Online Journal for Global Engineering Education

Volume 4
Issue 1 *National Summit Meeting Report on the Globalization of Engineering Education*

Article 1

April 2009

Educating Engineers as Global Citizens: A Call for Action / A Report of the National Summit Meeting on the Globalization of Engineering Education

John M. Grandin
University of Rhode Island, grandin@uri.edu

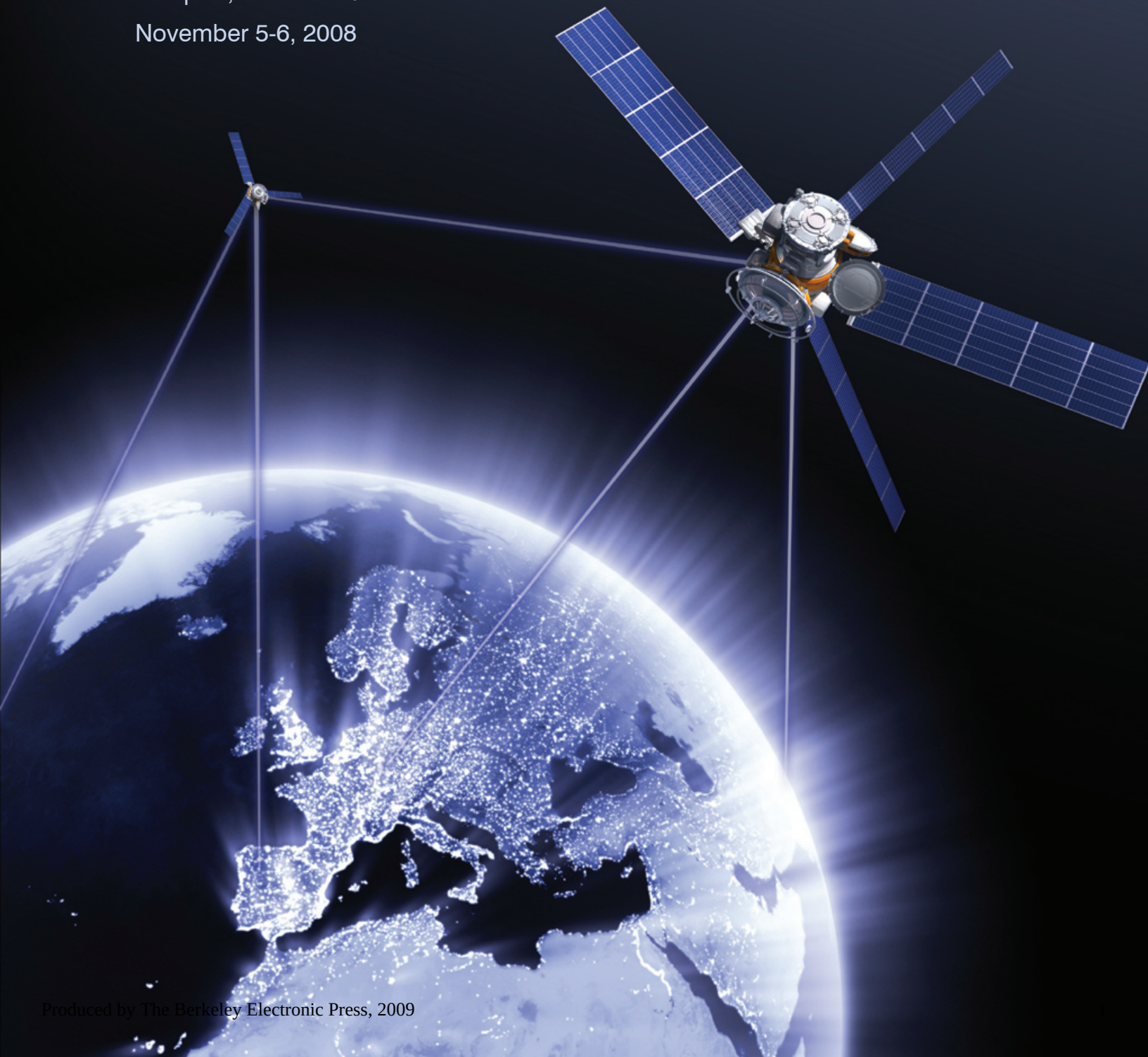
E. Dan Hirleman
Purdue University, hirleman@purdue.edu

Educating Engineers as Global Citizens: *A Call for Action*

A Report of the National Summit Meeting on the Globalization of Engineering Education

Newport, Rhode Island

November 5-6, 2008



Educating Engineers as Global Citizens: ***A Call for Action***

A Report of the National Summit Meeting on the
Globalization of Engineering Education

Grandin, J.M. and Hirleman, E.D. "Educating Engineers as Global Citizens: A Call for Action",
Report of the National Summit Meeting on the Globalization of Engineering Education, March, 2009.
Accessed at:http://digitalcommons.uri.edu/ojgee/vol4/iss1 or http://globalhub.org/resources/799.

I. EXECUTIVE SUMMARY

On November 5-6, 2008, a group of 23 distinguished engineering educators convened in Newport, Rhode Island to discuss the globalization of U. S. engineering education. Their goal was to consider the changes and challenges brought about by the recent wave of globalization and to ask, as so many colleagues are doing around the country, what proactive steps need to be taken by engineering educators to ensure that their graduates are prepared to be productive citizens and professionals in today's and tomorrow's complex world.

Encouraged and supported by the National Science Foundation (NSF) and its Division of Engineering Education and Centers, the group began its meeting with observations and advice from three executives in the contemporary global business arena. It was then tasked with a review of the rationale for incorporating global perspectives and skills into the engineering curriculum, as well as the urgency for doing so. The reasons for the generally slow response among engineering educators to this matter nationally, when compared to other nations in the industrialized world, were also explored. After consideration of the potential impact of the current economic downturn on this issue, the summit reviewed information about existing successful models and best practices for a more global engineering education at colleges and universities across the country in an attempt to answer the following questions: To what extent are American engineering programs sending their students abroad? What have we learned and what are the successful models and strategies for globalizing U.S. engineering education? What can be shared with the profession at large and by what means?

The group concluded its work with a set of recommendations for funding agencies such as NSF, as well as a strong and succinct call to the profession at large for action, in the form of a document included in this report, entitled **The Newport Declaration**.

