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# Keynote Speech:

# Emerging International Cooperative Programs and Funding to Enhance Quality and Productivity[1]

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***Abstract:*** *Globalization of industrial R&D and the need to upgrade the quality and productivity of engineering education and research is leading to increased interest in international cooperation among academic institutions around the world. The 9/11 disaster and the events following it have emphasized the increased need for international cooperation in academic research and education. Funding organizations are increasing their focus on development of trans-national linkages, while the worldwide community in engineering has started and continued to support several innovative partnership activities. The purpose of this paper is to highlight some of these trends, including examples of specific roadmaps for development and implementation of international academic linkages. We conclude by pointing out that a major commitment by all stakeholders in international cooperation is needed in order to prepare for the next major advancement in engineering.*

## Introduction

The recent upturn in interest in international cooperation has been motivated in part by the global expansion of marketing and R&D by many industrial companies. International cooperation in R&D has provided companies with access to leading-edge fundamental developments, technologies, and fresh ideas.

[1] Opinions expressed in this paper are the author's personal opinions. In the spirit of ensuring the widest dissemination of information on international cooperation, including posting on the iNEER website, the author wishes to retain copyright for this paper, with unlimited dissemination right given to the organizers of the IASEE.

Meanwhile, in order to meet new challenges in the 21st century, universities around the world are seeking to broaden their engineering education systems. Issues of concern include a curriculum that is more informed by industrial practice, and that incorporates information technology and distance learning, hands-on experience for undergraduates, global perspectives, and an emphasis on interpersonal and communications skills. Progress in these areas will require international cooperation.

The two primary products of engineering education are its graduates and new knowledge base that is the foundation of new technologies for nations' economic development. Increasingly, the economies of nations are interconnected, and graduates must possess the education that enables them to work in the international marketplace. Consequently, engineering education is becoming an international enterprise. Institutions of different nations must, therefore, work together. Such international cooperation needs the support and active participation of faculty. Equally important is the support and participation of the top administrators of educational institutions. Faculty and administrators alike must find innovative ways to work together across international boundaries. Recent advances in information and communications technologies are providing a new impetus for international cooperation in education and research.

In the following sections, we highlight recent developments and funding trends in international cooperation at a major funding organization in the U.S. This will be followed by a discussion of the new activities undertaken by the international community to foster international linkages.

## Effect of September 11

To many in the international community, the September 11 disaster and the events following it have underscored the degree to which our world is now interconnected. The e-mails that we have received [1][2] show that the international academic engineering community wants international cooperation now more than ever. Additionally, the community has continued its active support and participation in several initiatives started before the 9/11 disaster. This includes the ICEE-2002 conference held in August 2002 in Manchester. Based on the abstracts submission rate for ICEE-2003, scheduled for July 2003 in Valencia, Spain, the widening support for international cooperation is continuing. This is clear from the discussion in a following section in this paper.

In parallel with the continued interest for cooperation among members of the international engineering education and research, funding organizations are continuing or even increasing their support for international partnership programs. Examples are given below.

## Recent Policy Announcements Relating to International Cooperation at National Science Foundation

[2] Numbers in brackets refer to References listed at the end of this paper.

The U.S. National Science Foundation is an independent funding agency whose goal is to expand the U.S. capability in science and engineering by supporting research in science and engineering education and research, primarily at academic institutions. Established in 1950, the agency is focusing increasing attention on the support of international cooperative activities. Recently, the agency took several steps to strengthen its support for international cooperation. Specifically:

1. In 2001 the National Science Board formed a Task Force on International Issues in Science and Engineering. The Task Force issued its Interim Report in 2000 [2]. In this report, the NSB recommends that NSF strengthen the coordination and management of U.S. international science and engineering research and education activities, and that NSF facilitate international collaboration in science and engineering research and education, particularly by younger scientists and engineers and with developing countries.
2. In January 2002, NSF announced the establishment of the Office of International Science and Engineering.
3. In August 2002, NSF announced the continuation of the Information Technology Research Program that also includes support for U.S. investigators who collaborate with international researchers [3].
4. On December 4, 2002, the National Science Board published a draft report on science and engineering infrastructure for the 21st Century [4]. Noting that several Nobel prizes have been awarded for development of new instrument techniques, the report emphasizes the importance of new research equipment and instrumentation in opening new research frontiers that fueled technological innovations in areas such as biotechnolology, nanotechnology and communications. The report recommends the facilitation of international partnerships to enable the mutual support and use of research facilities across national boundaries.

In the following sections, we details specific disciplinary funding opportunities recently announced by the National Science Foundation, as examples of developing trends in support for international cooperation. The sections also provide roadmaps for development and implementation of international cooperation in academic research and education.

