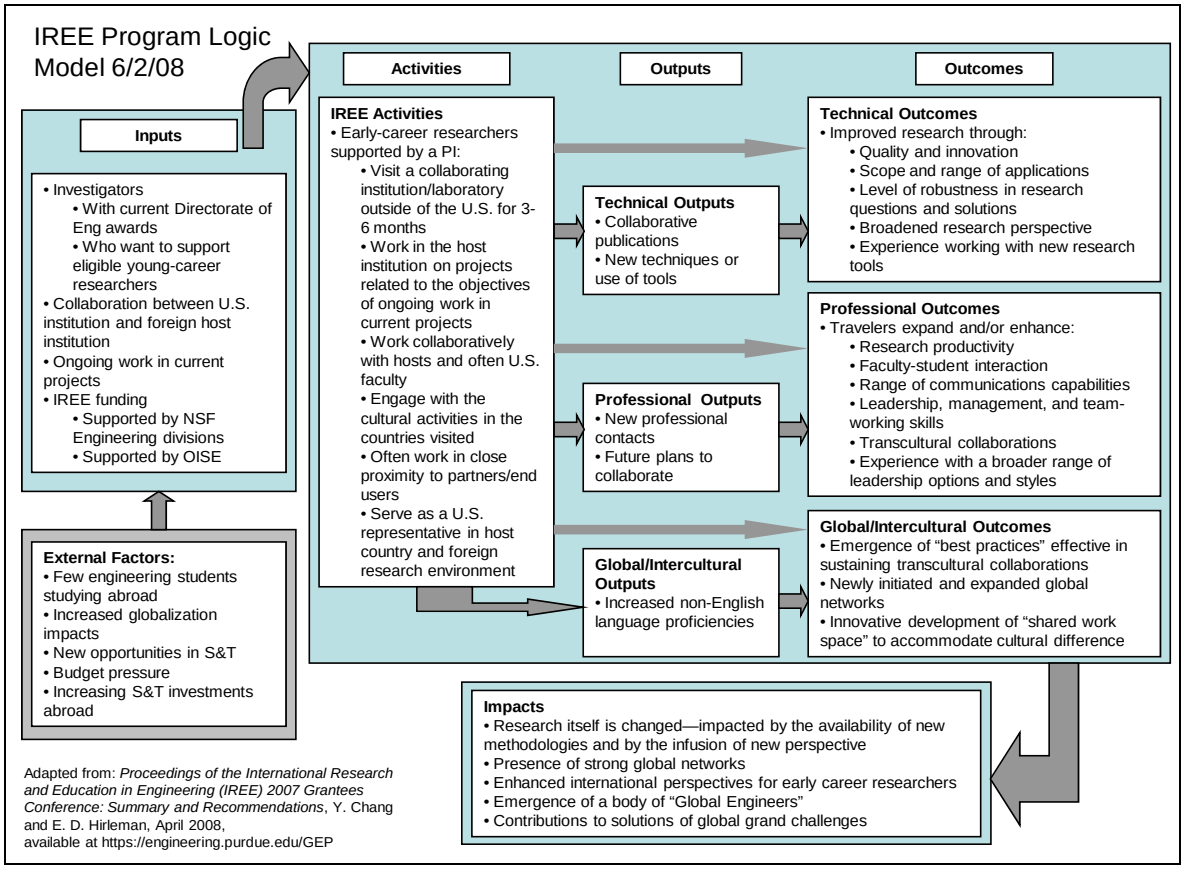
Method

To conduct its analysis, STPI reviewed budget information furnished by the National Science Foundation, as well as the trip reports filed by the FY 2006 grantees. The analysis of the trip reports was conducted using a text analysis method.

To guide its work, STPI generated a set of "study questions" for purposes of analyzing the portfolio of IREE awards. Appendix B provides a detailed listing of the study questions that guided the work of the STPI project team.

STPI also interviewed a sample of IREE "travelers" to gain further insights into the nature of their research and education experiences abroad, outputs, and anticipated outcomes and impacts. Appendix C describes the STPI sampling strategy and the types of questions posed to IREE awardees.

Figure 1: IREE Logic Model



SOURCE: IDA Science and Technology Policy Institute, 2008.

Limitations of the IREE "Trip Report" as a Research Document

The National Science Foundation requires that IREE principal investigators (PI) and/or travelers complete a "trip report" upon return to the United States. The Foundation provided STPI with 100 trip reports filed by IREE travelers in the FY 2006 cohort as of April 2008. These trip reports represent narrative documents that generally follow the outline appearing in Appendix A of this report.

STPI encountered several problems in using the IREE trip reports for purposes of the analysis that follows. The first problem involves authorship of the trip reports. Of the 100 trip reports filed by the FY 2006 IREE cohort, only 68 were authored by the traveler. Trip reports were often authored by PIs reporting on the travel experiences of one – and sometimes more than one – IREE traveler. STPI discovered a duplicate trip report among the 100 reports furnished by the Foundation. In the end, STPI successfully identified 114 travelers:

- 18 undergraduate engineers
- 84 graduate student engineers
- 12 postdoctoral engineers, including tenure-track junior faculty

If NSF intends that trip reports will serve as a record of the IREE travel experience, it would be helpful to require that the report be authored by the traveler.

The IREE trip reports represent narrative summaries of the travel experience. Using a text analysis method, STPI constructed 12 categories for purposes of tallying the frequency of certain activities viewed to reflect the goals of the program. STPI conducted random quality-control checks throughout the process of tallying the activities and outputs of the IREE travel experience. STPI identified 12 categories for purposes of scoring the contents of the trip reports. The 12 categories appear below, together with an overall frequency count (in parentheses) of the number of occurrences of each activity based on a reading of the 114 trip reports.[15]

1. **Publications accepted, submitted, or planned for submission** (28 occurrences)
2. **Conference paper, technical paper, or manuscript** (10)
3. Attended conference/workshop (8)
4. Plan future conference/workshop (5)
5. **Continuing/future collaborative research planned** (60)
6. **Future exchange of researchers/students planned** (21)
7. **New tools, techniques or methods learned or developed** (36)
8. Patent application (1)

[15] Owing to the fact that some trip reports reported the experiences of more than one IREE traveler, STPI made an effort to identify the experiences unique to each traveler but otherwise understood the report to include experiences shared by all travelers included in the trip report.

9. Experience contributed to thesis (6)
10. Consider further education/employment abroad (2)
11. **Language studied/learned** (19)
12. Experience included industry/university interaction (6)

For purposes of the analysis that follows, STPI selected the six most frequently cited activities/outputs for use in the report that follows. These appear in **bold** lettering in the preceding list.

Using the IREE framework introduced during the 2007 conference proceedings,[16] STPI considers key outputs utilized in this report to contribute to the following categories:

- Technical Outputs
  - Publications accepted, submitted, or planned for submission
  - Conference paper, technical paper, or manuscript
  - New tools, techniques, or methods learned or developed
- Professional Outputs
  - Continuing/future collaborative research planned
  - Future exchange of researchers/students planned
- Global/Intercultural Outputs
  - Language studied/learned

Organization of the Report

In the pages that follow, STPI presents the results of its analyses using the program lifecycle outlined in Figure 1. The report presents descriptive statistics, supplemented by examples drawn from the reports of the IREE travelers. The report also identifies certain emerging issues for further consideration by the Foundation's Division of Engineering Education and Centers as it reviews the status of the IREE program in the coming years.

The STPI report also includes numerous technical appendixes. Taken together, these appendixes provide an archival summary of many aspects of the IREE program as it was structured in FY 2006 and documented by the STPI analysis.

[16] Chang and Hirleman, *op. cit.*, 2008

Inputs

STPI defines "inputs" to the IREE program to include funding support provided by the National Science Foundation and project leadership and management, including U.S./non-U.S. institutional arrangements.

NSF Support of the IREE Program, FY 2006

Principal investigators with active grants[17] supported by the following Engineering Directorate Divisions were eligible to apply for supplemental travel funds through the IREE program:

- Engineering Education and Centers (EEC)
- Electrical and Communications Systems (ECS)
- Bioengineering and Environmental Systems (BES)
- Chemical and Transport Systems (CTS)
- Civil and Mechanical Systems (CMS)
- Design and Manufacturing Innovation (DMI)

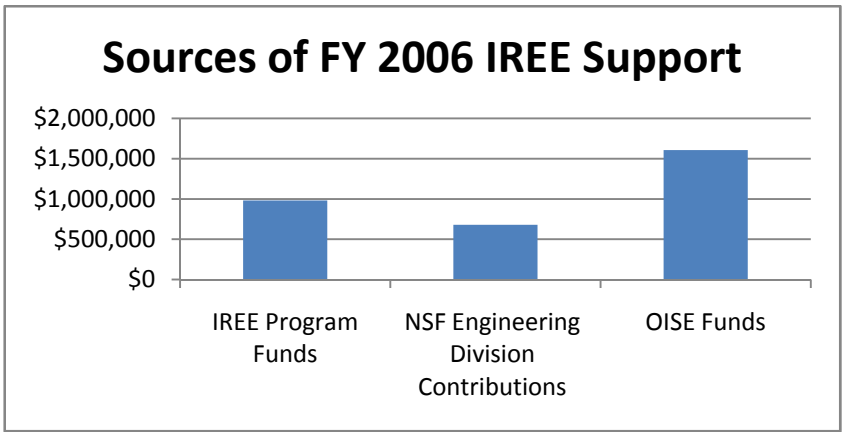
NSF program officers from those NSF Divisions and the NSF Office of International Science and Engineering Programs (OISE)[18] managed the IREE requests for supplemental funding. As mentioned earlier, NSF received a total of 177 applications for supplemental travel support during this pilot phase of the program, and funded 114 travelers (64% success rate.) IREE program support combined with Division program funds and OISE funding provided a total of about $3.3 million for these travel awards in FY 2006 – or an average of $28,500 per traveler. (See Figure 2.)

IREE program funds	$981,700
Division program funds	$678,600
OISE funds	$1,606,700
TOTAL FY 2006 IREE Support	$3,267,000

[17] "To be eligible, the expiration dates, including no-cost extension, of current awards must fall on or after September 1, 2007. The maximum duration for IREE supplements is one (1) year." See, NSF, "Dear Colleague Letter: IREE," NSF 06-026, *op. cit.*, 2006.

[18] The Office of International Science and Engineering (OISE) serves as a focal point for international science and engineering activities both inside and outside NSF. The Office carries out its functions through close partnership with the NSF Directorates and through its own program activities. OISE is housed within the Office of the NSF Director since its role is Foundation-wide. OISE encourages funding applicants to include an international component in proposals submitted to the appropriate research directorate. See: http://nsf.gov/div/index.jsp?org=OISE.

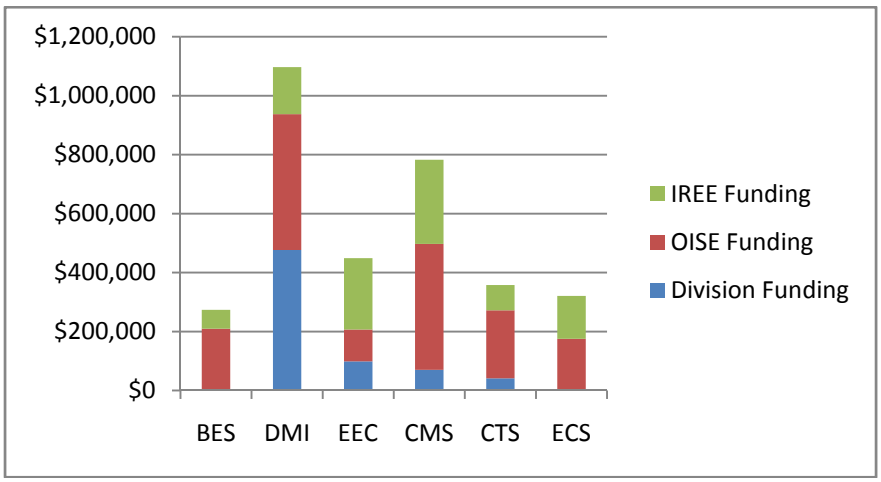
Figure 2: Relative Contribution of NSF Support for IREE in FY 2006



SOURCE: National Science Foundation, 2008.

When analyzed by NSF Engineering Divisions, the Division of Design and Manufacturing Innovation provided a larger share of travel support than any other NSF Engineering Division in FY 2006, as shown in Figure 3 (below). The NSF Office of International Science and Engineering (OISE) supported IREE travelers in all six NSF Engineering Divisions in FY 2006. OISE funding served as the primary source of travel support in most those divisions. The Bioengineering and Environmental Sciences (BES) and Electrical and Communication Systems (ECS) divisions relied exclusively on a combination of OISE and IREE program support to fund travelers in FY 2006. (See Figure 3.)