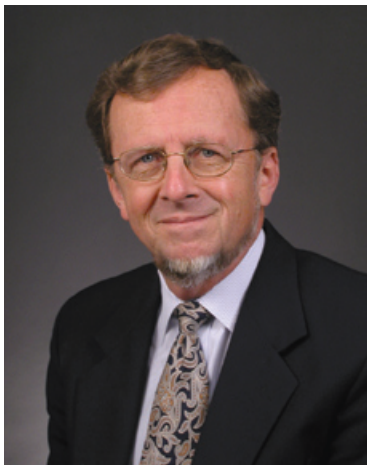
The following is a summative and detailed report of this meeting, based in part on a set of papers and documents which had been prepared in advance and were then revised to include the benefit of the group's discussions.[1] The summit participants wish to express their appreciation to those who have contributed to this special meeting and its report, and especially to the NSF Division of Engineering Education and Centers and Director Allen Soyster for supporting this project. It is hoped that the report and associated documents and information will be of value to the profession at large as it considers the current state of American efforts to globalize engineering education, as part of the overall strategy to educate the next generations of engineers for the grand challenges before us. We intend this set of documents to serve not only as a report of the current status of global engineering education, but also as a useful reference and handbook for the profession.

1. The papers prepared in advance of the meeting, as well as a video recording of the session with business leaders, are available as a special issue of the Online Journal for Global Engineering Education. To access these papers, see: http://digitalcommons.uri.edu/ojgee/. They are also available at: http://globalhub.org/resources/nationalsummit2008.

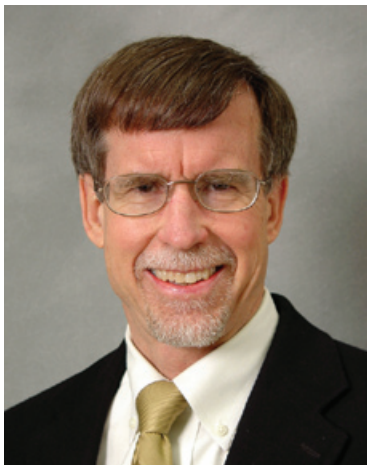
Online Journal for Global Engineering Education, Vol. 4 [2009], Iss. 1, Art. 1

II. ORGANIZATION

The Summit Meeting on the Globalization of Engineering Education was organized by John M. Grandin, Director of the International Engineering Program at the University of Rhode Island and E. Daniel Hirleman, Head of the School of Mechanical Engineering at Purdue University, in collaboration with Allan Soyster, Director of the Division of Engineering Education and Centers, and his colleague Win Aung.



John M. Grandin, Director of the International Engineering Program at the University of Rhode Island



E. Daniel Hirleman, Head of the School of Mechanical Engineering at Purdue University

III. PARTICIPANTS:

Participation in the Summit was by invitation and included the division leadership from NSF, several deans of colleges of engineering, as well as educators with substantial experience in global education for students of engineering. The following persons took part in this meeting:

- **Duane Abata**, Dean of Engineering, South Dakota School of Mining and Technology
- **Win Aung**, Senior Staff Associate, NSF Division of Engineering Education and Centers
- **James Bernard**, Interim Dean of Engineering, Iowa State University
- **Sigrid Berka**, Director of the MIT Germany Program
- **Steven Blair**, Associate Professor, Department of Electrical and Computer Engineering, University of Utah
- **Gary Downey**, Alumni Distinguished Professor, Department of Science and Technology in Society, Virginia Tech
- **Gayle Elliott**, Assistant Professor, Division of Professional Practice, University of Cincinnati
- **Janet L. Ellzey**, Assistant Dean for International Engineering Education, Professor of Mechanical Engineering, University of Texas Austin
- **Lester Gerhardt**, Professor-Electrical, Computer and Systems Engineering, Rensselaer Polytechnic Institute; Chair, Global Engineering Education Exchange Program
- **Claire F. Gmachl**, Professor of Electrical Engineering, Princeton University
- **John M. Grandin**, Professor and Director, International Engineering Program, University of Rhode Island
- **E. Daniel Hirleman**, Head, School of Mechanical Engineering, Purdue University
- **Hans Hoyer**, Deputy Secretary General, Director of International Programs and Strategies, ASEE
- **Thomas Katsouleas**, Dean of Pratt School of Engineering, Duke University
- **Steven W. McLaughlin**, Vice Provost for International Initiatives, Georgia Institute of Technology
- **Joseph Mook**, Chair, Mechanical Engineering, University of Buffalo
- **Alan Parkinson**, Dean of Engineering, Brigham Young University
- **Kurt Paterson**, Professor, Michigan Tech, Chair of ASEE International Division
- **Allen Soyster**, Director of NSF Division of Engineering Education and Centers
- **Richard Vaz**, Dean, Interdisciplinary and Global Studies, Worcester Polytechnic Institute
- **David Wormley**, Dean of Engineering, Pennsylvania State University
- **Raymond Wright**, Interim Dean of Engineering, University of Rhode Island
- Recorders: **Susan Gomes**, URI Division of Research and Economic Development and **Erin Papa**, URI Chinese Flagship Coordinator
- Observer: **Mourad Ouzzani**, Purdue University, GlobalHub
- Videographer: **Timothy Tierney**, URI IT Services
- Photographer: **Michael Salerno**, URI News Bureau

IV. GOALS AND METHODOLOGY

The goal of the summit was to first assemble information regarding the globalization of engineering education, including its rationale, its urgency, its best practices, and its barriers and hurdles, in preparation for detailed discussion at the summit itself. The larger goal was to subsequently make clear and useful recommendations to both funding agencies and the profession as a whole. To this end, several participants volunteered to gather background information and to draft papers and documents in preparation for the November 5-6 meeting. The following is a review of this work, including the discussion and conclusions. Any papers or documents prepared in advance have been revised to reflect the group discussion and are available in the form of a special edition of the Online Journal for Global Engineering Education (see: http://digitalcommons.uri.edu/ojgee/vol4/iss1 and at: http://globalhub.org/resources/nationalsummit2008).

Claire Gmachl, Princeton
John Grandin, URI

Kurt Paterson,
Michigan Tech

Thomas Katsouleas, Duke
Susan Gomes, URI

Raymond Wright, URI
Richard Vaz, WPI

V. PERSPECTIVES FROM THE PRIVATE SECTOR

The Summit Meeting began on Wednesday evening, November 5, with presentations by three executives, each with impressive records of experience and achievement in the global workplace, and clear opinions about the skills required of engineers in such an environment. Each of the guests spoke for approximately ten minutes and then participated in a lively and productive discussion with the Summit participants. The video recording of the presentations and discussion, the texts of their topics and/or PowerPoint presentations are available with the collected papers in the special issue of this report to be found in the Online Journal for Global Engineering Education at: http://digitalcommons.uri.edu/ojgee/vol4/iss1 or http://globalhub.org/resources/nationalsummit2008.