## Collaboration Between U.S. and European Nations

In June 2002 NSF issued a letter soliciting proposals from U.S. investigators in materials research who are interested in collaborating with their counterparts in European nations [5]. Seventeen nations ranging from Austria to UK are involved, as is the European Science Foundation that is headquartered in France. The new funding opportunities originated from international workshops designed to stimulate enhanced collaboration among materials researchers and create networks linking individuals and centers in participating countries. These workshops identified possible areas for mutually beneficial collaboration, and recommended that extensive use be made of electronic communication, information exchanges, and databases to promote and facilitate research

collaboration and educational activities at the international level. NSF supports the U.S. side of such collaborations, with the expectation that funding or research organizations from the appropriate country or countries will support the costs of the European participants. Proposals to NSF must be linked to a counterpart proposal submitted by a European partner(s) to counterpart organization(s) in Europe, or to an existing project funded by such an organization. Proposals from European investigators must be submitted to the counterpart European funding organization in accordance with the guidelines of that organization.

**International Collaboration in Graduate Education**

In July 2002 NSF announced the continuation and expansion of the Integrative Graduate Education and Research Traineeship (IGERT) program that began five years ago, which provides funding for U.S. institutions to focus on innovative research-based graduate education and training activities in emerging areas of science and engineering [6]. In 2002, the initiative expanded its emphasis on, and increases significantly the funding for, international cooperation in response to the globalization of research and career opportunities, which places importance on providing students an international perspective, such as through internships, fieldwork, or other experiences abroad appropriate to the research area.

Concerning international collaboration, the initiative specifically:

(1) Addresses opportunities for career development such as may be provided by internships and mentoring in non-U.S. institutions, or other settings.

(2) Provides a budget for each year of support requested, not to exceed $550,000 per year for 5 years, with the exception that (a) the first-year budget may include up to an additional $200,000 special allocation for special purposes, and (b) up to an additional $100,000 per year for 5 years may be requested for international activities, as described below.

(3) May also provide additional funds of up to $100,000 per year for five years to support international activities that will significantly enhance the research, education, and training experiences of the IGERT graduate students.

(4) Requires proposals seeking support for international cooperation to discuss career development opportunities for students, and provision for developing professional and personal skills, an international perspective, and integrated instruction in ethics and the responsible conduct of research.

(5) Should a multi-institution project be proposed, requires a careful justification that considers the administrative complexity and the expected benefits to student experiences. Also requires a discussion of the role of other academic institutions or organizations such as industry, government, non-U.S. institutions, or private

foundations that are expected to participate in the IGERT project. Also, requires details of anticipated resource commitments by these organizations.

(6) Stipulates that the major portion of funds must be used for doctoral student stipends, educational and training activities, and for related expenditures, such as student travel, publication costs, and recruitment.

(7) Further stipulates that the primary support is intended for graduate students through internships (university, government, industry), fieldwork with foreign collaborators, or in other settings abroad appropriate to the research area. The stays should be of sufficient duration to acculturate the student and provide a meaningful research and education experience.

**Collaboration between U.S. and Latin American Nations**

Also in July 2002, NSF issued a letter soliciting proposals from U.S. investigators in materials research who are interested in collaborating with their counterparts in Argentina, Brazil, Canada, Chile, Colombia, and Mexico [5]. Research funding agencies in these countries provide their own funding, and researchers in these countries are required to apply to their own agencies, including CONICET (Argentina), CNPq (Brazil), NSERC (Canada), CONICYT (Chile), COLCIENCIAS (Columbia), CONACYT (Mexico). The new funding opportunities emanated from international workshops held in May 1995 in Saltillo, Mexico, and in June 1998 in Rio de Janeiro, Brazil, in which scientists and engineers from the Americas identified possible areas for mutually beneficial collaborations. The recommendations that emerged from these workshops included: identifying and supporting cooperative research projects that leverage the strengths of each country's scientific community; the extensive use of electronic communication, information exchanges, and databases to promote and facilitate research collaborations; and educational activities at the international level.

**Establishment of Pan-American Advanced Study Institutes (PASI)**

Under this funding arrangement, approximately 6 to 8 awards will be made yearly to U.S. research institutions or professional societies for the purpose of organizing a PASI [7].

The cost of any one institute may not exceed $100,000. Salaries will not be supported by these awards although a reasonable stipend for a graduate student to assist with the organization of the PASI pre- and post- meeting will be allowed. In addition, student participants from industry are expected to cover their own costs.

Pan American Advanced Studies Institutes are short courses of two to four weeks duration, involving lectures, demonstrations, research seminars and discussion at the advanced graduate and post-doctoral level. PASIs aim to disseminate advanced scientific and engineering knowledge and stimulate training and cooperation among researchers of the Americas in the mathematical, physical, and biological sciences, and in engineering fields. Whenever feasible, an interdisciplinary approach is recommended.