Figure 3: IREE Funding by NSF Engineering Division, FY 2006

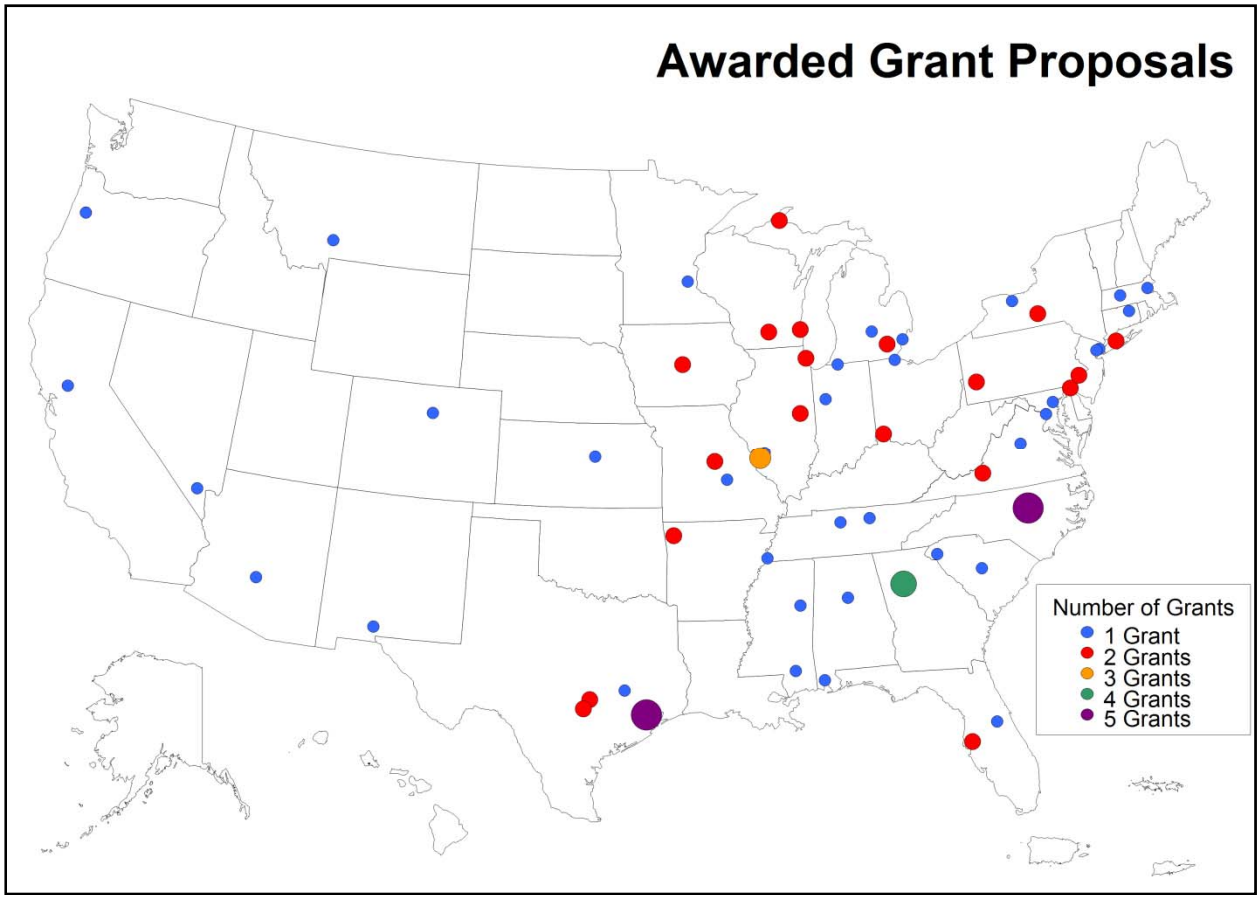


SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

Geographic Distribution of NSF IREE Support in FY 2006

Figure 4 (below) is a map of the U.S. institutions sending travelers abroad. U.S. institutions participating in the IREE program in FY 2006 reflected a broad geographic distribution, but with greater participation evident for those travelers whose home institutions were located in the Midwest or on the East Coast. More than half the U.S. institutions sponsored just one traveler in FY 2006, while others sponsored multiple travelers that year.

Figure 4: Geographic Distribution of Participating U.S. Institutions by Number of Funded IREE Grants, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)
NOTE: See Appendix D for a list of participating U.S. institutions.

Project Leadership and Management

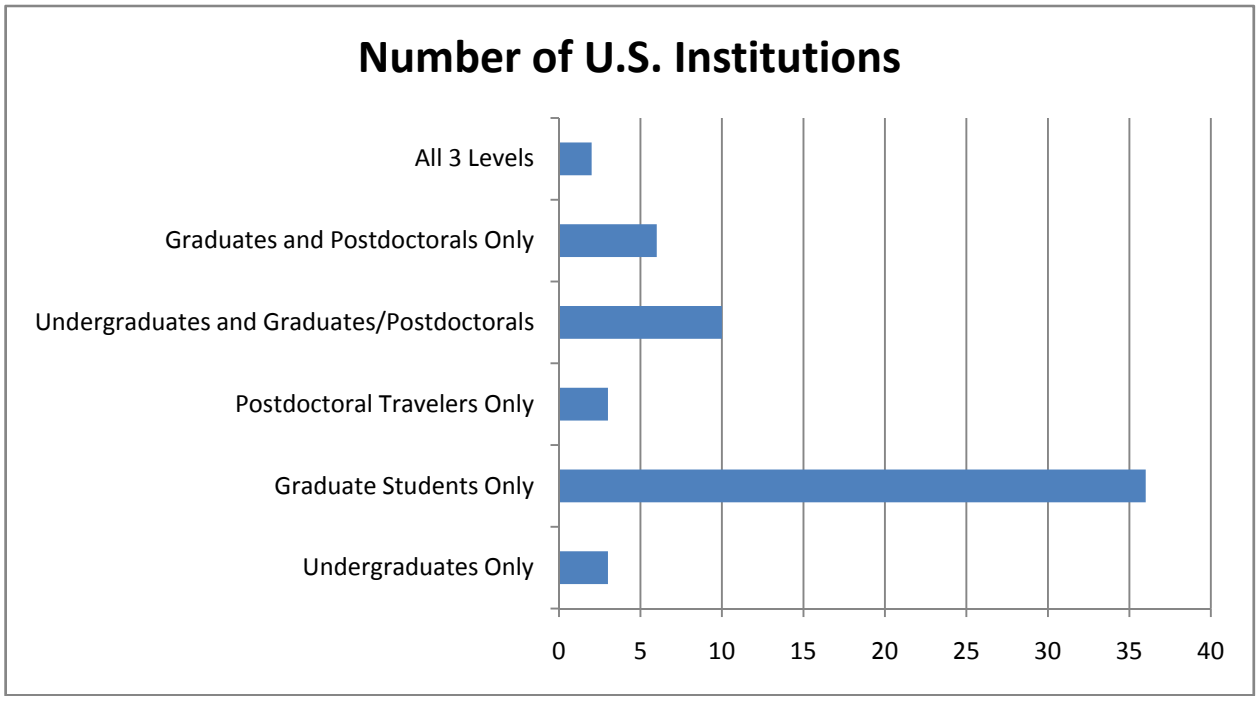
To explore the nature of the interaction between U.S. institutions and their foreign counterparts,[19] STPI examined the trip reports filed by FY 2006 IREE travelers and constructed a data file for purposes of further analysis.

U.S. "Sending" Institutions

In FY 2006, 60 U.S. colleges and universities sponsored the IREE travelers. Appendix D provides a detailed listing of those institutions.

Institutions varied on the number of travelers each sent abroad through the IREE program in FY 2006, and on the education level of the traveler. For example, three of the 60 participating U.S. institutions exclusively sponsored undergraduate travelers in FY 2006. The vast majority of U.S. institutions (36 out of 60) exclusively sponsored the travel of graduate students that year.

Figure 5: Number of Participating U.S. Institutions by Level of Education of the IREE Traveler, FY 2006

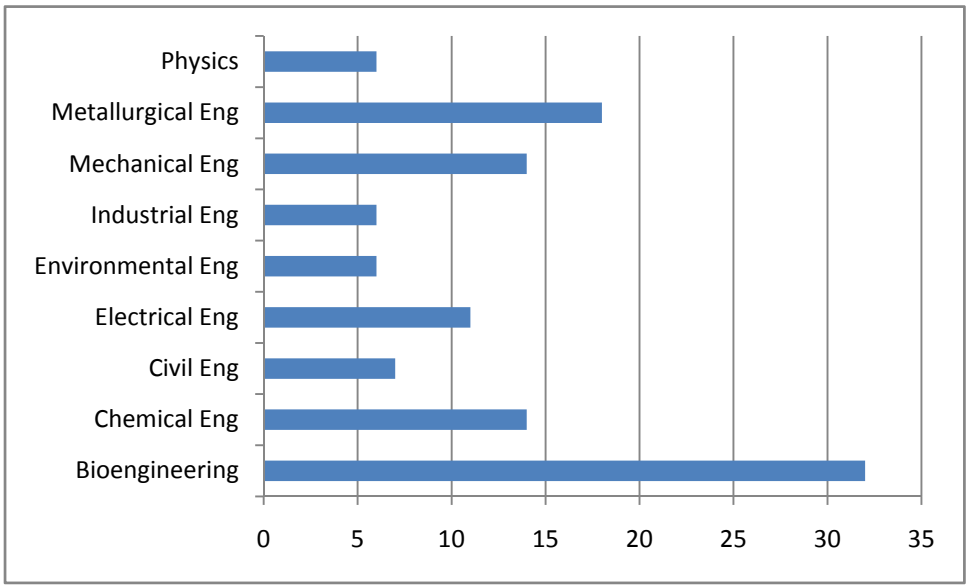


SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

[19] A goal of the IREE program articulated by the NSF, "Dear Colleague Letter: IREE," NSF 06-026, *op. cit.*, 2006.

About 30% of the IREE travelers represented early-career researchers specializing in bioengineering (32 of 114), as shown in Figure 6 (below). Other engineering specialities among these IREE travelers included: metallurgical (18), mechanical (14) and chemical engineering (14).

Figure 6: Research Specialization of IREE Travelers, FY 2006



SOURCE: National Science Foundation, IREE Trip Reports, 2008. (Tabulations generated by IDA STPI.)

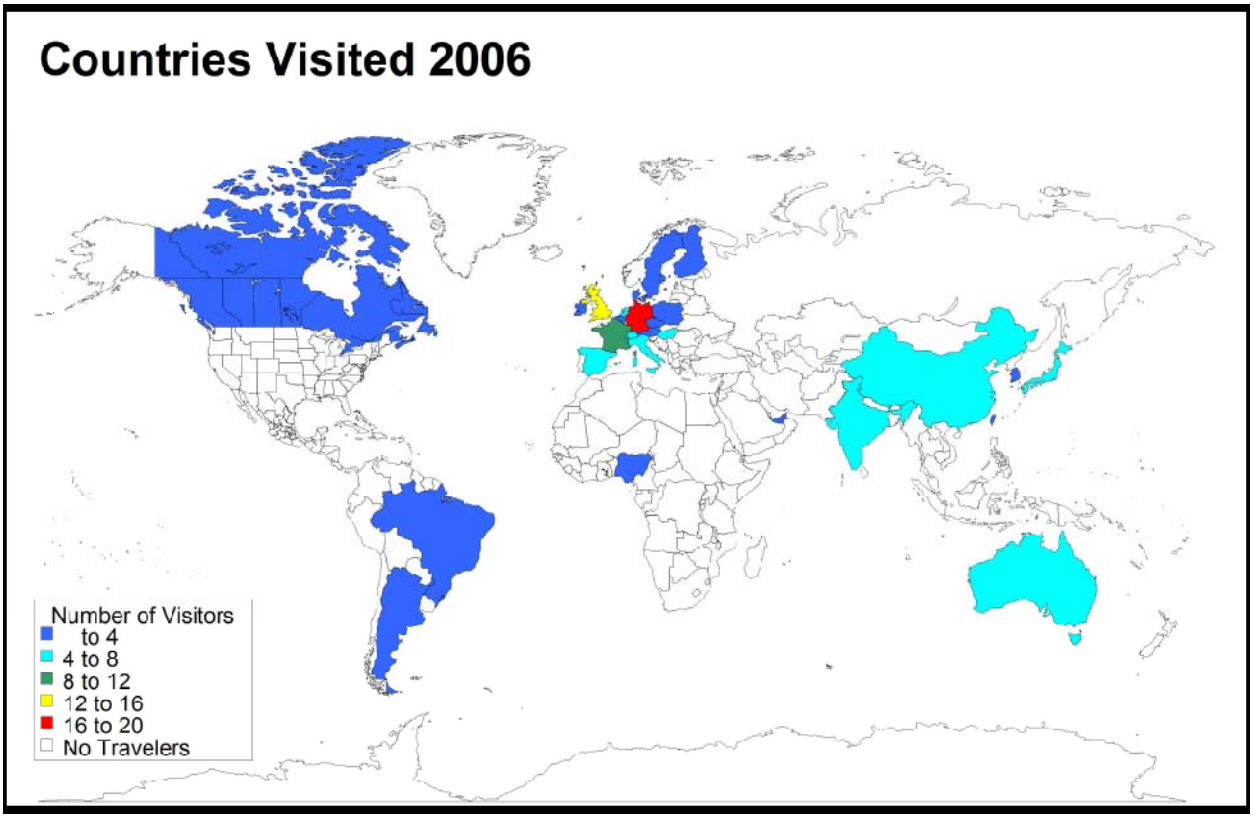
"Host" Institutions

Information regarding the institutions "hosting" IREE travelers in FY 2006 is available only by reviewing the trip reports filed by those travelers. STPI compiled a list of "host" institutions using those trip reports, which is reproduced in Appendix E. Travel patterns differed across the level of education of the IREE traveler:

- A total of 18 undergraduates traveled to a total of 10 different countries.
- A total of 84 graduate students traveled to a total of 26 different countries.
- The 12 postdoctoral IREE awardees traveled to 10 different countries.