The speakers were:

Donna Kimmel, Senior Vice President, Human Resources World Wide, Sensata Technologies (formerly Texas Instruments Sensors and Controls).

Al Verrecchia, Chairman of the Board, and recently retired CEO of Hasbro, Incorporated, the Rhode Island based manufacturer of toys and games.

Brigadier General (ret.) Michael Byrnes, Middle Kingdom Advisors, and recently retired President of Tyco's Asian operations.

Ms. Kimmel introduced Sensata Technologies as a global company, with major business centers and manufacturing plants in nine nations and overall operations in more than 20 countries in the Americas, Europe, and Asia. The focus of her talk was on the nature of the global teamwork required of herself and her colleagues at Sensata, characterized by a 24/7 flow of work as engineering teams interact with each other at R&D and manufacturing sites across numerous time zones and national borders, while sales and marketing teams call on customers, likewise around the world.

> "It is not unusual for our team in The Netherlands, for example, to be the primary contact with a European automotive customer for a sensor that is designed in the United States and manufactured in Malaysia. It's the way we do business every day. Faced with extremely short development cycles, our interconnected business typically has design teams passing work around the globe every eight hours as it literally works 24/7 to meet demanding customer schedules."

As a result of the need for smooth interaction among engineering teams located across the globe, which is critical for Sensata to ensure its competitive advantage, Kimmel stressed the importance of global skill sets as we consider engineering education for the coming decades:

> "As I think about the skill sets that are important for engineering students – in addition to engineering and learning another language, it's also about multicultural intelligence and the ability to participate in the creation of a common global culture as much as it is being able to appreciate and communicate with those of different cultures. ….. More recently, what has become more apparent is the need to move beyond an appreciation and respect for differences to synergistic global collaboration to create a culture of success."

Kimmel stressed the need for attention to these matters at the school and university level, and therewith explained Sensata's commitment to supporting the International Engineering Program at the University of Rhode Island, as well as her eagerness to participate in the Summit Meeting.

Mr. Verrecchia spoke about his role in leading Hasbro, the Rhode Island-based global manufacturer in the toy and game industry, with its manufacturing and much of its design as well as its customers now located in the Far East. There was a time when Hasbro did everything in Rhode Island and when communication could be achieved through a simple walk across the street. Today, however, Hasbro is dependent on the ability of global teams from the U.S., Europe, and Asia to work together smoothly and efficiently in order to remain ahead of its competitors. Verrecchia pointed out that the global nature of today's business has dire implications for the way we educate their future employees, especially engineers.

Hasbro first went to the Far East for low labor costs and more competitive manufacturing, but this advantage has in the meantime become a given for all players in this field. Today, Hasbro must be active globally in search

of the best talent and the best ideas, meaning that much of the company's innovation now evolves outside of Rhode Island and the United States, in collaboration with designers and engineers from a variety of different national or cultural backgrounds. Communication is thus paramount.

> "….we increasingly rely on collaborative development in which we partner with technology leaders and providers around the globe to take advantage of the best available expertise. Managing and leading this global tech network is no easy task and having the language skills and cultural knowledge is critical….. Today a critical success factor is the ability to collaborate and communicate with a large network of technology providers, inventors, vendors, manufacturers and peers worldwide. An ability to lead multi-national teams through challenging problems and a willingness to conduct late night conference calls with partners in all parts of the globe is essential."

Verrrecchia cited specific examples:

> " The Far East engineering team is a vital bridge between our U.S. engineering and design staffs and our vendors. They take concepts from our U.S. and European design teams as well as outside inventors and transform them into more detailed and specific products. They work with the vendor community on the detailed execution and communicate what we want to do and why. They help shape the actual features and attributes of a product and make necessary changes when manufacturing problems arise. They also help the U.S. teams understand the demands and constraints of the vendor community. Ultimately, they serve as a critical link in the process."

Mr. Byrnes spoke first about his career, which includes over 20 years of experience in China, first as U.S. Army Foreign Affairs Officer and then as an executive, first for the Chinese operations of Rockwell Automation, and later for Tyco. Mr. Byrnes stressed the need for Americans to be more educated about China, a huge country with growing power and world influence, which is currently far outpacing the U.S. investment in education, and which enjoys a very impressive emphasis on engineering education. China may be lagging behind in its ability to be innovative and responsive to change, but Byrnes argued that this is only temporary, as it is doing all in its power to prepare its young people to be globally aware and competitive.

The main focus of Mr. Byrnes comments was on the need for young American professionals, and most certainly engineers, to be cross-culturally competent. He argued that globalization, with all of its positives and negatives, is here to stay, and that educators must take that into consideration as we prepare the next generation of young professionals. This involves imparting sensitivity to culture in its broadest sense and the ability to bridge the differences between cultures encountered by engineers and other professionals in the day-to-day global workplace. Manufacturing, design, and R&D are all conducted today on a 24/7 basis, involving teams representing multiple cultural perspectives. In Mr. Byrnes' opinion, culture cannot be understood in depth without developing proficiency in the languages of our partners, because language and culture are so closely connected.

Online Journal for Global Engineering Education, Vol. 4 [2009], Iss. 1, Art. 1

VI. DISCUSSION TOPIC: RATIONALE

In preparation for the Summit Meeting, a position paper, entitled **"Global Competence: Why is it Needed? What Does it Mean? What is Most Important?"** was prepared by Professor Alan Parkinson, Dean of Engineering at Brigham Young University. As the title suggests, the paper addresses three questions related to the rationale and need for global engineering education. "Why do students need to have global competence?" "What does it mean for students to have global competence?" and, "What are the most important attributes of global competence?" In answer to the first question, Parkinson provides a brief overview of technical and geopolitical developments of the past 20 years and explains how they have impacted the ways in which engineering is conducted. He then cites recommendations from credible sources, such as ABET, former University of Michigan President James Duderstadt, New York Times correspondent Thomas Friedman, a former ASEE president, and a study supported by Continental AG, all of whom contribute to the call for a more global engineering education. Parkinson follows with specific and compelling examples illustrating the globalization of engineering practice in the fields of mechanical, chemical, electrical, and civil engineering. The paper concludes with a discussion of the role of global competence in addressing global engineering challenges. He proposes and explains 13 separate dimensions of global competence and presents the results of a survey of engineering educators and leaders in industry regarding the relative importance of these dimensions.