The Principal Investigator (PI) shall be the designated contact person for the Institute and is expected to provide leadership in fully coordinating and integrating its activities. The PI is responsible for (a) the preparation of the scientific and/or engineering program, (b) the selection of lecturers and students, (c) the administration of the meeting, and (d) the publication of lectures and proceedings from the meeting.

## New Trends in International Cooperation

In recent years, motivated by the belief that future advancement in engineering education and research will come though international cooperation, the international community has developed new strategies for international dialog and engagement.

Central to these strategies has been the formation of the International Network for Engineering Education and Research, or iNEER for short. iNEER is a new professional organization formed by the international engineering education community to promote international cooperation. A "virtual" global organization born in the information age, without constraints imposed by geography and culture, iNEER's principal approach is to use recent advances in information and communications technologies to foster the creation of collaborative networks and partnerships in the engineering education and research communities worldwide. It recognizes that, to achieve mutual progress, it is important to increase personnel and information exchanges, and link ongoing, already funded domestic research and education programs. It is built upon the belief that we have the best chance to make progress if we work together as a coordinated network, united by a desire to share ideas and information, and leverage our resources, and jointly formulate new solutions.

The iNEER community, at over 10,000 strong currently (March, 2003) is comprised of educators and researchers from academe, industry and government bonded by a desire to work collaboratively to elevate the quality of engineering education in institutions around the world.

Members are continually updated on developments concerning international cooperation in engineering education and research.

An organization without walls, iNEER invites and welcomes to its community membership educators who support the iNEER goals, and are interested in working collaboratively with other members. iNEER membership may be obtained by self-nomination or second-party nomination by sending an e-mail to the Secretary-General. Nominations by existing members are especially welcome. Membership is free, and is available without regard to national origin or creed. Educators worldwide are welcome to nominate themselves and their colleagues by simply sending in the names, affiliation, regular and e-mail addresses to: ineer@ineer.org.

Under the umbrella of iNEER, the international community has initiated several new approaches to establish communication and dialog. Some of these are described below.

## New Approaches

Notable recent international activities developed by the worldwide international community under the umbrella of iNEER includes the following:

***International Conferences on Engineering Education (ICEE)***. Eight ICEEs have been held in different parts of the world. In addition, future conferences are scheduled as follows: ICEE-2003 – Valencia, Spain; ICEE-2004 – Gainesville, Florida, U.S.A; ICEE-2005 – Gliwice, Poland; ICEE-2006 – Mayaguez, Puerto Rico. For ICEE-2007 and beyond, proposal solicitation will start in the near future. At ICEE-2001 held in Oslo, Norway, 320 papers were presented by speakers from 47 countries. For ICEE-2002, a record total of 482 abstracts have been received from 48 countries. Abstract submission closed recently for ICEE-2003. Over 650 abstracts came from 52 countries. Thus, so far recent world events have had no negative impact on international cooperation. Further information about these conferences, and the proceedings of past conferences, have been posted on the website **http://www.ineer.org**. Abstracts submitted for ICEE-2003 are tabulated in the following.

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**ICEE-2003 Abstract Count By Country** 7-Feb-03

**TOTAL ABSTRACTS: 651**

| | Country or Region | Abstracts | | Country or Region | Abstracts |
|---|---|---|---|---|---|
| **1** | Spain | 176 | **27** | Mexico | 3 |
| **2** | USA | 114 | **28** | Turkey | 3 |
| **3** | Taiwan | 68 | **29** | Hungary | 2 |
| **4** | Brazil | 41 | **30** | New Zealand | 2 |
| **5** | UK | 32 | **31** | Pakistan | 2 |
| **6** | Norway | 21 | **32** | Slovenia | 2 |
| **7** | Australia | 16 | **33** | Croatia | 2 |
| **8** | Czech Republic | 16 | **34** | Argentina | 2 |
| **9** | Germany | 15 | **35** | Greece | 2 |
| **10** | India | 13 | **36** | Morocco | 2 |
| **11** | Poland | 11 | **37** | Yugoslavia | 2 |
| **12** | Ukraine | 9 | **38** | Netherlands | 2 |
| **13** | Italy | 9 | **39** | Tunisia | 2 |
| **14** | Canada | 8 | **40** | Botswana | 1 |
| **15** | Russia | 8 | **41** | Chile | 1 |
| **16** | Portugal | 7 | **42** | Cyprus | 1 |
| **17** | Singapore | 7 | **43** | Lithuania | 1 |
| **18** | Japan | 6 | **44** | South Africa | 1 |
| **19** | Malaysia | 6 | **45** | Algeria | 1 |
| **20** | Switzerland | 5 | **46** | Finland | 1 |