Institutions located in Germany, England, and France hosted the largest number of FY 2006 IREE travelers regardless of level of education, as illustrated in Figure 7 (below).

Figure 7: Countries "Hosting" IREE Travelers and Number of IREE Travelers per Country, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)
NOTE: See Appendix E for a list of participating host institutions by country.

Relationships Between "Sending" and "Host" Institutions

"Sending" Institutions

A review of the FY 2006 IREE trip reports provides some insights into the relationship between U.S. "sending" institutions and the institutions that hosted IREE travelers. Forty-one of the 60 U.S. institutions sending IREE travelers abroad each sent travelers to just one host institution.

Nineteen of the 60 U.S. institutions participating in the IREE program in FY 2006 reported relationships with multiple host institutions. Examples include:

- Clemson University
  - Denmark Technical University
  - Max Planck Institute for Polymer Research
  - University of Duisberg-Essen

- Colorado State University
    - Universidad de Buenos Aires
    - University of Duisberg-Essen
    - National Institute for Earth Sciences & Disaster Prevention (Japan)

- University of Arizona
    - Budapest University of Technology and Economics
    - University of Leipzig
    - University of Zurich
    - SATIE (France)
    - University of Warsaw

Appendix F provides a complete listing of the 19 U.S. universities having multiple relationships with host institutions, as reported by IREE trip reports for FY 2006.

"*Host" Institutions*

A review of the FY 2006 IREE trip reports also revealed that some host institutions accepted travelers from more than one U.S. institution. Examples include:[20]

- The University of Western Australia hosted undergraduate IREE travelers the same year from:
    - Pennsylvania State University
    - LeTourneau University

- The University of Cambridge sponsored IREE graduate student travelers the same year from:
    - Portland State University
    - Virginia Tech
    - Northeastern University

Appendix G provides a complete listing of host universities having relationships with multiple U.S. sending institutions, as recorded by IREE trip reports for FY 2006.

[20] Note, no institution participating in the FY 2006 program hosted postdoctoral IREE travelers from more than one U.S. university.

Emerging Issues

Strengthening the Interaction Between U.S. Institutions and Their Foreign Counterparts

By themselves, the IREE trip reports shed no light on inter-institutional relationships. Other studies are needed to explore whether the IREE program strengthens the interaction between U.S. institutions and their counterparts, in line with the goals of the program. Some questions that merit further analysis include:

- Did the 60 U.S. institutions that participated in the IREE program in FY 2006 represent a unique subset of U.S. colleges and universities as far as having in place, on-going relationships with the host institutions that participated in the program that year?

- Could differences in institutional readiness to sponsor the international travel of engineers be reflected in the fact that NSF received 170 applications for IREE support in FY 2006, out of a total of 4,500 active grants that year?

    - Are there barriers to the participation of other U.S. universities in programs like the IREE that require the agreement of host institutions to accept early-career engineering researchers? Is there a role for the NSF in lowering or otherwise eliminating these barriers?

- What accounts for the disproportionate participation of graduate students in the IREE program in FY 2006?
    - Does it reflect a greater readiness of sending and/or hosting institutions to encourage international training of engineering students at this stage of early-career research development? Are there other factors at work?

- What accounts for the disproportionately low number of undergraduates participating in the IREE program in FY 2006?
    - Does it reflect a lack of interest of sending and/or hosting institutions to encourage the participation of engineering students at this stage of early-career research development?
    - Are there other sources of support being used by undergraduate engineering students for purposes of gaining international experience?

- What accounts for the disproportionately low number of postdoctorals (including tenure-track faculty) participating in the IREE program in FY 2006?
    - Does it reflect a lack of interest of sending and/or hosting institutions to encourage the participation of engineers at this stage of early-career research development?

- Are there other sources of support used by postdoctoral students in engineering for purposes of international travel?

As the National Science Foundation plans its investment in international research and education opportunities for engineers in the coming years, it will be important to learn more about those factors that contribute to the readiness of U.S. institutions to establish relations with host institutions abroad – and vice-versa.

The United States as a Learning Partner in International Inter-Institutional Cooperation

There are, of course, other programs throughout the world that also aim to strengthen inter-institutional relations across country boundaries for purposes of advancing science and engineering. The Erasmus Program of the European Union, for example, promotes inter-institutional interactions between institutions within Europe and abroad. Appendix H provides a brief overview of the program's goals and summarizes the results of two recent evaluations of the program. The experiences of the European Union in fostering inter-institutional cooperation across country boundaries, and the formulation of program goals and their measurement, may be instructive to the Foundation as it furthers its own investment for the advancement of engineering education and research through inter-institutional arrangements between the United States and other countries.

This page intentionally left blank.

Activities

STPI considers the activities of the IREE program to include key elements of the travel experience. This includes: trip duration, nature of the work, and collaboration at host institutions, as well as involvement in the cultural activities of the host country. In this section, STPI summarizes the activities of the 114 IREE travelers who filed trip reports by April 2008.

STPI further partitions the results of its analyses by the highest level of education of each IREE traveler: undergraduate, graduate, and postdoctoral (including tenure-track junior faculty).

Trip Duration

Undergraduate Travelers

A total of 18 undergraduate engineering students participated in the IREE program in FY 2006. A total of 15 U.S. universities sponsored the travel of these IREE early-career researchers. The undergraduates traveled to 10 different countries:

- Germany (6)
- Australia (2)
- Denmark (2)
- China (2)
- Hungary, France, Japan, Italy, Nigeria, and Canada (1 each)

The average duration of the IREE trip at the undergraduate level was 87.9 days.

Graduate Student Travelers

A total of 84 graduate students in engineering participated in the IREE program in FY 2006. A total of 53 U.S. universities sponsored the travel of these IREE early-career researchers. They traveled to a total of 26 difference countries, including:

- Germany (18)
- England (12)
- France (6)
- Japan (6)

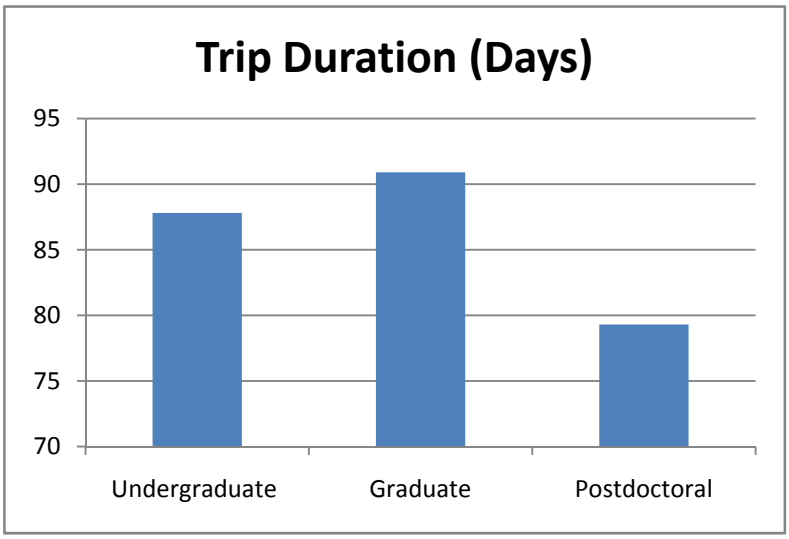
The average duration of the IREE trip at the graduate student level was 90.9 days.

Postdoctoral IREE Travelers

A total of 12 postdoctoral students in engineering students (including junior faculty) participated in the IREE program in FY 2006. A total of 12 U.S. universities sponsored the travel of these IREE early-career researchers. They sought early-career research training in 10 countries: Austria, Belgium, England, France, India, Italy, Japan, the Netherlands, Singapore, and Spain.

The average duration of the IREE trip at the postdoctoral level was 79.3 days.

Figure 8: IREE Trip Duration by Level of Education of the Travelers, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

On-Site Activities

The IREE trip reports served as the primary source of information regarding the nature of the research and education activities that took place under the aegis of the host institution. STPI supplemented these reports by conducting a limited number of interviews with IREE principal investigators and travelers. To provide some insight into the nature of these on-site activities, STPI offers a series of case study vignettes below. Taken together, the material provides some understanding of the variety and richness of the IREE experience as reported by the PIs and/or travelers.

Research Projects: Collaboration with Host Institutions

The IREE program expects the principal investigators at U.S. institutions, through their established contacts with investigators at host institutions, will arrange for a meaningful

research experience for travelers regardless of the level of education of the traveler. From the trip reports filed by FY 2006 IREE participants, STPI selected an example of a research activity at the undergraduate, graduate, and postdoctoral levels.

Undergraduate IREE Case Study

G. Nathan Green, an undergraduate major in bioengineering at LeTourneau University in Longview, Texas, traveled to the University of Western Australia (UWA) to develop a framework to study neuromusculoskeletal models from medical images. According to the IREE trip report, Green participated in all phases of laboratory activities during his tenure (83 days). Meetings regularly occurred between Green and his UWA supervisor. Green performed alongside PhD candidates, who according to the trip report: "greatly enhanced his international experience as well as the computational model."

Figure 9 (below) provides more detailed information regarding the subject of the research activity, in excerpt form. The trip report indicates that Green published his work at the Houston Society for Engineering in Medicine and Biology, and the American Society of Biomechanics.

Graduate Student IREE Case Study

Benjamin W. Jacobs and Andrew D. Bacziewski, both PhD candidates in Mechanical Engineering at Michigan State University, traveled to the Tokyo Institute of Technology with IREE support. Each student spent 90 days at the Tokyo Institute, which enabled them to "learn the skills of the nano-carbon onions growth group," according to the trip report.

The principal investigator, Virginia M. Ayers, explains in the project summary that the IREE grant allowed the students to "combine nanomaterial growth expertise of the Tokyo Institute of Technology group with the nano/atomic scale characterization expertise of the Michigan State University group…The visit has been a technical success with two joint USA-Japan authorship archival journal publications submitted and a third in preparation."

Figure 10 (below) provides selected details of the research activities that took place with IREE funding.

Both students reported learning Japanese language and culture as a result of the experience, as well as developing "valuable professional networks" in Japan.

Figure 9: Excerpt from IREE Trip Report (Grant No. 05-02638)

ACL-Deficient Knee Stability and Its Prevalence to Osteoarthritis

G. Nathan Green, traveler; Roger V. Gonzalez, PI
LeTourneau University, Texas

LeTourneau has a strong experimental program for model validation but, as an undergraduate institution, the number of students with multiple years to develop computational models is small. The University of Western Australia (UWA) has a large biomechanics graduate program that develops EMG driven models, but has little experimental validation of these models. This grant provided an excellent opportunity for one of LeTourneau University's computational modelers to gain experience in a graduate lab while establishing a relationship that will allow our experiments to validate UWA's models. This will be the foundation of future collaboration between our labs.
Nathan Green traveled to UWA from May 18th to August 8th, 2007, and Dr. Roger Gonzalez will travel there during March of 2008 to follow up on ideas for future collaboration.

Fig. 1 - Illustration of the modeling process as developed overseas. Progresses from MRI, to surface, to model during construction and final model.

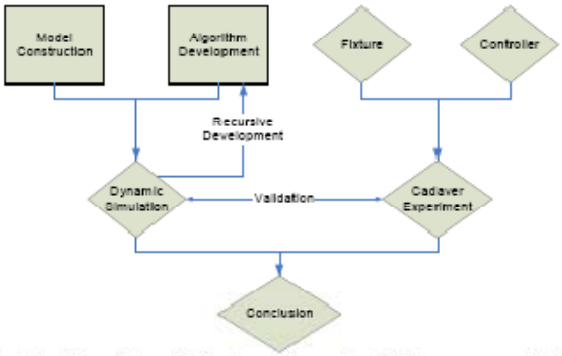


Fig. 2 - The relationship between the work of this summer and the larger NSF awarded research. Square boxes are work done during international travel, while diamonds are ongoing research.