The group expressed broad support and appreciation for Parkinson's paper (see: http://digitalcommons.uri.edu/ojgee/vol4/iss1 and at: http://globalhub.org/resources/nationalsummit2008), adding that engineering educators need to gain greater respect for the important "soft skills" associated with international work and study experiences. While the first tendency for engineers is to point to the compelling issues of economic and national competitiveness as a justification for global education, it was argued by many in the group that there is also a need to convince engineering faculty of the importance of the cultural dimensions of international education, and the personal and professional growth that so often takes place when students are sent abroad. One discussant argued in summary that: *International experiences should be considered as fundamental as having a course in heat transfer for a mechanical engineer.*

Summit participants at work at the Hotel Viking, Newport, Rhode Island

VII. DISCUSSION TOPIC: URGENCY

Additional discussion on the rationale for the globalization of engineering education was based upon input from Professor Claire Gmachl of Princeton University, who outlined the following issues illustrating the urgency of the matter:

There are *urgent* global problems – both short and long term – that can and should be addressed by engineers, ideally engineers with global training.

- o Deep new understanding, insights, and breakthroughs in the disciplines, e.g. physics, require increasingly expensive, high-tech experiments (e.g. ITER, controlled fusion, gravitational waves, …). These undertakings are by nature international with shared budgets and shared research teams. These research endeavors require global engineers able to collaborate in and lead international, multi-cultural teams.

- o The population of space – the space race – has become more international; a peaceful exploitation of space (lacking natural boundaries such as seas, mountains, …) must be done by global teams, if it be done efficiently (e.g. American astronauts getting rides on Russian space-craft to the International Space Station).

- o Anthropogenic climate change is a long-term – potentially irreversible – and global problem. Often, the most heavily polluting nations export pollution and hence climate change to other nations.

- o Sustainable development of the under-developed regions of the world needs to be one of avoiding errors of the developed world – e.g. wireline/wireless communication; resource & waste management; public transportation vs. personal mobility…

    - ■ Need to avoid exploitation, paternalism, cultural insensitivity.

- o Recent history (fear of terrorism, anti-immigration rhetoric) has shown that the U.S. could be vulnerable to closing its borders for international student and researcher influx. This can be mitigated by the existence and active participation in global networks and teams.

- o Outsourcing of manufacturing has significantly diminished job opportunities and depressed domestic regions; outsourcing of high tech engineering jobs may be starting; engineers need to be able to go where the jobs are, even abroad.

- o Sales are global, markets are global; engineers working in global sales need to be versed in local and global customs.
- o There is a dangerous attitude "problem" of overestimating U.S. engineering prowess and arrogance leading to laziness (e.g. U.S. based students who do not have passports, and who turn down offers to study abroad even for short times).
- o The perception of U.S. abroad has changed, while at the same time options for young engineers abroad have increased; this leads to less talent flux to U.S., as stronger "pull-back" programs from Europe & Asia begin.

There was broad agreement among the group that the globalization of engineering education has become a matter of great urgency. Though the profession has reached general agreement that students must be prepared to work internationally, and though many engineering programs are now sending students abroad, the Institute for International Education reports that fewer than 3% of all engineering students are actually going abroad for educational experiences during their undergraduate years. As a result, industry leaders and organizations such as NSF fear that our engineers, our scientists, our researchers are not prepared for professional practice in today's global workplace, and employers tend to complain that students are not prepared to work for their companies. The consensus of the group was that many schools have made a good start at offering global engineering education, but that our overall efforts are still in their infancy.

Win Aung, NSF Division of Engineering Education and Centers
Duane Abata, South Dakota School of Mining and Technology

VIII. DISCUSSION TOPIC: OBSTACLES AND HURDLES

In preparation for the Summit, Janet L. Ellzey, Assistant Dean for International Engineering Education and Professor of Mechanical Engineering at the University of Texas Austin, provided a summary of the typical hurdles to be overcome as engineers strive to incorporate international experiences in the undergraduate curriculum. Her document identifies sixteen barriers or hurdles in the path of a more global engineering education (see below). Though gradually gaining acceptance, it is still clear that engineering programs across the country lack an international education tradition, as the latter is still often perceived to be the prerogative of faculty and students in the humanities. Also high on the list of disincentives is the rigidity of the very demanding and lockstep engineering curriculum, making it difficult to leave campus, difficult to transfer credits back from a foreign institution, even difficult to take preparatory courses such as language classes in anticipation of time spent abroad. Furthermore, the academic rewards system, with its focus on teaching, research, and competing for research dollars, discourages faculty from investing time in the development of such programs. *There are no promotion and tenure rewards for sending students abroad or for arranging exchange programs or other special international academic opportunities.* A considerable barrier today is the cost factor, as parents and students deal with a weak dollar abroad and the increasing cost of education as a whole in a time of recession. The economic downturn was felt to be serious enough to merit separate consideration at the Summit, and is thus dealt with in detail below (see Discussion Topic on economy below, and Abata paper).

The sixteen obstacles and hurdles identified by Professor Ellzey and the group are:

1. **Curricular rigidity:** The engineering curriculum is very full and lock-step, allowing little opportunity for students to experiment with things such as language learning, culture study or semesters abroad. In-depth experiences abroad often imply extra time for degree completion.
2. **Lack of tradition:** Study abroad has always been considered the prerogative of students in the humanities. Even though engineers are far more likely to have to work abroad or work together with colleagues from other nations, there has been no tradition of sending engineers to study or work abroad. This leaves a void of experience among engineering faculty and administrators, at a time when we now find it critically important to prepare engineering students for eventual work in the global sphere.
3. **Lack of support from study abroad professionals:** Study abroad or campus international offices are not engineering oriented and are seldom prepared to help engineering students who want to study or work abroad.

4. **Lack of support for cross-disciplinary activities:** Even though there is considerable expertise across any given campus to support international study, such as in language departments, there is little encouragement or incentive for faculty to cross the disciplinary divides in order to work together.

5. **Lack of support by departments, colleges of engineering or faculty:** Engineering programs often do not have advisors who are knowledgeable about study abroad opportunities and who are willing to commit the time to compare courses and determine credit.

6. **American monolingualism:** Americans, as native speakers of English, have always felt that language learning is for others. This means that Americans do relatively little serious language learning at any educational level and are thus restricted to experiences abroad where work can be done in English. This limits the extent of the cross-cultural experience.

7. **Academic rewards system:** Building successful international programs for engineering students is labor intensive and requires substantial time commitments from faculty and administrators. Since faculty are promoted and tenured by traditional teaching, publication, grantsmanship, etc. and not by sending students abroad, there is little incentive for faculty to work in this area.

8. **University financial restrictions:** Building program opportunities for engineering students abroad is labor intensive and expensive. In a time when many universities feel squeezed financially, such programs often fall from the priority list.