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|---|---|---|---|---|---|
| **21** | China | 4 | **47** | Korea | 1 |
| **22** | France | 4 | **48** | Trinidad/Tobago | 1 |
| **23** | Slovakia | 4 | **49** | Venezuela | 1 |
| **24** | Colombia | 4 | **50** | Ireland | 1 |
| **25** | Sweden | 3 | **51** | Romania | 1 |
| **26** | Israel | 3 | **52** | Cuba | 1 |

Data Source: iNEER, http://www.ineer.org/Events/ICEE2003Info/ICEE-2003AbstractCountbyCountries2-7-03.htm

***Partnership Workshops***. Education workshops are an important component and are a regular feature of ICEE. At ICEE-2003, a pre-conference partnership workshop entitled: "Blueprint for Effective Partnership" will be held. At ICEE-2002, a similar pre-conference partnership workshop was convened. At ICEE-2001, the US-Czech Republic-Poland Workshop and the US-Scandinavia Workshop were coalesced into an umbrella workshop, the "ICEE International Partnership Workshop." A US-Taiwan-Korea workshop was also held. In addition to ICEE-related workshops, iNEER also develops and helps sponsor regional partnership workshops such as the present one held in Nanjing. In addition to workshops held in conjunction with ICEE, the community also meets outside of it in regional workshops, as in the case of the iNEER-SEU engineering education partnership workshop held in Nanjing in June 2002 [8].

***Outreach to Expand the Global Partnership***. In an effort to promote international understanding and cooperation, the Secretary-General of iNEER, on behalf of the iNEER Board and the international community, carried outreach visits to a number of academic institutions worldwide. Photo images of scenes from these visits may be accessed from the iNEER website [9].

***International Partnership Agreements***. Leaders of engineering education have used the occasion of the ICEE conferences to sign new cooperative agreements. The signing ceremony for international cooperative agreements usually takes place at the conference banquet. This was carried out in front of about 400 attendees during ICEE-2000 in Taiwan and similar audiences in Oslo during ICEE-2001 and in Manchester during ICEE-2002. Typical scenes may be viewed on the iNEER website [10].

***iNEER Awards***. The international community has adopted a new series of awards as a means of recognizing individuals for their leadership and accomplishments in furthering the ideals of international cooperation in engineering education and research. The citations of these annual awards are posted on the iNEER website [11].

***Other Partnership Activities***. In addition to the above, members of the international community has participated in planning meetings, special celebration and board meetings of a specialized nature. Scenes from some of these activities may be seen from the iNEER website [12].

***iNEER Special Volume.*** One of the most significant and tangible outcomes of the commitment by the international engineering education and research community to international cooperation is its support for the publication of the annual iNEER Special Volume. Entitled "Engineering Education and Research – A Chronicle of Worldwide Innovations", this archival series is being published by iNEER to give voice to the international community. Editing of the second volume by a 5-member multinational Board of Editors, to be published in time for distribution at ICEE-2003, is now in its final phase. An open call for papers led to submission of 82 final papers for peer review. Based on the reviews, 33 papers have been tentatively selected for publication. The Preface, Table of Contents and a photo of the Cover of the 2002 iNEER Special Volume have been posted on the iNEER website [13].

## Conclusions and Recommendations

In this paper, we have discussed recent trends in funding of international cooperation in engineering education and research, as well recent activities undertaken by the international community to develop linkages. These trends indicate an unmistaken momentum building in each of these sectors.

Though funding organizations around the world have steadily increased support for international cooperation over the past several years, the rapid pace of technological change and the high costs of high quality research and education programs are such that the needs for enhanced and sustained funding for engineering education and research are growing even more rapidly. These costs must be shared by all partners and stakeholders, including individuals and government and private organizations involved in the worldwide engineering education enterprise. We must make a major commitment to support international cooperation by contributing our time and financial resources as appropriate.

Meanwhile, we who are members of the international community must continue our course for dialog and engagement. We must continue our dialog and to seek innovative ways to expand linkages. Additional platforms for communication and partnership must be explored. We must also explore innovative ways for education and training of the young professionals and development of a more diverse workforce that involve more women and minorities.

The involvement of educators from developing nations must also be encouraged and supported.

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A member of .the U.S. Senior Executive Service, Win Aung is a recipient of the NSF Federal Engineer of the Year award, and a Fellow of American Society of Mechanical Engineers (ASME). He has published over 120 technical publications, and edited or co-edited 8 books. An expert in thermal science and heat transfer, he received the ASME Classic Paper Award in 1999 and the *Doctorem Honoris Causa* (honorary doctorate degree) from VSB – Technical University of Ostrava, Ostrava, Czech Republic in the same year. He is the founder of the ICEE conference series; a co-founder of the International Network for Engineering Education and Research (iNEER); and is its Secretary-General. He has served as an adjunct or visiting professor at several universities.