Nathan Green was completely integrated into UWA laboratory activities during his onsite tenure. For example, he participated as a volunteer subject for a motion capture study as well as taking part in the daily scholarly activities of the laboratory. By participating in discussions among lab members, he was able to

Figure 10: Excerpt from IREE Trip Report (Grant No. DMI-0637134)

Nano Mechanical and Electronic Investigations with Tokyo Institute of Technology

Benjamin W. Jacobs and Andrew D. Baczewski, travelers; Virginia Ayres, PI
Michigan State University

A new scanning probe microscope methodology has been developed under the current NSF award: DMI-0400298: Scanning Probe Recognition Microscopy. Scanning Probe Recognition Microscopy (SPRM) gives the scanning probe microscope system itself the ability to auto-track regions of interest through incorporation of recognition-based tip control. A low resolution scan to identify regions of interest is followed by auto-track high-resolution scans of just these areas. New and powerful investigative capabilities result from this approach.

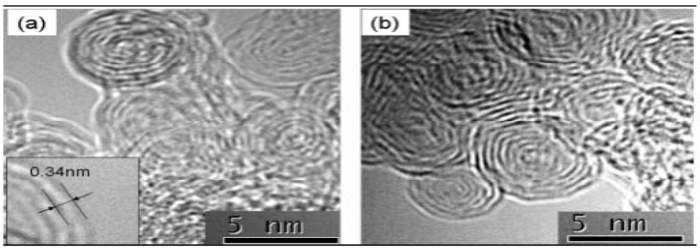
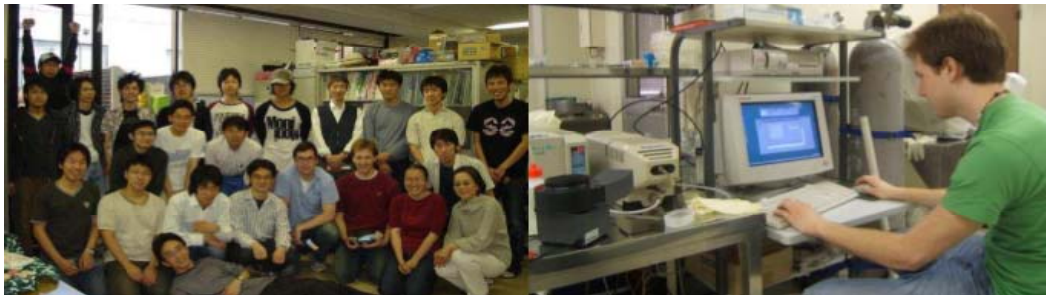


Figure 1 from A. Hirata, R. Yamada, V. M. Ayres, B. W. Jacobs and A.D. Baczewski, "Correlation of Fundamental Properties with Tribological Performance of Carbon Onions with Oxidation Treatment", submitted to Japan Journal of Applied Physics shows high resolution transmission electron microscopy of (a) untreated and (b) treated carbon onions.

Mr. Jacobs and Mr. Baczewski conducted research through learning several new techniques, including thermogravimetric analysis, X-Ray photoelectron spectroscopy, and carbon onion growth procedures with a quartz tube furnace. Graduate student group members of the host laboratory trained Mr. Jacobs and Mr. Baczewski on these instruments and provided assistance after training was completed. Additionally, Mr. Jacobs and Mr. Baczewski were able to suggest improvements in existing experimental procedures within their host lab. Mr. Jacobs and Mr. Baczewski participated in productive discussions in completing a publication with the host professor and making suggestions for future experiments as well as future publication possibilities.



- New research results that correlate atomic-scale surface and structural properties with tribological measurements and lubrication performance of nanoscale carbon onions have been achieved through this collaborative activity and have been reported. Manuscripts currently (September 2007) in preparation will report the results of additional experiments in heavy ion interactions in carbon onions, and in electronic transport in gallium nitride nanowire nanocircuits.
- The IREE showcased the new capabilities of the foundation grant in Scanning Probe Recognition Microscopy within an international investigation of key mechanical and electronic properties of two important nanomaterials, carbon onions (nested fullerenes) and gallium nitride nanowires.
- The visit has been a technical success with one joint USA-Japan authorship archival journal publications submitted and two in preparation. The visit has also been a technical success in that it greatly strengthened the collaborative interaction between the Tokyo Institute of Technology groups and Electronic and Biological Nanostructures Laboratory at Michigan State University group. This will lead to future significant research results and further international opportunities.
- The two early career researchers were, respectively, just finishing and just entering Graduate school. The IREE opportunity will have a powerful impact on their career development.
- The visit has been an international success as the early career researchers learned both Japanese language and culture, and developed valuable professional networks within Japan.

Postgraduate IREE Case Study

Jon Pearlman recently completed his doctorate at the University of Pittsburgh in Rehabilitation Science and Technology. The IREE travel grant allowed him to engage in postdoctoral research to strengthen ties between the University of Pittsburgh and the Indian Spinal Injuries Center (ISIC) in New Delhi. Specifically, Pearlman worked for three months at ISIC to identify research problems related to poor devices and clinical provisions for wheelchair users. Figure 11 (below) provides excerpts of the research work from the trip report.

The authors indicated that collaborations between ISIC and the University of Pittsburgh had previously "focused primarily on workshops, training, and curriculum development ... The IREE supplement [promoted] two important goals. First, the IREE helps support students to perform research abroad, diversifying their research experience, and putting them in reach of foreign collaborators for future research projects. Second, the IREE helps disseminate the research methods from what have been primarily U.S. based, to locations in India."

Involvement in the Cultural Activities of the Host Country

The trip reports filed by IREE travelers often mention the opportunities available for learning more about the culture of the host country, both formally and informally. STPI took the opportunity to interview several former IREE travelers to gain additional insights into the cultural benefits afforded by the IREE award.

One graduate student noted that students traveling to Europe soon realized "Europe has a very diverse student body with greater than expected research opportunities." This realization encouraged some travelers to consider obtaining postdoctoral training or employment positions abroad.

In conducting its interviews, STPI found that many IREE travelers were eager to convey to the National Science Foundation ways in which changes in the IREE program might help travelers live and work in different cultures. Highlights from some of those interviews follow:

- There was some confusion on the part of some students on how much travel/cultural exploration was possible under the IREE program relative to the research component.
- The worst part of the trip, according to more than one traveler, was the language barrier; language training before the trip would have been useful.
- The time needed to procure equipment from the host institution was the "worst part" of the IREE experience.
- Established research goals "took a different direction" half-way through at least one IREE project due to equipment problems.

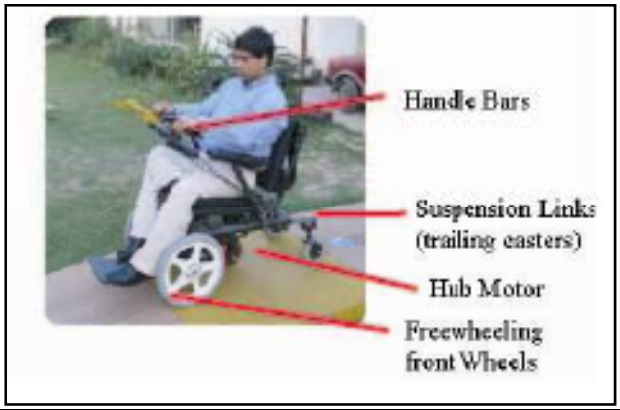
Figure 11: Excerpt from IREE Trip Report (Grant No. EEC-0552351)

International Training and Research on Assistive Technologies for India and other Low-Income Countries

Mr. Jon Pearlman, traveler; Dr. Rory Cooper, PI
University of Pittsburgh

Wheelchairs in India are scarce—of the 10 million potential users in India, only a small portion have wheelchairs. Compounding the problem is that the wheelchairs which are available are either of very low quality [8, 9], or they are high quality, but far too expensive to reach most of the potential users. A common ground must be found, where low-cost wheelchairs meet international standards [8-11], and can be produced and provided at a large scale. The fact that these products do not meet the needs of the potential users has been attributed to the fact that there is little user involvement in designing and evaluating the devices before they are manufactured. Our research goal was to address this problem, by performing a comprehensive evaluation in India of a novel powered mobility device for non-industrialized countries. Apart from the direct results from the research protocol, which suggested that the LC-PMD was a viable mobility device, the protocol itself was being tested. Such little research has been done in these countries, that it is unclear which protocols will yield the most informative results. For example, the UN and WHO [6, 7] have suggested that research needs to be carried out to help ensure mobility devices are low-cost and meet the users' needs, but research protocols are not suggested. One of the most important results from this project was to perform the research protocol in India and demonstrate that its effectiveness; this will help build research future research capacity, so the UN and WHO mandates can be carried out.

Encouraged by the success of this IREE, a second proposal was submitted which has a broader scope of research activities, and includes funding for three graduate students. These studies will specifically address issues related to service provision, training, and product quality described in recent UN and WHO documents [6, 7]. This will help build research capacity in rehabilitation technology in developing countries which is sorely needed [2, 4, 5].



- It would be nice if NSF took into account the "fluctuating global economics" when allocating travel funds.
- One traveler spent 5 months abroad with IREE funding, which she believes is a more appropriate length of time for graduate research project than the 3 months suggested by the program.
- It would have been better if the NSF had administered a pre-IREE and post-IREE questionnaire to gauge the effectiveness of the experience.
- It would have been useful if the U.S. institutions formalized ways for returning travelers to convey information about their experience to peers at the home institution.
- Computer keyboards are set up differently, which can slow participant progress.
- Housing arrangements were poor as reported by more than one traveler, with little help provided by host institutions.
- In the future it would be helpful if NSF established a network of former IREE travelers to contact before, during, or after travel.
- In the future, it might be better to offer multi-year funding to U.S. institutions to permit more effective inter-institutional planning and the recruitment of a stronger pool of travelers.
- The biggest challenge of the IREE program is that it "caters" only to U.S. institutions, making U.S. travelers guests rather than colleagues of the host institutions.

Emerging Issues

The IREE trip reports represent a useful starting point for the documentation of the travel experience. However, based on the diversity of experiences mentioned by the small sample of IREE travelers interviewed by STPI, more formal methods are needed to capture both the on-site research activities and cultural dimensions of the IREE experience. Formal data collection mechanisms, such as pre- and post-travel questionnaires to gather feedback from travelers might help the Foundation refine the program in the coming years.

Little is known about the experience of the host institutions in sponsoring the research and education activities of the U.S. travelers. The Foundation would most likely benefit from the development of mechanisms to gather such feedback. Such instruments are used by managers of other travel programs, including the Fulbright Fellowship Program,[21] as well as the Erasmus and Marie Curie Fellowship programs as outlined in Appendix H of this report.

[21] See, for example, http://fulbright.state.gov.

Outputs

As reported earlier, STPI identified an initial set of 12 variables that could be used to capture the outputs of IREE support. Based on an initial review of trip reports, STPI limited the set of output measures to six:

- Technical outputs
    - Publications accepted, submitted, or planned for submission
    - Conference papers, technical papers, or manuscripts
    - New tools, techniques, or methods learned or developed
- Professional outputs
    - Continuing/future collaborative research planned
    - Future exchange of researchers/students planned
- Global/Intercultural outputs
    - Language studied/learned

Because the types of outputs are likely to vary by level of education, STPI presents the findings of its analysis separately for undergraduate engineers participating in the IREE program, graduate students, and postdoctorals. The analysis concludes with a comparison of results by level of education for each variable.