9. **Student financial restrictions:** Programs abroad are often arranged for summer when students need to work for precious tuition dollars. Students often do not understand the costs of the various programs. Semester programs may be less expensive on a per-week-abroad basis than summer programs but still might require a larger total financial commitment.

10. **Difficulty in transferring credit:** Credit systems vary around the world. In the U.S., credit is generally based on the number of contact hours. In many European countries, this is not the case and defining an "equivalent" is difficult. Also, ABET needs to be part of this process to ensure that we are not risking our accreditation.

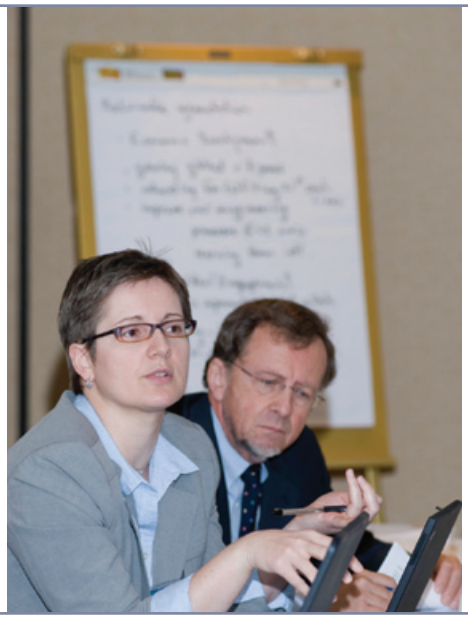
11. **Negative perception of study abroad:** Study abroad experiences are not uniformly regarded as worthwhile by either parents or recruiters. While some view study abroad as an important learning experience, others view it as a vacation.

12. **Disconnect in the corporate world between CEO and HR:** While CEO's often speak of the importance of global education, the message often does not reach the human resource departments. The message does not reach the recruiters who interact with students and do the hiring.

13. **Private vs. university-based programs:** Study abroad is now a big business and many private companies organize international educational experiences. Many of these enterprises are reputable but there is no well-established means of evaluating them.

14. **Lack of emphasis on total immersion for a significant length of time:** Evidence collected by IIE indicates that study abroad experiences are becoming shorter and sometimes have little cultural immersion. Students often seem to gravitate to these programs to "check a box" on their resumes. Universities also tend to boast about total number of students who have gone abroad and not student-months abroad.
15. **Difficulty in recruiting:** Students do not necessarily value the experience abroad or are hesitant about taking the risk. They also sometimes sign up for a program but do not end up going, thus creating administrative hassles in the agreements with partner institutions.
16. **Lack of cultural preparation:** Engineering students are often ill-prepared to accept the norms of another culture. Their educational experience is generally lacking in world history, art, and comparative politics thus often setting them up for a difficult transition.

Claire Gmachl, Princeton
John Grandin, URI

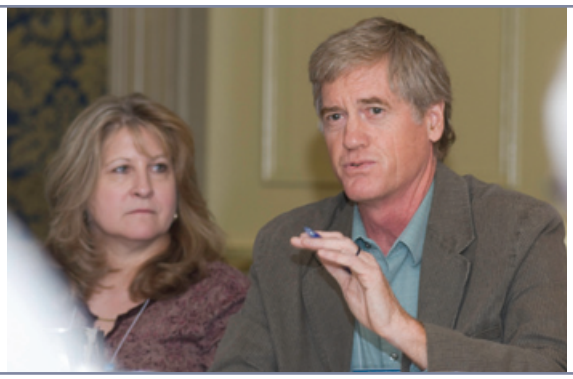


Online Journal for Global Engineering Education, Vol. 4 [2009], Iss. 1, Art. 1

IX. DISCUSSION TOPIC: IMPACT OF THE CURRENT ECONOMIC DOWNTURN

With the Summit Meeting taking place two days after the Presidential election, in the midst of economic crisis, including the bursting of the real estate bubble, the mortgage crisis, the fall of several major investment houses, the drastic adjustment in the stock market, the decline of the value and reputation of several major corporations, the Summit attendees were asked to assess how all of this would impact the need or desire for international education. Did this mean that globalization would retreat? Did this mean that Americans would rebel against foreign trade and attempt to recreate the insular marketplace of years ago? Would it now be less important to prepare students for a global workplace? And, even if that were not the case, would the economic crisis make international education less feasible? Would the weak value of the dollar abroad and the high cost of education push international programs to the side? Would high unemployment, tight credit, declining investment returns, and falling donations mean fewer resources for study abroad and less interest or ability to create and support such programs?

Duane Abata, former ASEE President and Dean of the South Dakota School of Mining and Technology, prepared a paper on this topic (see: http://digitalcommons.uri.edu/ojgee/vol4/iss1 and at: http://globalhub.org/resources/nationalsummit2008), based in part on a survey of the 23 Summit attendees, and the paper was subsequently revised to incorporate the observations from the group discussion. In essence, Abata and the Summit attendees are convinced that international engineering education will suffer during this period of economic crisis and hardship, even though there is no evidence for a lesser need. With less money at hand, and degrees available without international experience, the trend will be to view international education as a frill rather than a necessity and thus a priority for the future. The attendees see this as an unfortunate development, which will negatively impact American competitiveness, as it once again falls behind the world in terms of the global preparation of its students. As Abata points out in his paper, it will require strong leadership in the profession as a whole, but also from government leaders, and from organizations such as ASEE, ABET and NSF to maintain the gains made in recent years in the globalization of engineering education. Though parents may not appreciate the value of experiences abroad, the group believes that students will continue to remain open to such opportunities. Every effort must be made to offer creative and affordable programs for our students abroad during this difficult time.



Gary Downey, Virginia Tech
Gayle Elliott, University of Cincinnati

X. DISCUSSION TOPIC: CURRENT AND BEST PRACTICES

This portion of the Summit was dedicated to identifying where we stand nationally in terms of the globalization of engineering education. What are the successful models for sending engineering students abroad? How many institutions have made clear commitments to preparing their engineering students for cross-cultural and cross-national work? What resources are available for the profession on these matters? What and how can we learn from each other?

Due to the size of this topic, it was subdivided into three areas, each of which was supported with a paper or report prepared in advance and subsequently revised: **1)** A review of program types, including a survey of international activities at U.S. ABET accredited institutions, prepared by John M. Grandin and Kathleen Maher, University of Rhode Island. **2)** A study of strategic approaches for the development of international engineering programs at several institutions across the country recognized as leaders in this area, prepared by Sigrid Berka, Director of the MIT Germany Program. **3)** A study of several successful international engineering programs across the country, with a special focus on the persons responsible for their development and success. With a study of these individuals and their experiences, Gary Downey of Virginia Tech extrapolates "what we have learned," and what we need to seek in leadership styles, when planning to internationalize engineering education. (see: http://digitalcommons.uri.edu/ojgee/vol4/iss1 and at: http://globalhub.org/resources/nationalsummit2008)

A. Programmatic Models for Educating the Global Engineer

1. Survey: For the organizers of the Annual Colloquium on International Engineering Education, now in its twelfth year, the sense has been that international programs catering to engineering students have been on the rise at a rapid rate. And yet there has been little evidence to support that. Is it just that there are more programs "on the books," or is a surge in participation truly underway? The Institute of International Education (IIE)'s "Open Doors Report on International Education Exchange" is considered the best source for monitoring the international mobility of students to and from the United States, however, it tracks only those US students participating in credit-bearing study abroad programs. For a variety of reasons, engineering undergraduates seem to be more likely than the general student population to select research, internship, or short-term programs abroad, which often do not count for credit, and are therefore not included in "Open Doors."

   A month prior to the Summit meeting, in an effort to capture national trends in the globalization of engineering education beyond just credit-bearing study abroad, a 28-question survey was sent via email to the Deans/Directors of Engineering at close to 500 ABET institutions. A return of close to 30% was achieved in time for the meeting. Based on preliminary results it is clear that, in addition

to more traditional for-credit study abroad opportunities, more than half of institutions polled also offer research collaboration (62%) and internships (53%); more than a third offer service learning programs or co-ops; and more than half of respondents also indicated that they offer an integrated curricular option, such as a minor (15%), certificate (20%), or dual/double degree (24%.) Much higher participation among women engineering undergraduates than their male peers was another clear trend among responding institutions.

A second phase of this survey is underway at the time of this printing, to gather additional information via the study abroad offices serving ABET institutions, as well as third-party program providers. Once the survey closes a complete analysis of the results, as well as an online directory of international engineering programs will be made available via the special summit issue of the Online Journal for Global Engineering Education.

2. Based on the aforementioned survey of ABET accredited institutions, the authors' experience at URI, and observations published in articles by Lohmann (Georgia Tech)[2], Parkinson[3] (Brigham Young University), and Gerhardt (RPI) and Renganathan (IIE)[4], Grandin and Maher categorize and summarize eight types of international engineering programs which have emerged, and also provide a list of factors that may be considered when seeking to understand and classify the relative nature of one program versus another. (See also the following paper in this study by Sigrid Berka from MIT, who develops case studies of seven institutions with successful programs, likewise considering program types.)

2. Lohmann, J. R. , Rollins, Jr, H.A. and J. J. Hoey (2006) "Defining, Developing and Assessing Global Competence in Engineers," European Journal of Engineering Education, Vol. 31, No. 1, March 2006, 119–131.
3. Parkinson, Alan, "Engineering Study Abroad Programs: Formats, Challenges, Best Practices," Online Journal for Global Engineering Education, Volume 2 (2007), Issue 2.
4. Gerhardt, Lester and Renganathan, Vijay, "Incorporating Global Perspective in U.S. Engineering Education," Proceeedings of the Annual Meeting of the American Society for Engineering Education, June 2008.

General Program Types utilized by Colleges of Engineering:

1. Double Major or Dual Degree Programs (e.g. Pennsylvania State University, Iowa State University, and University of Rhode Island)
2. Minors or Certificates (e.g. Georgia Tech, Iowa State University, Purdue University, University of Illinois, University of Michigan, University of Pittsburgh)
3. International Internships, International Co-Op (e.g. Georgia Tech, MIT, University of Rhode Island, University of Cincinnati)
4. International Projects (e.g. Worcester Polytechnic Institute)
5. Study Abroad and Academic Exchange (e.g. University of Minnesota, Rensselaer, Global E3).
6. Collaborative Research Projects and Global Teaming with partners abroad (Purdue University, Harvey Mudd)
7. Service Learning Projects Abroad (University of South Florida, Worcester Polytechnic University, University of Dayton, Duke University)
8. Graduate-Level International Programs, including research experiences abroad, research collaborations with colleagues abroad, dual and joint degree programs with partner universities abroad, (e.g. University of Rhode Island Dual Degree Masters and Doctoral Programs, NSF PIRE and IREE projects)

Other Defining Factors:

1. Short-Term versus Long-Term: There are many programs sending students to short-term study experiences and/or visits such as winter- or summer term programs. There are fewer programs involving a full-semester or academic year.
2. English Language or Non-English Language: The majority of programs for engineers abroad are conducted in English. Some expect their students to become bilingual and study and/or intern in a language immersion environment.
3. Degree of Cultural Exposure/Immersion: Many programs are designed to support groups of Americans within their cultural comfort zones, i.e., in English with faculty teaching in accustomed ways. Fewer require the students to adapt to the foreign educational system.
4. Degree of Curricular Integration: Many programs are built as short-term “add-ons,” i.e., summer experiences, and are not integrated into the overall curriculum.

5. Degree of Cultural/Linguistic Preparation for Experiences Abroad: There is a great range in this regard, with some programs beginning preparation in the Freshmen year and coordinating course selection as a conscious plan anticipating the experience abroad, while others offer little to no preparation.
6. Degree of Engineering-Specificity: Some programs are designed to be generalized experiences abroad, without being engineering specific. Others are designed to incorporate engineering education as it is known elsewhere, including professional research, design or internship opportunities.
7. Degree of Institutional/Administrative Commitment: Some programs are designed and offered by engineering faculty, others are offered by language faculty or study abroad offices, or by external service providers. Some institutions have declared global education for their engineering students to be a high priority. Others see it as a good idea, but not absolutely necessary.

B. Institutional Strategies: Seven Case Studies

Sigrid Berka, Director of the MIT Germany Program, presents a set of seven case studies of universities which have successfully launched and institutionalized models for the global preparation of their engineering students. She provides an overview of these programs and an analysis of how they are integrated into the larger curriculum. Are they international internship programs? Are they student exchange and study abroad programs? Are they based upon special project and research work abroad? Are they strictly undergraduate or also graduate programs? Do they include language and culture study? Is the work abroad done solely in English or also in other languages? Berka explains how they work, how students are recruited and retained, and what the "secrets" are to their ongoing success. She also examines the diverse ways of funding such programs, from within, but also from outside funding agencies, both public and private.

Berka then asks how the programs came about and in what kind of an institutional context. Were they products of a top-down internationalization strategy of the university administration? Were they the results of individual faculty efforts from departmental ranks? Were they the product of faculty or administrators outside the engineering departments, for example, from a language department? Or were they the result of a mixture of these original sources?