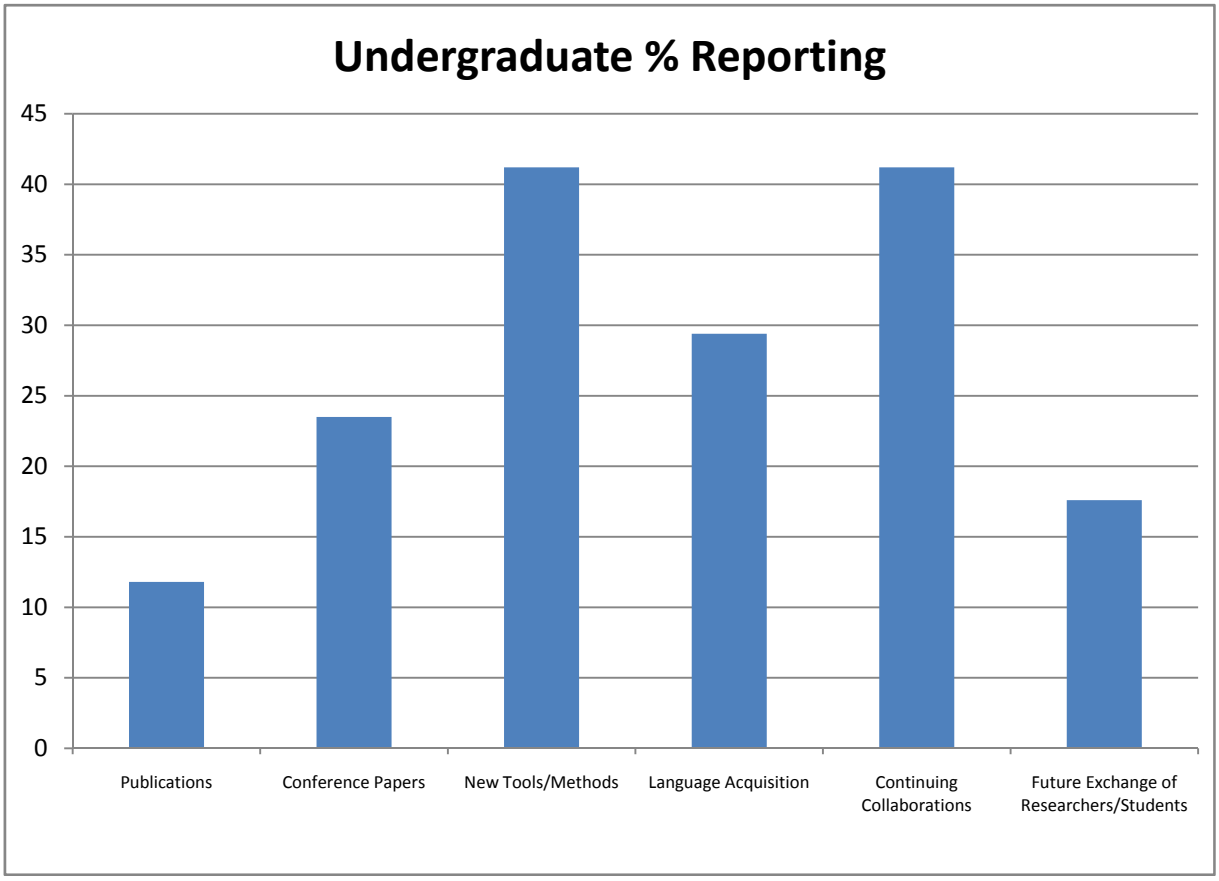
Outputs Reported by Undergraduate IREE Travelers, FY 2006

The preparation of formal publications and conference papers, and the acquisition of new tools, techniques, or methods comprise the "technical outputs" selected by STPI for analysis. Among undergraduate IREE travelers, over 40% reported that they had acquired new tools, techniques, or methods as a result of their travel experience. (See Figure 12.) Few reported the preparation of journal publications (just over 10%); greater emphasis was given to the presentation of conference papers as a result of or in conjunction with the IREE award.

Of the 18 undergraduates who participated in the program, 40% indicated that they intended or had established continuing collaborations as evidence of "professional output." Fewer reported plans for the future exchange of researchers/students by their home institutions following the completion of their IREE experience.

With respect to the measure of "global/intercultural outputs," about one-third of the IREE travelers at the undergraduate level identified language acquisition as an output of their experience.

Figure 12: Distribution of Selected Outputs Reported by Undergraduate IREE Travelers, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

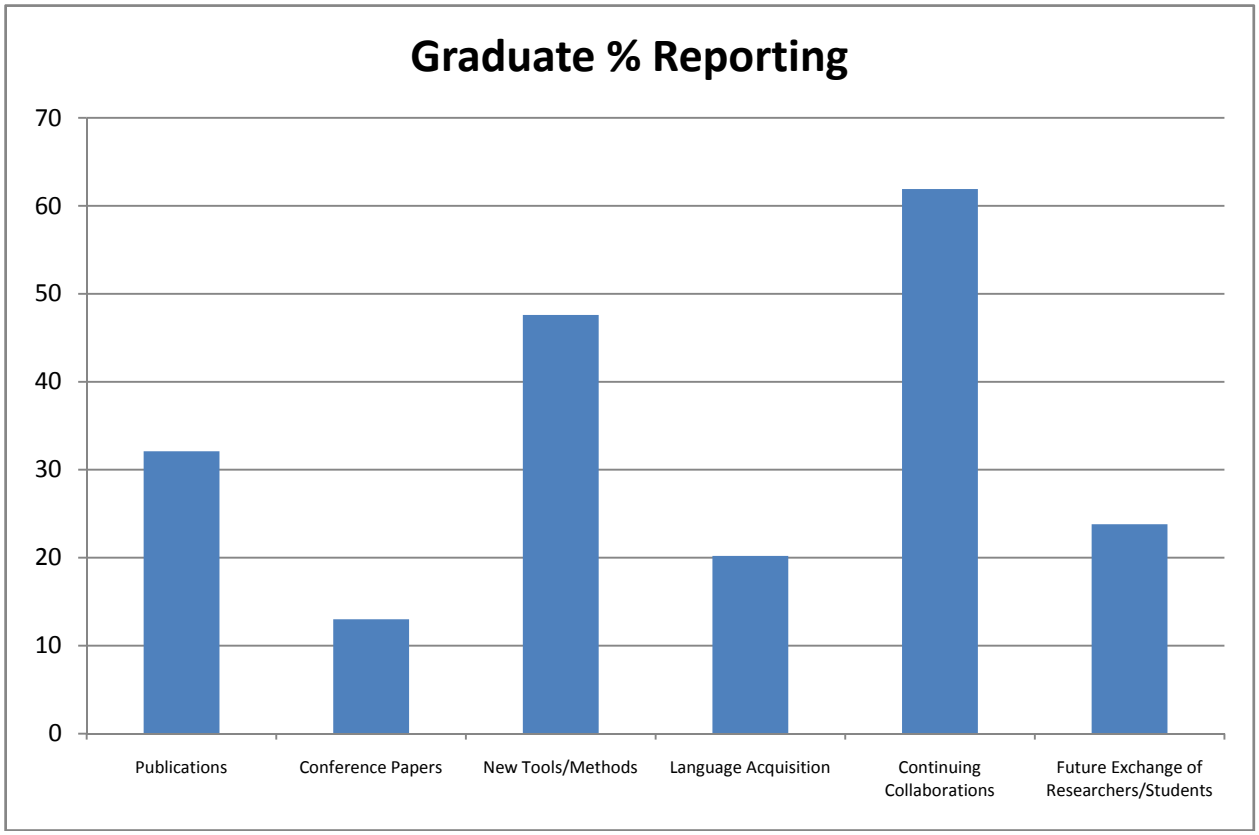
Outputs Reported by Graduate Student IREE Travelers, FY 2006

The preparation of formal publications and conference papers, and the acquisition of new tools, techniques, or methods comprise the "technical outputs" selected by STPI for analysis. Among graduate student IREE travelers, nearly half reported that they had acquired new tools, techniques, or methods as a result of their travel experience. (See Figure 13.) Another third (32%) reported that they had prepared or planned to prepare a journal publication as a result of the IREE experience. Just over 10% reported the presentation of conference papers as a result of or in conjunction with the IREE award.

Of the 84 graduate students who participated in the program, nearly two-thirds (62%) indicated that they intended or had established continuing collaborations as evidence of "professional output." About one-fourth reported that they or their home institutions planned to sustain collaborations through the future exchange of researchers/students by their home institutions following the completion of their IREE experience.

With respect to the measure of "global/intercultural outputs," about one-fifth of the IREE travelers at the graduate level identified language acquisition as an output of their experience.

Figure 13: Distribution of Selected Outputs Reported by Graduate Student IREE Travelers, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

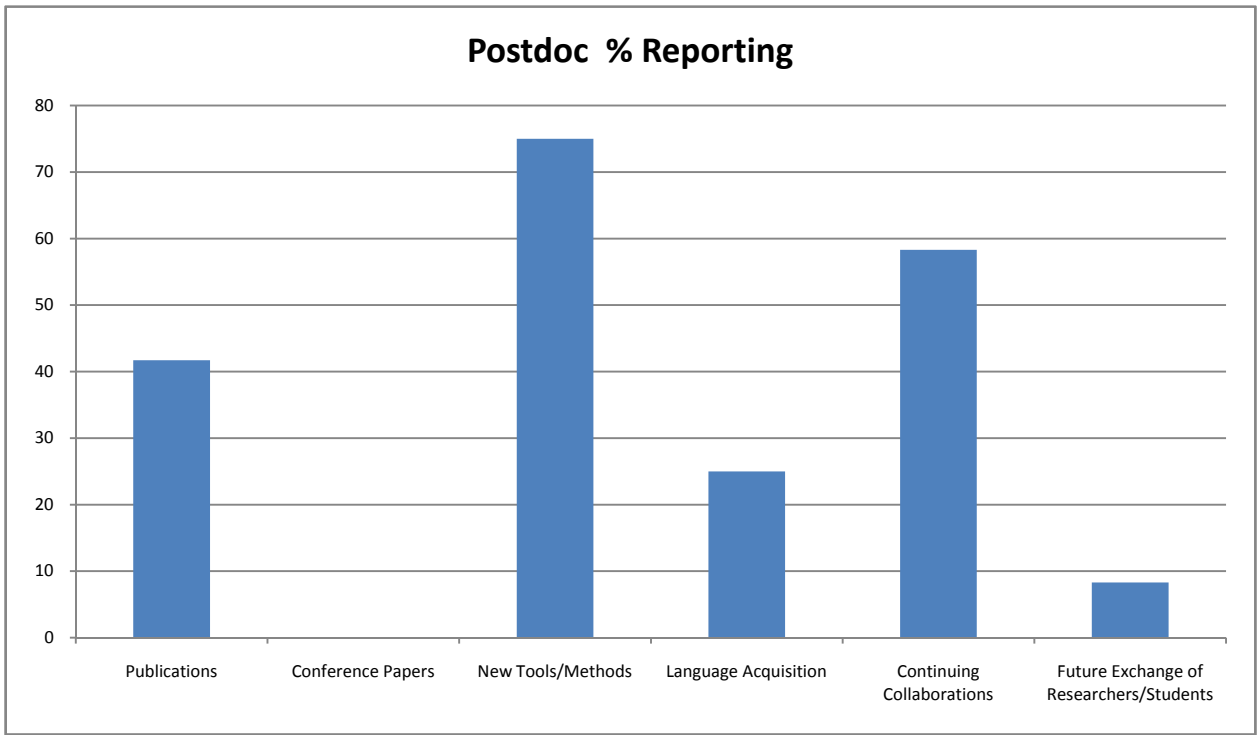
Outputs Reported by Postdoctoral IREE Travelers, FY 2006

The preparation of formal publications and conference papers, and the acquisition of new tools, techniques, or methods comprise the "technical outputs" selected by STPI for analysis. Among postdoctoral IREE travelers, three-fourths (75%) reported that they had acquired new tools, techniques, or methods as a result of their travel experience. (See Figure 14.) Nearly half (42%) reported that they had or planned to prepare a journal publication. None of the postdoctoral travelers presented conference papers as a result of or in conjunction with the IREE award.

Of the 12 postdoctoral travelers who participated in the program in FY 2006, nearly 60% indicated that they intended or had established continuing collaborations as evidence of "professional output." Fewer reported that they or their home institutions

planned to sustain collaborations through the future exchange of researchers/students following the completion of their IREE experience.
With respect to the measure of "global/intercultural outputs," about one-fourth of the IREE travelers at the postdoctoral level identified language acquisition as an output of their experience.

Figure 14: Distribution of Selected Outputs Reported by Postdoctoral IREE Travelers, FY 2006

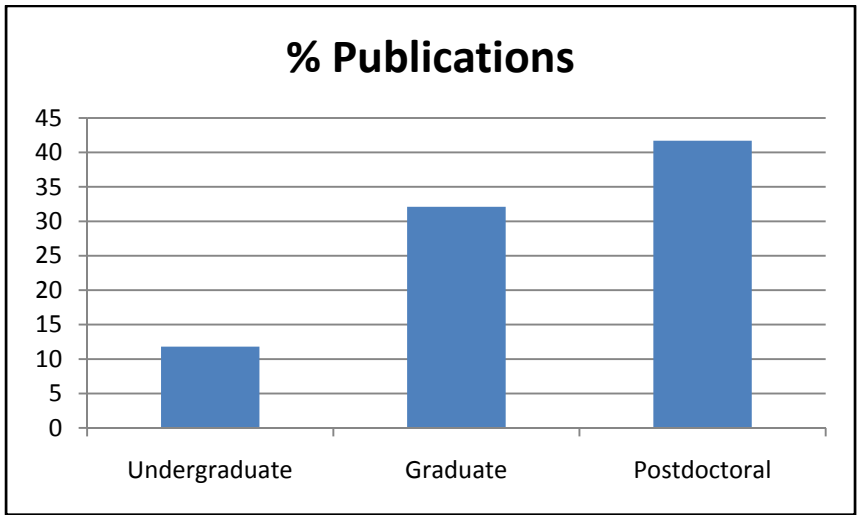


Cross-Comparisons by Level of Education

The charts below illustrate the interactive effects of level of education of the IREE travelers with the outputs reported in their trip reports.

- Graduate and postdoctoral IREE travelers are more likely to publish as a result of their IREE experience than undergraduates (See Figure 15 below.)