Berka looks closely at seven programs from these points of view, at: MIT, RPI, WPI, Purdue, and the Universities of Cincinnati and Rhode Island, thereby helping us to understand that international engineering programs are

not monolithic, deriving from any one set of practices or strategies, but that such programs will vary, not only due to individual initiatives but also to the fact that each university or college has its own culture and its set of working dimensions. What works for one school, may not be possible at another, even though much can be learned from the many approaches and systems.

C. International Engineering Education. What we have learned.

The Newport Summit Meeting was able to benefit from a second and simultaneous major investigation of the internationalization of engineering education. Gary Downey, Alumni Distinguished Professor, Department of Science and Technology in Society at Virginia Tech, likewise with funding from the National Science Foundation, has taken a very different approach to the study of this issue by asking very different questions. Rather than ask which institutions have built what kinds of programs, he has identified some of the universities most active in the area, and then looked carefully at the leadership involved. He wants to know who the players are, how and why they became involved, and what characteristics they may share which could give us clues leading to greater activity in this area.

Downey understands that the internationalization of engineering education is not instinctively a high priority for engineering educators, that engineering deans might agree on its importance, but will not value it above the given commitment to research, traditional teaching and the standard goals upon which engineering reputations and rankings are built. He knows, therefore, that the entrepreneurs on behalf of international engineering programs are individuals, generally outside the mainstream, who have devoted themselves to a special side of education with considerable sacrifice and passion.

Downey has identified and assembled such international engineering educators from several schools and asked them to share information about themselves and their own career trajectories, which can help us to understand the origins and histories of their programs and what experiences, ideas, beliefs, personality traits, etc. lead to such commitments and thus to their programs. Each participant in the Downey study has been asked to write a "personal geography," which may be understood partially as autobiography, partially as career biography, partially as analysis of program. Unlike a paper one might write for an ASEE conference, the personal geography does not focus first and foremost on the nature of the program, the students and their experiences, but rather on the program entrepreneur and the struggles he or she has had to bring an idea to fruition. The foreground is the author, the international educator who is expected to tell about him- or herself and his/her commitment and also how he/she has woven his/her way through the university culture in order to build a meaningful and lasting international program for students of engineering.

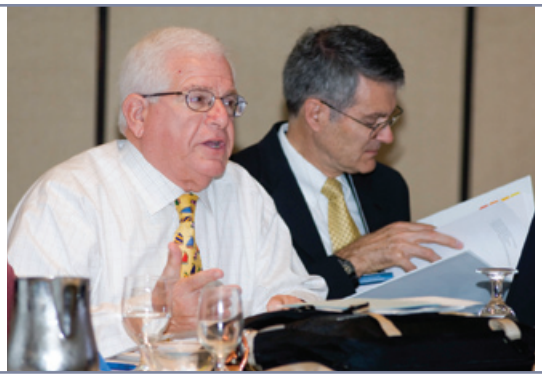
As may be seen in Downey's paper, accessible through the special issue of the Online Journal for Global Engineering Education (see: http://digitalcommons.uri.edu/ojgee/vol4/iss1), he has been able to draw a number of preliminary conclusions and made a number of recommendations, even though his study is not yet complete.

Online Journal for Global Engineering Education, Vol. 4 [2009], Iss. 1, Art. 1

XI. DISCUSSION TOPIC: RECOMMENDATIONS

The following recommendations were put forth for discussion at the Summit Meeting by Professor Lester Gerhardt of Rennsalaer Polytechnic Institute regarding steps that might be taken by the National Science Foundation to enhance global engineering education:

- NSF should publicly declare the globalization of engineering education a high priority;
- NSF should establish a policy that selected programs and proposals mandate an international requirement as part of the proposal to promote international cooperation and experiences for students, along the lines of the outreach and under-represented minority focus of the Engineering Research Centers (ERC);
- NSF should should build upon its PIRE (Program in International Research and Education) and IREE (International Research and Education in Engineering) initiatives to globalize science and engineering education at the graduate levels;
- NSF should create mechanisms to assure bi-lateral funding for both domestic and international partners by creating more partnership programs with their peer agencies in other countries;



Lester Gerhardt, RPI
Alan Parkinson, BYU

- NSF should establish and fund a National Resource Center for the Globalization of Engineering Education to:
  - gather and disseminate information on relevant programs and activities;
  - provide information and assistance to help universities to globalize their engineering curricula;
  - provide international travel grants to students in conjunction with ongoing research programs as is done with the Undergraduate Research Program (URP);
  - facilitate dialogue and share best practices;
  - otherwise promote international cooperation via conferences and workshops, and have global initiatives permeate all Divisions and Programs;

- NSF should strengthen and more strongly integrate current globally oriented NSF organizations and programs such as the Office of International Science and Engineering and GlobalHUB.org;

- NSF should focus and support programs that are both SCALABLE and SUSTAINABLE:
  - Institutional investment necessary;
  - Faculty involvement necessary;
  - Curriculum structure necessary to permit/encourage international experiences for substantial number of students;

- NSF should furthermore:
  - identify how existing approaches to international engineering education offer opportunities to acquire different types of knowledge;
  - develop instruments for assessing these forms of knowledge experiences;
  - increase faculty involvement by providing motivation;
  - focus on scalability and sustainability;
  - make the value of international education more visible & accessible.

Janet Ellzey, University of Texas Austin
Win Aung, NSF Division of Engineering Education and Centers

Online Journal for Global Engineering Education, Vol. 4 [2009], Iss. 1, Art. 1

XII. CONCLUSIONS AND NEWPORT DECLARATION

This report and the supplementary documents, papers and presentations are intended to be a comprehensive collection of resources for the profession as a whole as it considers the value and importance of global engineering education for American students. At the same time, it has been assembled and organized by colleagues who are highly committed to the internationalization of engineering education, and who present this information in order to advance that cause. This is most obvious in the concluding document on the next page, the **Newport Declaration**, which was developed by the Summit participants and stresses not only the need but the urgency for a more global engineering education, as we look forward to solving the grand challenges of the coming decades. **To join in endorsing the newport declaration, please go to: globalhub.org/newportdeclaration.**

Though the Summit Meeting did a credible job of identifying the issues associated with global engineering education, the ensuing unpublished debate by e-mail among the Summit participants leading to the final version of the **Newport Declaration** revealed some of the issues that had not been brought into clear focus at the meeting itself. In considering the rationale, for example, the tendency at the Summit was to stress the issues of economic competitiveness, even though there are many other benefits or justifications, arguably of equal or even greater weight. As we consider the challenges before us of clean water, sufficient water, global climate change, sustainability, renewable energy, and clean air, these are all issues requiring global coordination and cooperation, and thus expertise in cross-cultural communication. Also, the Summit failed to stress the almost universally accepted, though generally unmeasured, personal benefits that students accrue through international study or work experiences. The latter are the “soft” benefits that might speak less directly to the analytical minds of engineers and yet, students spending time abroad tend to make great personal progress as a result of mastering another language, encountering perspectives of those who have grown up in different cultural environments, being forced to deal with new problems on their own in an unfamiliar setting, and simply from seeing how the world works outside of the U.S. A lively post-Summit e-mail debate helped to clarify that global education for engineers is a phenomenon with a multitude of facets and benefits, which have been referenced in the group’s call to action.

This summary report was written by John M. Grandin (grandin@uri.edu) and E. Dan Hirleman (hirleman@purdue.edu) based upon input from summit participants. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and participants, and do not necessarily represent the official views, opinions, or policy of the National Science Foundation.

The Newport Declaration
To Globalize U.S. Engineering Education

WHEREAS the world is experiencing dramatic geopolitical and technological changes which are continually revolutionizing transportation, communication, commerce, education, and life experience; and

WHEREAS these transformations are intertwined with rapidly increasing human population and resource consumption, and therefore bring about increased worldwide challenges and tensions; and

WHEREAS engineering is crucial to addressing these grand challenges facing the planet, and to thereby enhancing global peace and prosperity, and

WHEREAS collaboration on grand challenges builds a stronger sense of global community, and U.S. engineering students engaged in global outreach are uniquely positioned to be ambassadors for the nation; and

WHEREAS the national economy, competitiveness, security, and well-being depend upon successful participation in a global, technology-driven marketplace; and

WHEREAS the U.S. engineering culture brings ingenuity, boldness, and a results-oriented mentality that are crucial to global collaborative progress, and

WHEREAS U.S. citizens tend to be poorly informed about nations and cultures and therefore under-equipped to work effectively with international partners; and

WHEREAS all of the above have vital implications for the education of U.S. engineers;

IT IS IMPERATIVE that U.S. engineering educators and education adapt to the contemporary global environment; and

IT IS IMPERATIVE that **all** engineering students develop the skills and attitudes necessary to interact successfully with people from other cultural and national environments.

TO THIS END, we call on engineering educators, engineering administrators, and engineering policy leaders to take deliberate and immediate steps to **integrate global education into the engineering curriculum to impact all students**, recognizing global competency as one of the highest priorities for their graduates; and

TO THIS END, we call on funding agencies, foundations, and leaders in the private sector to **shape their policies and priorities in support of these goals**; and furthermore

TO THIS END, we urge that this document be widely distributed and **endorsed by all key constituencies**.

Composed and endorsed this 6th day of November, 2008 by the undersigned participants of the NSF-supported Summit Meeting on the Globalization of Engineering Education, who are committed to its realization and who put it forward for consideration by the profession at large:

John Grandin, URI, co-chair
Dan Hirleman, Purdue, co-chair
Duane Abata, SDSU
James Bernard, ISU
Sigrid Berka, MIT
Steven Blair, Utah
Gayle Elliott, Cincinnati
Janet L. Ellzey, UT Austin
Lester Gerhardt, RPI
Claire F. Gmachl, Princeton
Hans Jürgen Hoyer, ASEE/IFEES
Thomas Katsouleas, Duke
Steven McLaughlin, Georgia Tech
Joseph Mook, SUNY Buffalo
Alan Parkinson, BYU
Kurt Paterson, Michigan Tech
Richard Vaz, WPI
David Wormley, Penn State
Raymond Wright, URI

The Online
Journal for Global Engineering Education

The Berkley Electronic Press

ISSN 1933 -1703

The Online Journal for Global Engineering Education (OJGEE) serves as a unique peer-reviewed research outlet for the cross-disciplinary and corporate constituencies involved in creating, maintaining, and growing global engineering education programs. An outgrowth of the annual Colloquium on International Engineering Education, the Online Journal for Global Engineering Education provides an academic forum to exchange ideas, find like-minded thinkers and researchers, foster new collaborations, and explore new facets of global engineering education. The Online Journal strives to disseminate pertinent research to academics and professionals interested in the field of global engineering education.

http://digitalcommons.uri.edu/ojgee

This entire report and the following supporting papers and speeches are available as a special issue of the Online Journal for Global Engineering Education at: http://digitalcommons.uri.edu/ojgee/vol4/iss1 and also at: http://www.GlobalHub.org/resources/nationalsummit2008.

1. **Prepared Remarks**: Donna Kimmel, Sensata Technologies
2. **Prepared Remarks**: Al Verrecchia, Hasbro, Incorporated
3. **PowerPoint Presentation**: Michael Byrnes, Middle Kingdom Advisors
4. **Global Competence**: Why is it Needed? What Does it Mean? What is Most Important?, Alan Parkinson, Brigham Young University
5. **The Urgency of Globalizing Engineering Education**, Claire Gmachl, Princeton University
6. **The Impact of the World Economic Downturn on the Globalization of Engineering Education**, Duane L. Abata, South Dakota School of Mining and Technology
7. **Survey of International/Global Engineering Education in the United States**, Kathleen Maher, University of Rhode Island
8. **Institutional Strategies of International Engineering Programs**, Sigrid Berka, MIT
9. **International Engineering Education as a Knowledge Problem: What We Have Learned from Agents of Change**, Gary Downey, Virginia Tech

GLOBALHUB

A Virtual Community for Global Engineering Education, Research, and Collaboration

E. Dan Hirleman, Purdue University
Jan Helge Bøhn, Virginia Tech
Deba Dutta, University of Michigan
Eckhard Groll, Purdue University
Juan Lucena, Colorado School of Mines

WWW.GLOBALHUB.ORG

IOWA STATE UNIVERSITY
College of Engineering

Sponsored by the College of Engineering and the College of Liberal Arts and Sciences
In collaboration with the University of Rhode Island International Engineering Program

Engineering for the Future– Global Pathways

12th Annual Colloquium on International Engineering Education

Please join us in America's heartland for the 2009 colloquium.

October 22–25, 2009
Gateway Hotel and Conference Center
Ames, Iowa

Co-Chairs
James Bernard, Interim Dean, College of Engineering
Mark Rectanus, Professor and Chair, World Languages and Cultures

For more information, contact
Jan Putnam, Conference Coordinator
Phone: 515 294-3901 • E-mail: jwputnam@iastate.edu

www.engineering.iastate.edu/aciee
www.uri.edu/iep/colloquia