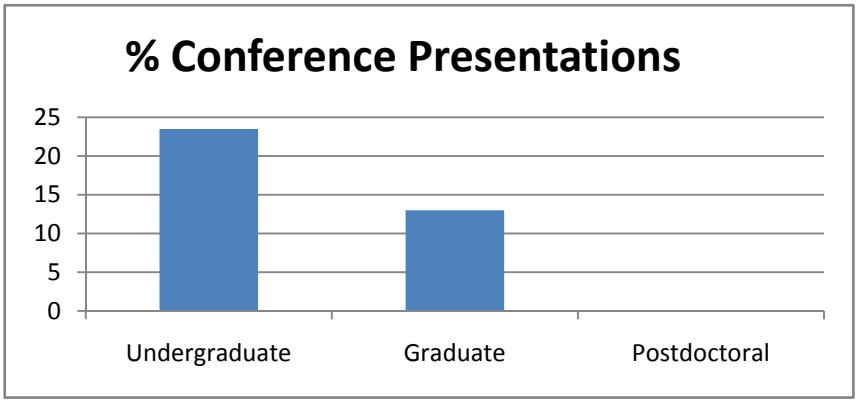
Figure 15: Comparison of Reported Plans for Journal Publications by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

- Undergraduate IREE travelers are more likely to present papers at conferences in conjunctions with or following their IREE experience than graduate students.
- Postdoctoral IREE travelers reported no involvement in conference presentations as part of their research and education experience. (See Figure 16 below.)

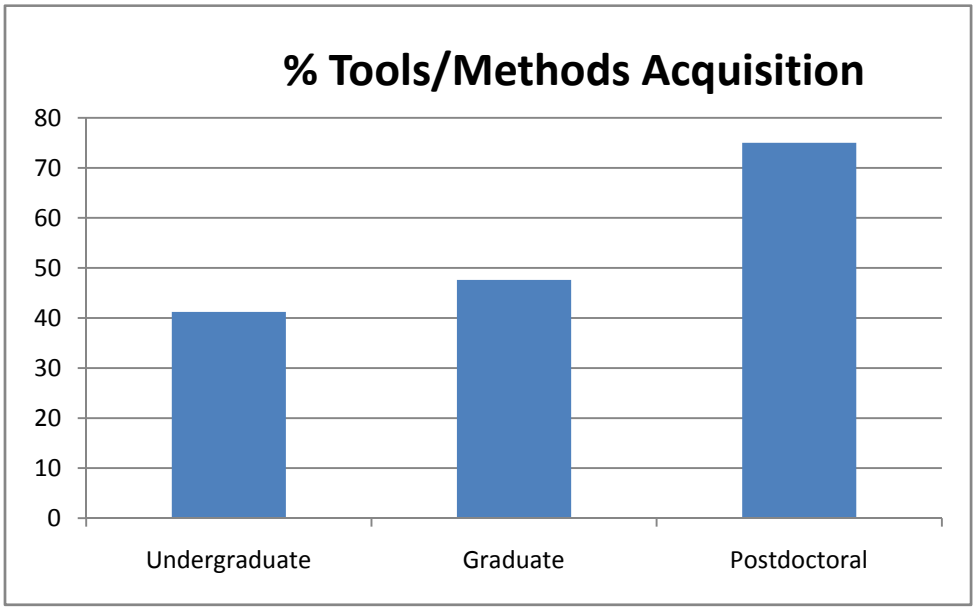
Figure 16: Comparison of Reported Plans for Conference Presentations by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

- The probability of acquiring new tools, techniques, or methods as a result of IREE travel increases as a function of the level of education of the traveler. (See Figure 17 below.)

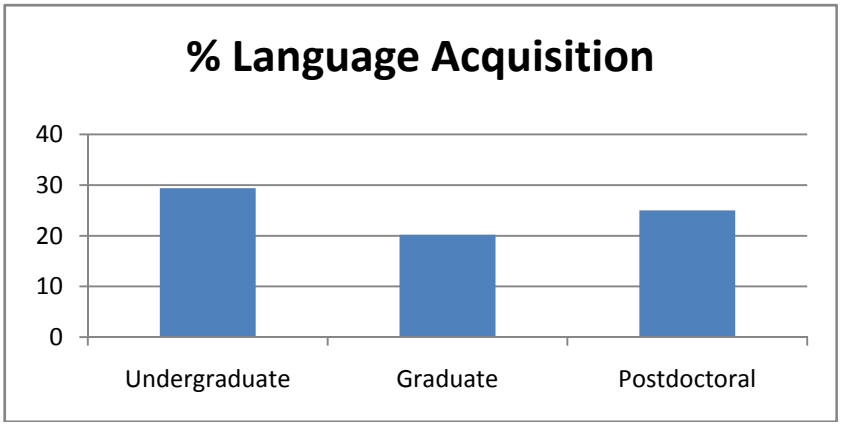
Figure 17: Comparison of Reported Acquisition of Tools, Techniques, or Methods Reported by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

- Less than one-third of IREE travelers at any level of education reported acquiring language skills as a result of their travel experience. (See Figure 18 below.)

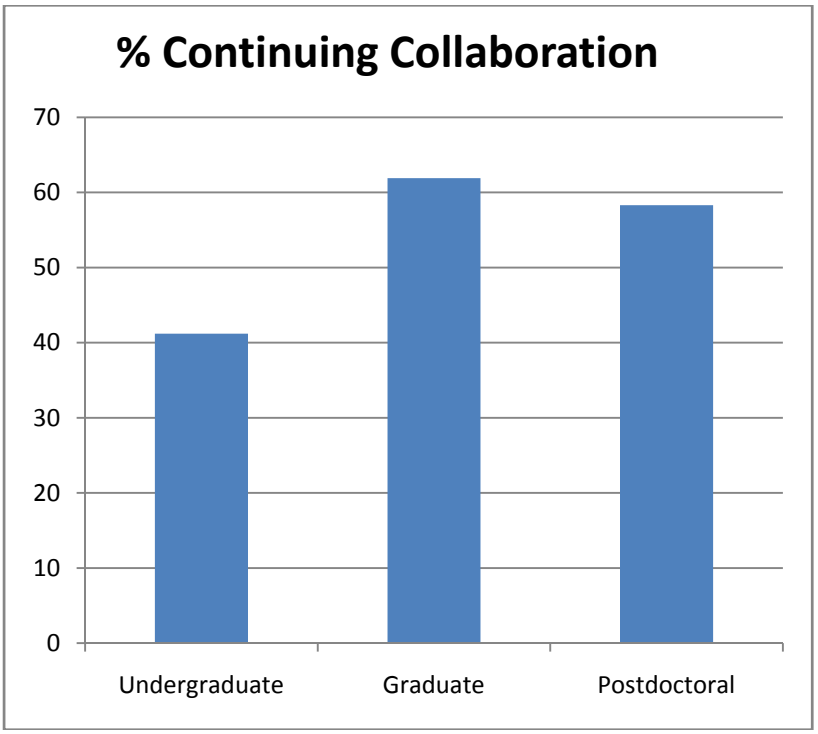
Figure 18: Comparison of Reported Acquisition of Language Skills Reported by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

- Graduate student IREE travelers were slightly more likely than postdoctoral travelers to report that they or their home institutions planned on continuing collaborations at the conclusion of the IREE experience. (See Figure 19 below.)

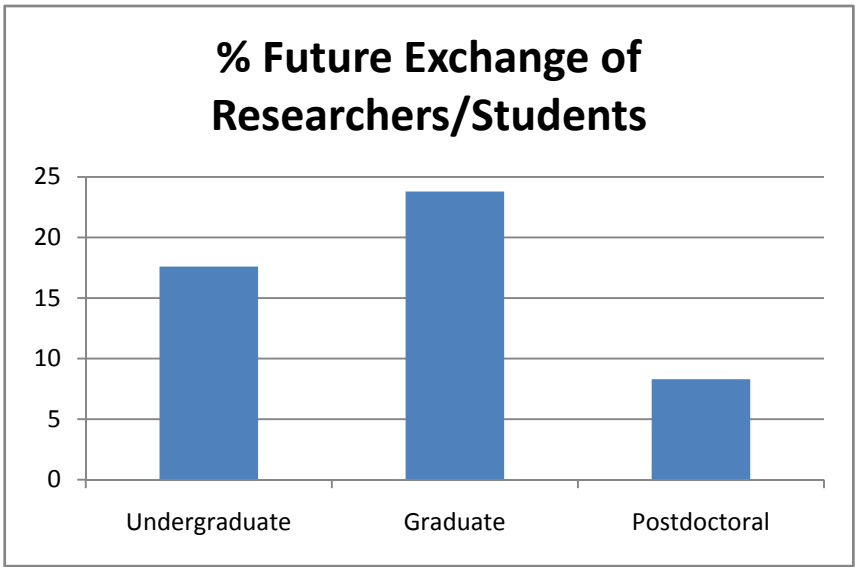
Figure 19: Comparison of Reported Plans for Continuing Collaborations Reported by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

- Less than one-fourth of IREE travelers at any level reported that they or their home institutions planned future exchanges of researchers/students following the completion of the IREE experience.
- Graduate student IREE travelers were slightly more likely than travelers in the other categories to report such plans. (See Figure 20 below.)

Figure 20: Comparison of Reported Plans for the Future Exchange of Researchers/Students Reported by IREE Travelers by Level of Education, FY 2006



SOURCE: National Science Foundation, 2008. (Tabulations generated by IDA STPI.)

Emerging Issues

Differences in the reported outputs of the IREE program when examined by level of education of the traveler raise profound questions about the structure of the IREE program. In general, most if not all IREE travelers reported gaining new research experiences and perspectives. However, postdoctoral travelers and graduate students were more likely than undergraduates to report specifically that an output of their travel included the acquisition of new tools, techniques, or methods, and publications. Postdoctoral travelers and graduate students were also more likely to report plans for continuing collaborations following the completion of their IREE experience. Taken together, these observations suggest that investment in international research and education experiences for purposes of furthering the early careers of researchers is more effective at later stages of the educational process in engineering than at the undergraduate level, at least in terms of conventional career advancement outputs like publications.

Nonetheless, undergraduate engineers participating in the IREE program in FY 2006 were more likely to report the benefit of IREE support in terms of language acquisition, and the communication of research and education results through conference presentations, when compared to travelers at the graduate and postdoctoral level of education.

This page intentionally left blank.

Outcomes and Impacts of the IREE Program

In this report, STPI analyzed the portfolio of IREE awards in FY 2006 focusing on characteristics of U.S. and host institutions, and on the activities and outputs of travelers as reported in trip reports filed by April 2008. The National Science Foundation is interested, of course, in measuring the longer-term outcomes and impacts of the program relative to the preparation of a global research workforce in engineering.

STPI concludes, however, that the pilot program launched by the Foundation in FY 2006 lacked focus, precluding the specification of longer-range measurement at this time. For example, postdoctoral and graduate engineers participating in the IREE program in FY 2006 were more likely than undergraduates to report that IREE support furthered their research careers as measured by tool acquisition, publication patterns, and future collaboration. In contrast, undergraduate travelers reflected greater acquisition of language skills and conference participation. If the Foundation favors the development of research careers in engineering through international travel, continued and even expanded investment at the later stages of the education and career process makes more sense than investment at early points in the education of the engineer. Investment in graduate and/or postdoctoral education of engineers suggests the adoption of longer-term outcome and impact measures that would focus on the next stages of career formation – such as international co-authorship or editing international journals in engineering research.

The IREE program is also ambiguous about the ways in which U.S. institutions might establish research collaborations with foreign host institutions – or document the outcome of such collaborations. STPI found little evidence in the materials furnished by the Foundation that an effort was being made on the part of the agency to track developments in this area – whether as outputs or outcomes/impacts reported by the U.S. institutions receiving IREE support. If the agency determines that the IREE program will actively promote such collaborations, new strategies will be needed involving participating institutions both in the United States and abroad. Program announcements should describe the types of collaborations of interest to the Foundation, as well as the types of arrangements and documentation needed to permit an assessment of the success of such funding efforts. As it stands, NSF expectations relative to the establishment of collaborations between U.S. institutions and foreign host institutions is unclear and undocumented.

More careful specification of program goals, the role of international travel funds in furthering early research careers, and the expectations of inter-institutional collaborations would make it possible to formulate longer-range outcome and impact measurement than is currently the case.

This page intentionally left blank.

APPENDIX A: IREE Trip Report Template[22]

TITLE OF CURRENT NSF AWARD

(Insert the title of the current award here)

AUTHOR NAMES

(Insert author name(s) and addresses here)

ABSTRACT

(Insert a one-paragraph abstract of this report. [Limit:1/2 page; size 10 font].)

INTRODUCTION

(LIMIT: 1 PAGE)

Please include:

- Name of awardee institution for current NSF award
- A brief summary of work being carried out under current NSF Award
- Reasons/rationale for international cooperation carried out under IREE
- An explanation of how the researcher was selected and why he/she was the best qualified candidate
- Anticipated research and education outcomes
- Information about host laboratory
- Name of travelers and the early-career category of each (assistant professor, associate professor, postdoc, graduate student, undergraduate student)
- Dates of travel

[22] Original document is available at: https://engineering.purdue.edu/GEP/IREE2008.

RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION

(LIMIT: 1-1/2 PAGES)

Please include information on:

- Program of research carried out during international research experience
- How the work on-site is related to the work of the current NSF award
- A substantive description of the general interaction between researcher and host laboratory during the international research experience
- Research accomplishments of student(s) during the trip
- Relevant schedule, if applicable
- Any other information that relates to the Intellectual Merit of the research carried out abroad
- Be sure to include at least two graphics that highlight the progress of the research

BROADER IMPACTS OF THE INTERNATIONAL COOPERATION

(LIMIT: 1-1/2 PAGES)

Please describe traveler's international activities under the IREE award that are relevant to enhancing the Broader Impacts criterion of NSF merit review. Specifically, please provide:

- How the supplement award promoted diversity
- How the supplement award helps expand the original scope of the current award
- How the travel fosters closer future interaction between awardee institution and host institution
- How the visit has helped to enhance international perspective for the U.S. researchers. Include information on activities that increased the researcher's familiarity with foreign languages, culture, and applicable technological trends and business practices

DISCUSSION AND SUMMARY

(LIMIT: 1 PAGE)

In this section, include:

- Summary of the most significant accomplishments of the international research experience
- Recommendation for "Best Practices" in future operation of the IREE Program

ACKNOWLEDGEMENTS

Include any relevant information including:

- The NSF Award Number of current grant and the name of your NSF program officer.

REFERENCES

(INCLUDE IF RELEVANT)

BRIEF BIOGRAPHIES OF RESEARCHERS

(Sample) Tim Dallas received the B.A. degree in Physics from the University of Chicago in 1991. He received his M.S. and Ph.D. degrees in Physics from Texas Tech University in 1993 and 1996, respectively. Following a year in the semiconductor equipment industry he was a postdoctoral fellow at The University of Texas in the department of Chemical Engineering. Since 1999, he has been an Assistant Professor of Electrical and Computer Engineering at Texas Tech University and the Associate Director of the Nano Tech Center. Research interests include microfabrication and microanalysis systems.

(Sample) Jordan M. Berg received the BSE and MSE in Mechanical and Aerospace Engineering from Princeton University in 1981 and 1984. He received the PhD in Mechanical Engineering and Mechanics, and the MS in Mathematics and Computer Science from Drexel University in 1992. He has held postdoctoral appointments at the US Air Force Wright Laboratory in Dayton, OH.

This page intentionally left blank.

APPENDIX B: Study Questions Guiding the STPI Analysis of the NSF IREE Grants Program

2. Basic characterization of portfolio
2.1. Who are the investigators (their institutions, departments, fields of research, etc.)? What is their caliber? Who are the travelers (their institutions, departments, fields of research, etc.)? Why were they chosen as recipients by the PIs? What are their prior international experiences? What is the host country and institution? Why was this site chosen? What is the origin of the collaboration between the U.S. and hosts institution? How long was the visit?
2.2. What is the funding structure? How are grant funds expended? How effective and appropriate was this funding method?
2.3 What was the programmatic and geographical balance between grant awards?
2.4. Other information about grant.
3. To what extent does the program address the technical, professional, and global/transcultural aspects of developing a global engineer?
3.1 On a technical level, did the grant award: Bring Proximity to Partners/End Users? Enhance Research Productivity? Provide Access to New Research Tools? Improve Quality and Innovation in the Research? Widen Scope and Range of Applications of Ongoing Research? Increase Level of Robustness in Research Questions and Solutions?
3.2 On a professional level, did the grant award work to: Reinforce Project Management Imperative? Exercise a Broad Range of Leadership Options and Styles? Enhance Transcultural Teamwork and Collaboration? Expand Range of Communications Capabilities? Establish Global Networks? Encourage Faculty-Student Interaction?
3.3 On a global/transcultural level, did the grant award: Fuel Emergence of "Best Practices" Effective in Sustaining Transcultural Collaborations? Encourage the Innovative Development of "Shared Work Space" to Accommodate Cultural Difference? Develop/Extend Research Communities beyond the U.S.? Increase Non-English Language Proficiencies? Affirm the Centrality and Power of Language? Contribute to Solutions of Global Grand Challenges?
4. In what ways and to what extent does the IREE program enable early-career researchers in the US to gain international research experience and perspective?
4.1 What are the basic outputs of the grant (publications, presentations)? What are other non-traditional outputs of this collaboration (continuing partnership, future visits to host site, friendships, participation in cultural activities)?

This page intentionally left blank.

APPENDIX C: STPI Interview Partitioning Strategy and Questions for a Sample of NSF IREE Travelers

For purposes of this analysis, STPI emailed all PIs (74 total) and travelers (88 total) for whom contact information had been furnished by the National Science Foundation. A copy of the contact email is presented below:

Dear **PI/Traveler**:

The IDA Science and Technology Policy Institute (STPI) is conducting an evaluation of several programs supported through the National Science Foundation's Directorate for Engineering. As part of our analysis, we would like to talk with you about the grant you received to travel abroad as part of the "International Research in Engineering Education" program. During a brief phone interview of not more than 20 minutes we would like to discuss your insights, accomplishments, and experiences as a result of the IREE funding.

Please let me know by return email whether you are available during the weeks of **June 30-July 15** – and which date/time might be most convenient.

We look forward to talking with you soon.

Thank you.

A total of 26 travelers and 31 PIs responded to the request to participate in the informal survey. STPI selected 9 PIs and 9 travelers, with attention to representation in the following categories:

- Research area
- Region of destination for research
- Male/female
- PI supporting multiple travelers
- PI also visiting foreign research site

STPI scheduled and completed telephone interviews between July 8 and 23, 2008.

Appendix Table C.1: Distribution of IREE Travelers Responding to STPI Interview Request, By Host Country and Education Level

Host Country	Graduate	PhD Candidate	Postdoctoral	Undergraduate	(blank)	Grand Total
Australia		2				2
Brazil		1				1
China				1		1
Denmark				1		1
Denmark & Germany				1		1
Finland		1				1
France		1		1		2
Germany	2	4				6
Italy	1					1
Japan		2				2
Netherlands		1				1
Singapore			1			1
South Korea		1				1
Switzerland		1				1
Taiwan		1				1
UK		2			1	3
Grand Total	3	17	1	4	1	26

STPI staff conducted a total of 19 interviews: 9 with IREE Principal Investigators; 8 with IREE graduate student travelers; and 2 with undergraduate student travelers. The set of questions guiding the interviews follows. Staff selected the appropriate subset of questions based the individual being interviewed (PI versus undergraduate versus graduate student).

Traveler Discussion Questions:
Did you know what you'd be doing before you left (did you have a workplan)? Did you do what you'd planned to do? How did your IREE experience match up with your expectations?
How has this grant award related to the direction of your research? What if anything about your research has changed due to IREE? Were you able to accomplish something you wouldn't have been able to without this experience?
In hindsight, what was the best thing about your trip? The worst thing about your trip?

Continued
Are you continuing contact or collaboration/do you have future plans with your host? Do you have firm plans for the future? Please elaborate.
What kind of step was this in the U.S./foreign host relationship (first time collaborating, one of a number of student exchanges, etc.)?
What changes in IREE would be beneficial? Are there other programs that make good models?
Additional Questions:
Did you supplement your IREE grant with other funds?
What was the configuration of the trip (did the PI travel? For how long? Did multiple students travel under the same PI? Was the PI's travel all/part IREE funded?)
To what extent does the IREE program counteract or overcome noted obstacles to engineering students participating in international experiences? (Such as: difficulty in scaling, negative impact on time to graduate, negative impact on finances, lack of faculty incentives, unclear outcomes assessment, rigid curriculum structure)
What is your prior international experience? Was this your first trip outside of the U.S.?

Staff prepared a set of interview notes to inform the work of the STPI project team.

This page intentionally left blank.

Appendix D: U.S. "Sending" Institutions by Education Level of the Traveler(s), as Documented by IREE Trip Reports Filed by April 2008

IREE Undergraduate Traveler(s) Only

Auburn University
Lafayette College
LeTourneau University

IREE Graduate Student Traveler(s) Only

Arizona State University
California Polytechnic University
Florida International University
Massachusetts Institute of Technology
Michigan State University
Mississippi State University
Missouri University of Science and Technology
North Carolina State University
Northeastern University
Portland State University
Purdue University
Rice University
SUNY – Stony Brook
SUNY – Buffalo
University of Arkansas
University of California – Davis
University of California – Irvine
University of Central Florida
University of Connecticut
University of Illinois – Chicago
University of Kentucky
University of Maine
University of Maryland
University of Michigan
University of Nebraska
University of New Mexico
University of North Carolina
University of South Carolina
University of South Florida
University of Southern California
University of Texas – San Antonio
University of Texas – Austin
University of Utah
Utah State University
Virginia Polytechnic Institute and State University
Wayne State University

IREE Postdoctoral Traveler(s) Only

New Mexico State University
Renssalaer Polytechnic Institute
University of Wisconsin – Madison

IREE Undergraduate and Graduate or Postdoctoral Student Traveler(s)

Clemson University
Howard University
Kansas State University
Ohio State University
Oklahoma State University
Pennsylvania State University
Texas A&M University
The Johns Hopkins University
University of Arizona
University of Wisconsin – Milwaukee

IREE Graduate and Postdoctoral Traveler(s)

Colorado State University
Georgia Technological University
University of Massachusetts
University of California – Santa Barbara
University of Illinois – Urban–Champaign
University of Pittsburgh

IREE Undergraduate, Graduate and Postdoctoral Traveler(s)

Northwestern University
Princeton University

TECHNICAL NOTE: The trip reports submitted by FY 2006 IREE recipients served as the basis for the information included in this listing. These reports do not represent an official source of information about IREE grantee institutions. Such a listing is available through the NSF on-line search tool at: www.nsf.gov/awardsearch.

APPENDIX E: Institutions "Hosting" IREE Travelers by Education Level of the Traveler(s), as Documented by IREE Trip Reports Filed by April 2008

Hosting Undergraduate IREE Traveler(s)

Australia
- University of Western Australia
- University of New South Wales

Canada
- University of Toronto

China
- Dalian University of Technology

Denmark
- Denmark Technical University

France
- Louis Pasteur University

Germany
- Fraunhofer Institute for Production Technology
- Karlsruhe University
- Technical University of Munich
- Max Planck Institute for Polymer Research

Hungary
- Budapest University of Technology and Economics

Italy
- Scuola Normale Superior di Pisa

Japan
- Nagoya Institute of Technology

Nigeria
- University of Benin

Hosting IREE Graduate Student Traveler(s)

Argentina
- Universidad de Buenos Aires

Australia
- University of Adelaide
- University of Western Australia
- University of Sydney

Belgium
- University of Liege
- Vrije University of Brussels

Brazil
- Universidad Federale de Santa Catarina

Canada
- University of Toronto

China
- Jiangsu University
- Harbin Institute of Technology
- CAS Institute of Mechanics

Czech Republic
- Czech Technology Institute

Denmark
- Haldor Topsoe A/S
- Denmark Technical University

England
- University of Nottingham
- University of Cambridge
- King's College London
- University of Manchester
- Loughborough University
- Imperial College, London
- University of Sheffield
- Keele University

Finland
- Tampere University of Technology
- VTT (Otaniemi)

France
- Universite de Technologie Troyes

- Centre National de la Reserche Scientifique
- Ecole de Mines d'Albi
- Institut Fresnel
- Louis Pasteur University
- SATIE

Germany
- Max Planck Institute for Human Development
- Max Planck Institute for Polymer Research
- RWTH University of Aachen
- Fraunhofer Institute for Production Technology
- Karlsruhe University
- Technische Universitat Muenchen
- University of Duisberg-Essen
- University of Leipzig

Hungary
- Budapest University of Technology and Economics

India
- National Chemical Laboratory

Ireland
- National University of Ireland

Italy
- Politecnico di Milano
- University of Udine
- University La Sapienza Rome
- University of Pisa
- University of Turin

Japan
- Tokyo Institute of Technology
- Osaka University
- University of Tokyo

Korea
- Seoul National University

The Netherlands
- TU Delft Faculty of Technology, Policy and Management
- Eindhoven University of Technology

Nigeria
- University of Benin

Poland
- Jagiellonian University
- University of Warsaw

Spain
- University of Seville
- IIQAB
- Technological University of Catalonia

Sweden
- Corporate Research Center (Vasteras)
- Royal Institute of Technology
- Lulea University of Technology

Switzerland
- Eidgenossiche Technische Hochschule
- Ecole Polytechnique Federale de Lausanne
- University of Zurich

Taiwan
- Industrial Technology Research Institute

United Arab Emirates
- American University of Dubai

Hosting IREE Postdoctoral Traveler(s)

Austria
- University of Vienna
- Vienna University of Technology

Belgium
- Katholieke University of Leuven

England
- Imperial College, London

France
- INSA – Lyon

India
- Anna University
- Indian Spinal Injuries Center

Italy
- University of Turin

Japan
- National Research Institute for Earth Sciences & Disaster Prevention

The Netherlands
- Technische University of Eindhoven

Singapore
- Institute of High Performance Computing

Spain
- Universidad Politecnica de Valencia

TECHNICAL NOTE: The trip reports submitted by FY 2006 IREE recipients served as the basis for the information included in this listing and the institutional names listed here reflect the information as reported by IREE travelers. STPI made an effort to introduce some consistency in the spelling of the institutions, and apologizes for any remaining misrepresentation of an institution's name or the spelling of that name.

This page intentionally left blank.

APPENDIX F: U.S. "Sending" Institutions Having Relationships with Multiple "Host" Institutions , as Documented by IREE Trip Reports Filed by April 2008

- Clemson University
  - Denmark Technical University
  - Max Planck Institute for Polymer Research
  - University of Duisberg-Essen
- Colorado State University
  - University of Buenos Aires
  - University of Duisberg-Essen
  - National Institute for Earth Sciences & Disaster Prevention (Japan)
- Georgia Tech
  - Imperial College, London
  - University of Tokyo
  - Lulea University
- Kansas State University
  - Dalian University
  - Universidad Politecnica de Valencia
- MIT
  - TU Delft
  - Max Planck Institute for Human Development
- Northwestern University
  - Nagoya Institute of Technology
  - INSA – Lyon
- Pennsylvania State University
  - University of Western Australia
  - ETH (Switzerland)
  - VTT (Finland)
- Princeton University
  - Scuola Normale Superior di Pisa
  - University of Sheffield
  - Vienna Technical University
- University of Arizona
  - Budapest University of Technology and Economics
  - University of Leipzig
  - University of Zurich
  - SATIE (France)
  - University of Warsaw
- SUNY – Buffalo
  - IIQAB (Spain)
  - University of Zurich
- University of California – Davis

    - Tampere University of Technology
    - Max Planck Institute
    - Seoul National University
- University of Illinois – Urbana-Champaign
    - University of Tokyo
    - Institute of High Performance Computing (Singapore)
- University of Kentucky
    - Ecole de Mines d'Albi
    - King's College, London
- University of Massachusetts
    - Ecole Polytechnique Federale de Lausanne
    - Katholieke University of Leuven
- University of Michigan
    - American University of Dubai
    - Universidad Federale de Santa Catarina
- University of Pittsburgh
    - ETH (Switzerland)
    - University of Sydney
    - National Chemical Laboratory (India)
    - Indian Spinal Injuries Center
- University of South Florida
    - Jagiellonian University
    - National Chemical Laboratory (India)
- Virginia Tech
    - University of Cambridge
    - UT Delft

TECHNICAL NOTE: The trip reports submitted by FY 2006 IREE recipients served as the basis for the information included in this listing. STPI made an effort to introduce some consistency in the spelling of the institutions, and apologizes for any remaining misrepresentation of an institution's name or the spelling of that name.

APPENDIX G: "Host" Institutions Having Relationships with Multiple "Sending" Institutions, as Documented by IREE Trip Reports Filed by April 2008

At the Undergraduate Level

- The University of Western Australia hosted undergraduate IREE travelers from:
  - Pennsylvania State University
  - LeTourneau University
- The Denmark Technical University hosted undergraduate IREE travelers from:
  - Auburn University
  - Clemson University

At the Graduate Level

- University of Cambridge
  - Portland State University
  - Virginia Tech
  - Northeastern University
- Max Planck Institute for Polymer Research
  - University of California – Davis
  - Clemson University
  - Wayne State University
- RWTG University of Aachen
  - University of Central Florida
  - University of Nebraska
- University of Duisberg-Essen
  - Clemson University
  - Colorado State University
- National Chemical Laboratory (India)
  - University of South Florida
  - University of Pittsburgh
- University of Tokyo
  - Georgia Tech
  - University of Illinois – Urbana-Champaign
- TU Delft
  - MIT
  - Virginia Tech
- Eidgenossiche Technische Hochschule (Switzerland)
  - Pennsylvania State University
  - University of Pittsburgh

(No university hosted postdoctoral IREE travelers from more than one U.S. university.)

TECHNICAL NOTE: The trip reports submitted by FY 2006 IREE recipients served as the basis for the information included in this listing and the institutional names listed here reflect the information as reported by IREE travelers. STPI made an effort to introduce some consistency in the spelling of the institutions, and apologizes for any remaining misrepresentation of an institution's name or the spelling of that name.

APPENDIX H: The Role of the ERASMUS and Marie Curie Fellowship Programs in Promoting Inter-Institutional Cooperation within the European Union

THE ERASMUS INTERUNIVERSITY COOPERATIVE PROGRAM

BACKGROUND: In 1987, the Commission of European Communities (EC) launched the ERASMUS[23] program to enable students to study and work abroad. By 2009, the EC reported that 1.9 million students have participated since it started and that around 90% of European universities take part in the program. The annual budget is in excess of €400million, involving more than 3,100 higher education institutions in 31 countries."[24]

PROGRAM OBJECTIVES: The ERASMUS program aims to promote the European Union as a center of excellence in learning around the world, to improve the career prospects of students, and to promote intercultural understanding through cooperation with Third Countries. Participating institutions can apply for ERASMUS support for joint master's courses and doctoral programs offered by a consortium of European and Third-Country higher education institutions. Individuals apply for scholarships/ fellowships to these approved programs. Shorter-term scholarships are also available to academics to conduct research or to teach as part of the joint master's programs. Between 2009 and 2013, ERASMUS expects to support over 8,000 master's students, nearly 800 doctoral candidates, and nearly 4,000 scholars.

DOCUMENTING OUTCOMES: The ERASMUS program asks that students file a "Final Report Form" to their home institution.[25] Questions probe such topics as:

- Study period duration
- Factors that motivated study abroad
- Quality of the professors at the host institution
- Quality of courses
- Experience upon arrival at the institution
- Events organized for the students
- Type of accommodations
- Linguistic preparations/competency
- Cost

---

[23] ERASMUS stands for the "European Community Action Scheme for the Mobility of University Students." Detailed information about the program may be obtained at this site: http://ec.europa.eu/education/lifelong-learning-programme/doc80_en.htm.

[24] ERASMUS, *op. cit.*

[25] For a sample form, see: http://www.vs.ksgrm.net/dokumenti/erasmus/final.pdf.

- Academic and personal outcomes of the experience, and those outcomes they appreciated the most

EVALUATIONS OF THE ERASMUS PROGRAM: STPI located two assessments of the ERASMUS program: November 1991[26] and November 2004.[27] The earlier study focused on such issues as the arrangement of credit transfer and academic recognition, curriculum, and teaching approaches. The latter study assessed institutional contracts between academic years 2000 and 2004, and addressed the following set of basic questions:

- What have been the objectives of national policies regarding internationalization?
- What is their relationship to the overall national policies regarding higher education?
- What have been the instruments (including regulations and funding arrangements) used to achieve the objectives?
- Why have these objectives and instruments been chosen (e.g., how have governments perceived environmental changes and how have they reacted to these changes?)
- How have governments reacted to or anticipated the ERASMUS program in their policies?

Key conclusions at the institutional level reported in 2004, include:

- Improving partnership configuration is an important goal, including involving more countries and institutions in the program.
- Language training is often stated to be an important factor in the success of exchanges and for the value of graduates in the international labor market.
- When asked what stimulates institutions to internationalize, more reported being influenced by the pressure to cooperate than by pressure to compete with other providers.

THE MARIE CURIE FELLOWSHIP PROGRAM

BACKGROUND: The European Community (EC) has supported researchers since 1958 through many different programs. In 1996, the EC introduced the Marie Curie Fellowships to provide young researchers with 1 to 2 years of experience at a host institution in another EU member state or in an associate state. Modified in recent

[26] "Comparative Evaluation of ERASMUS ICPs in the Subject Areas of Business Management, Chemistry and History" A. Monasta, ERASMUS Monograph No. 8, 1991. Available through ERIC, 2009.

[27] "External Evaluation of ERASMUS institutional and national impact" by Price, Waterhouse, Coopers for the European Commission, DC EAC, November 2004. Available at: http://ec.europa.eu/education/programmes/evaluation/erasmusext_en.pdf .

years, the Marie Curie Fellowship remains one of the key European "human capital" programs in which mobility is a universal element.[28]

The summary that follows derives from a study that assessed the impact of the Marie Curie Fellowships as of 2000. Thus, descriptions that follow relate to program elements as they appeared in the late 1990s.

PROGRAM OBJECTIVES: The Marie Curie Fellowships sought to create a European research area through the "more efficient use" of EC funding for training through research.[29] Between 1996 and 1998, fellowships had been awarded to 1,400 individuals (41% of the applicants), with an average duration of about 21 months of support. Most applicants came from Spain, Italy, Germany, and France; the most popular host nations were UK, France, Germany, and the Netherlands.[30]

Program objectives described during this period included:

- Stimulating the training of young researchers through research
- Promoting equality of opportunity for men and women
- Promoting transnational cooperation between research teams
- Promoting the mobility of researchers throughout Europe
- Encouraging cooperation, interactions, and staff mobility between academia and industry
- Promoting the scientific and technical cohesion of the EC, particularly in "less favored" regions

EVALUATION OF THE MARIE CURIE FELLOWSHIP PROGRAM: STPI located a report prepared by the staff of SRPU, a science and technology policy research unit of the University of Sussex, under contract to the European Commission (January 2000). Of specific interest to STPI was the selection of measures to assess the impact of the fellowship on:

- Careers of individual scientists
- Host institutions
- General development of science and technology in Europe
- General impact on the European Union's research program

---

[28] Other internationally oriented fellowship programs available to Europeans in the 1990s included those sponsored by the European Science Foundation, NATO, Association of Commonwealth universities, and the Alexander von Humboldt-Stiftung.

[29] See: "A methodology for assessing the impact of the Marie Curie Fellowships," SPRU, Contract ERBFMARCT980100, January 2000.

[30] SPRU, *ibid.*

Core variables and indicators of interest to the SPRU researchers for purposes of the impact assessment included but were not limited to:

- Career progress
    - Change in employment status
    - Change in employment location
    - Change in type of job
    - Change in level of responsibility
    - Value of the fellowship to career progress
- Research excellence
    - Honors and prizes
    - Journal editorships
- Contacts and networks
    - New contacts formed during the fellowship
    - Cross-border distribution of new contacts
    - Collaborations as a result of the fellowship
    - Cross-border distribution of new collaborations
    - Fund-raising success
- Public impact of research
    - Media coverage related to the fellowship
- Development of new research fields
    - Editorial boards of new journals
    - Founding new research groups and centers
- Contributions to education and teaching
    - Guest lectureships

The purpose of the SPRU report was to field test certain of these measures and to recommend to the European Commission a data collection strategy linked to the goals of the Marie Curie Fellowship. No statistical outcomes or impacts are reported by these authors.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED *(From–To)*
January 2009	Final	April 2008 – December 2008

4. TITLE AND SUBTITLE

Portfolio Evaluation of the National Science Foundation's Grants Program on "International Research and Education in Engineering" (IREE)

5a. CONTRACT NUMBER
OIA-040-8601

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Pamela Ebert Flattau (Task Leader)
Bhavya Lal
Allison Laskey
Joseph J. Ford, III

5d. PROJECT NUMBER

5e. TASK NUMBER
OSTP 20-0002.37

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Institute for Defense Analyses
Science and Technology Policy Institute
1899 Pennsylvania Avenue, Suite 520
Washington, DC 20006-3602

8. PERFORMING ORGANIZATION REPORT NUMBER

IDA Document D-3727
Log: H 09-000464

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

In Fiscal Year (FY) 2006, the National Science Foundation, through the Directorate for Engineering, launched a program of supplemental grant support entitled the International Research and Education in Engineering (IREE) awards. Principal investigators with active grants could apply for supplemental funding through the IREE program, allow early career researchers "to gain international experience and perspective" and to promote the "closer research interaction between U.S. institutions and their foreign counterparts." The Foundation defined early career researchers to include undergraduate, graduate and postdoctoral engineers (including tenure-track junior faculty). In 2008, the IREE program was "paused" to permit a systematic analysis of specific outcomes and accomplishments attained by IREE grantees. To that end, the Foundation's Division of Engineering Education and Research Centers asked the IDA Science and Technology Policy Institute (STPI) to assess the early outcomes of these IREE travel awards.

15. SUBJECT TERMS

Engineering education, international research, international education

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Susan Kemnitzer
Uncl.	Uncl.	Uncl.	SAR	68	19b. TELEPHONE NUMBER *(include area code)* 703-292-5347

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

The Institute for Defense Analyses is a non-profit corporation that administers three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges.