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Engineering Education Societies Becoming Global: The Evolving Development of the International Federation of Engineering Education Societies (IFEES)

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Seeram Ramakrishna, PhD, is a Professor and Dean of Engineering at the National University of Singapore (NUS). He belongs to the top 200 highly cited materials scientists in the world. He is a vice-president of the International Federation of Engineering Educators Societies (IFEES), and spearheads its Global Engineering Deans Council (GEDC) initiative, a world-wide forum for engineering deans around the world. The GEDC envisions the enhanced capabilities of engineering deans to transform their schools in support of their societies in a globalised world. In keeping with its vision, the GEDC will provide a forum for cooperation, and for discussion of experiences, challenges and best practices in leading an engineering school. He is a Fellow of Institution of Mechanical Engineers (FIMechE), UK; Institution of Engineers Singapore (FIES); Institute of Materials, Minerals & Mining (FIMMM), UK; and American Institute for Medical and Biological Engineering (FAIMBE), USA. He received several awards and honors including Lee Kuan Yew Fellowship, NUS Outstanding University Researcher Award, JSPS, ASME Best Paper Award, IES Prestigious Engineering Achievement Award, and ASEAN Outstanding Engineering Award.

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José Carlos Quadrado is the coordinating professor of electrical machines in the electrical engineering and automation department of the Instituto Superior de Engenharia de Lisboa (ISEL), Portugal. Currently he holds the place of President of ISEL. He has a BSc in Energy and Power Systems, a diploma degree in Electrical Engineering, Automation and Industrial Electronics, a MSc and a Doctor degree in Electrical Engineering and Computers from Lisbon Technical University. Also he holds an Habilitation Degree from the University of Beira Interior. He is the president of a research and project center on electrical machines control and applications. He is currently in the board of directors of the Portuguese Electrical Vehicle Association (APVE) and he his the elected Vice-President of the Ibero-American Engineering Education Association (ASIBEI).

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Hans J. Hoyer, Ph.D. Director for International Programs and Strategy for ASEE and Deputy Secretary General of IFEES. Prior to coming to ASEE in early 2006, CEO of World Links, a spin-off of the World Bank supporting on-line collaborative projects globally. Visiting Scholar at MIT and Fellow at Harvard; dean at the School for International Training, Brattleboro, Vt; post-doc fellow of the OAS; Ex VP and COO of Heifer International; and resident regional director in Latin America, Africa, Asia, Europe and the Middle East for several NGOs and membership trade organizations. Author of books, articles related to development and politics and board member of several global organizations focusing on socio-economic development. Born in Berlin, Germany and fluent in seven languages.

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Abstract

Globalization is making both developed and developing countries think about effective and efficient strategies that will advance their economies and social development. Throughout the history of civilization, engineering has played a critical role in economic development. Engineers are key not only in solving local problems but also in knowledge creation and knowledge transfer. Thus, it is imperative that technical know-how be supplemented with professional skills to develop an 'adaptive leader' who is capable of addressing the multiple challenges of an ever changing world. The key-question posed by the 21st century global economy to engineering educators and stake-holders is this: "*How can education in science and technology help to reduce poverty, boost socio-economic development, and take the right decisions for sustainable and environmental compatible development?"* To answer these questions, a global approach is needed: and this can only be accomplished by a "team" which has its roots in all regions of the world, i.e. which is enabled to think globally and then act locally. There's a need to establish effective engineering education processes of high quality around the world to assure a global supply of well-prepared engineering graduates.

This paper describes the reasons for the creation in October 2006 of IFEES – the International Federation of Engineering Education Societies. It will describe the vision, mission, and key strategies of IFEES. It will also describe some of the initiatives currently underway and how the various engineering education stakeholders can leverage and benefit from engaging with IFEES, thus strengthening the organizational capacity of engineering education societies throughout the world. The paper will share plans to help members learn from each other's best practices and even failures and how those organizations that have been in existence for quite some time (ASEE was founded in the late 19th century) can contribute to the institution building of some of the recently founded engineering education societies such as in Africa, Kazakhstan, and other parts of the world. The paper presents not only the view of educators but also of industry and other key stakeholders involved in IFEES around the world.

1. IFEES History, Vision, and Mission

Dr. Muhammad Yunus (Nobel Price laureate 2006) mentioned in his Commonwealth Lecture in 2003 the need to "recognise the role of globalisation and engineering and information technology in reducing poverty."[1] He stressed a "need to be urgently revisited" to address the needs of the poor so "*…that they can get themselves out of poverty if we give them the same or similar opportunities as we give to others. The poor themselves can create a poverty-free world: all we have to do is to free them from the chains that we have put around them."* Therefore, recognizing that the 21st century global economy requires well-trained and culturally-sensitive engineers, representatives of 31 organizations in 10 countries gathered in Rio de Janeiro, Brazil, on October 9, 2006 to launch the International Federation of Engineering Education Societies (IFEES). In addition to electing a distinguished leadership team and approving governing documents, the organization's members discussed their overarching goal of building a vibrant, virtual global community to foster collaboration and learning among the world's engineering education societies. The key question posed by the 21st century global economy to engineering educators and engineering education stakeholders was: *"How can education in science and technology help reduce poverty, boost socio-economic development and take the right decisions for a sustainable and environmental compatible development?"*

To answer the key question above, a global approach was needed. The desire was to create a worldwide network of engineering educators and engineering education stakeholders that could attempt to answer such formidable basic questions and drastically raise the horizon of target and ambitions: i.e., to pass from the day by day engineering education issues and problems [2] to the "actual impact" on the worldwide development and socioeconomic growth. IFEES was born with the vision to contribute significantly to changing the world (within the context of its mission and competences), i.e. to the extent that engineering education can contribute to these changes. With this in mind, IFEES is developing partnerships with major organizations worldwide dealing with social development and education. A primary cooperation has already been established with the World Bank Institute (WBI), Group for "Human Development and Knowledge." WBI and IFEES have both expressed the intention to cooperate on major engineering education subjects as they have recognised how those regions where education in science and technology is most developed and sustained, this might have "*a great impact on the political stability of the region*" (Frannie Leautier, Former Vice President of WB and Chair of the WB Institute., Washington DC, January. 2007)

Through the collaboration of its member societies, IFEES mission is to establish effective and high quality engineering education processes to assure a global supply of well prepared engineering graduates. IFEES strives to strengthen member organizations and their capacity to support faculty and students. It will attract corporate participation, helping to connect engineering graduates with international corporations that have a pressing need for well-trained engineers who can work in a global environment. IFEES will also aim to enhance the ability of

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[1] M. Yunus: *"Halving poverty by 2015: we can actually make it happen"*, Commonwealth Lecture 2003

[2] E.g., issues like curriculum development, quality assurance and accreditation, mobility and recognition of titles, joined curricula, international dimension, ethics, ethics and gender issues in engineering education, employment & attractiveness of engineering education, etc.

engineering faculty, students, and practitioners to understand the varied cultures of the world and work effectively in them.

"IFEES will become the largest worldwide forum of discussion on engineering education, it will increase the awareness of policy makers on engineering education priorities, and it will boost innovation in science and technology,"[3] were the words of Claudio Borri, the founding president of IFEES. "The formation of IFEES underscores the importance of high quality engineering education to national economies and the global economy," said Wayne Johnson, previous Vice President, University Relations Worldwide at Hewlett-Packard. "It also spotlights the great significance of technology in today's society. Engineers have played a key role in developing new information technologies, and those innovations can now be used to advance global engineering education."

The initial elected leadership team included a president plus an executive board of 11 individuals, including vice presidents representing four geographic regions of the globe: Americas, Africa/Middle East, Europe, and Asia/Pacific. Claudio Borri was elected IFEES president. Mervyn Jones, Qing Lei, James Melsa, Lueny Morell, and Nitte Shetty were elected as executive board members for the next two years. Kwang Sun Kim, Norbert Kraker, Maria Larrondo-Petrie, Sipho Madonsela, Yuri Pokholkov, and Javier Paez Saavedra were elected as executive board members for the next year.

Following this vision, the global engineering education community was called to action in their specific branch of competence and expertise: "What more, which higher goal could we set for but to contribute to loose these chains, by joining the vision of such a great mind?" (Yunus) [4]

2. Engineering Education's Role in Developing Knowledge Based Economies

Throughout the history of civilization, engineering has played a critical role in economic development. Engineers are key not only in solving local problems but also in knowledge creation and knowledge transfer. But in a globalized world, engineering, and engineers face challenges that go beyond science and technology themselves. Globalization, which is often defined as the process in which geographic distance becomes a diminishing factor in establishing and maintaining cross-border economic, political, and socio-cultural relations, is making both developed and developing countries think about effective and efficient strategies that will advance their economies and social development. The basic premise is that knowledge is becoming a primary factor of production, in addition to capital, labor, and land. In fact, many economists now argue that knowledge has become the most important component of production. Fifty years ago competitiveness and growth were driven by access to natural resources and labor. With globalization and the technological revolution of the last decades, knowledge has clearly become the key driver of competitiveness. Today, the prosperity of nations depends on how effectively they use their human resources to raise productivity and nurture innovation. And so, countries around the world are moving fast in developing knowledge based economies.

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[3] ASEE Press Release, November 6th 2006.

[4] Words of Claudio Borri, founding president of IFEES. "We" stands here, of course, for the true worldwide community of educators and stake-holders in engineering education.

2.1 Knowledge Based Economies

A knowledge based economy is one that utilizes knowledge as the key engine of competitive growth. It is an economy where knowledge is acquired, created, disseminated, and used effectively to enhance economic development. Transitioning from a traditional economy to a knowledge based economy requires long term investments in education, innovation, and Information and Communications Technology (ICT), and an appropriate economic and institutional regime that allows efficient mobilization and allocation of resources.

A recent book published by the World Bank Institute [3] argues that whatever their level of development, countries should consider embarking on a knowledge- and innovation-based development process. In these times of accelerated globalization, "grey matter" is a country's main durable resource. Its exploitation for economic and social well-being is increasingly at the center of development strategies. The analysis and information on which this book is based are largely drawn from work by the World Bank Institute's Knowledge for Development program, launched in 1999, which has carried out a number of knowledge based economy diagnostics and case studies, using the Knowledge Assessment Methodology (KAM)[5].

What are the basic foundations of knowledge based economies? The World Bank suggests four major areas [2]:

- *Education & Training*– An educated and skilled population is needed to create, share, and use knowledge.
- *Information Infrastructure* – A dynamic information infrastructure, ranging from radio to the internet, is required to facilitate the effective communication, dissemination, and processing of information.
- *Economic Incentive & Institutional Regime*– A regulatory and economic environment that enables the free flow of knowledge, supports investment in ICT, and encourages entrepreneurship is central to the knowledge based economy.
- *Innovation Systems*– A network of research centers, universities, think tanks, private enterprises, and community groups is necessary to tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new knowledge.

These diagnostics have confirmed the critical role of education. Many of the growth stars owe their success to solid gains in human capital. While education has always been a key component of innovation and technological advance, the complexity and speed of the interplay between education, knowledge, technology and skills require far reaching adjustments of education systems. Knowledge enabled economies are able to constantly modernize their education systems in line with changes in economic policies. These changes have been both systemic and deep affecting the nature of teaching and learning.

Most OECD countries increased their public expenditures on education over the last decades, not only because technology adoption (and thus economic growth) are strongly linked to the

[5] The KAM consists of 83 structural and qualitative variables for 140 countries to measure their performance on the 4 Knowledge Economy (KE) pillars: Economic Incentive and Institutional Regime, Education, Innovation, and Information and Communications Technologies. Variables are normalized on a scale of 0 to 10 relative to other countries in the comparison group

education of the labor force, but also because education has such an important effect on civic participation and social cohesion. Developing countries also have made significant investments in education. Once countries reach a literacy rate of about 40 percent, they can increase growth by opening their economies to technology transfer.

2.2 Engineering Education

Over the last decades there has been a dramatic increase in the size of the global labor force, and in a connected world, successful firms are able to tap into the best human resources available anywhere in the world[6]. However, talent and skills has become the world's most sought-after commodity. As economies increasingly shift towards knowledge-intensive directions, the demand for skills and competencies increases significantly.

There are significant shortages of qualified personnel. "In most western countries, schools are churning out too few scientists and engineers -- and far too many people who lack the skills to work in a modern economy (that's why there are talent shortages at the top alongside structural unemployment for the low skills). Even in Asia, home to many of the world's fastest-growing economies, the biggest problem facing employers is a shortage of qualified people. In China and India, early investments in education, especially science, engineering and technical education have provided a critical mass of scientists and engineers, but these countries are suffering from acute skill shortages at the more sophisticated end of their economies." (Dean Seeram Ramakrishna of the National University of Singapore and vice president of IFEES)

More importantly, performance in the marketplace is driven by the quality, skills, and flexibility of labor and management. In addition to traditional "hard" skills and ICT competencies, the knowledge based economies require a new set of "soft" skills, such as spirit of enquiry, adaptability, problem solving, communications skills, self learning, and knowledge discovery, cultural sensitivity, social empathy, and motivation for work. Countries need to develop teaching and learning environments that nurture inquiry, adaptability, problem-solving, and communication skills. But mastery of these skills is quite low in many countries.

The talent shortage is expected to get far more severe in the coming decade. About 80 percent of the fastest-growing jobs of the future will require some post-secondary education[7]. Competitiveness will increasingly depend on the capacity to tap into global pools of knowledge and leverage the best human resources available in the world. The explosion of knowledge, coupled with the global movement of ideas, makes it impossible to fully anticipate the nature of future innovations. It remains that countries that will derive the most from globalization will be those in which the systems of education, business, and government can cooperate to educate, train, and put to work their human capital.

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[6] According to the IMF 2007 World Economic Outlook, the effective global labor force has risen four folds over the past two decades, reflecting population growth and the integration of China, India and the former Eastern Block in the global trading system.

[7] Fact Sheet: Jobs for the 21st Century
http://www.whitehouse.gov/news/releases/2004/01/20040121.html

It is very clear that engineers play and will continue to play a very important role in the creation and development of knowledge based economies. Thus, it is imperative that technical know-how be supplemented with professional skills to develop an 'adaptive engineering leader' who is capable of addressing the multiple challenges of an ever changing world. Engineering education should respond to these challenges with effectiveness and efficiency.

3.1 Mobilizing the Best Human Resources: Corporations, Professionals, and Students

All IFEES officers (the President, the Vice-Presidents, the Executive Committee members, and the Secretariat members in Washington, DC) are committed to promoting, developing and putting in place initiatives to mobilize the best human resources and contributing to the common vision of IFEES. Only through the "top people" worldwide will IFEES become influential and have an impact on major changes. Participation must include corporations, as well as professionals from industry, governmental and non-governmental agencies. In this context, IFEES' goal is to build a network of high value partnerships with key leaders around the world, in organizations as well as the engineering education sector. From the economic sector to social sciences, from political sciences to peace keeping, from banking to financial investors, IFEES shall carry out its mission hand-in-hand with all of them.

One way to reach this goal is to involve students and student organizations in IFEES strategy definition and IFEES events. The archaic vision of students as "customers" or (even worse) "end products" of engineering education process needs to be abandoned. IFEES wants and needs to have students on board because they are key stakeholders and their vision, needs, and ideas are important. They are also important in matchmaking opportunities with and obtaining support from the corporate world. Omer Hantal, the current president of the Board of European Students of Technology (BEST), served a two year term on the executive committee.

3.2 IFEES Action Plan and Key Strategies

IFEES operational objectives include:

- promote engineering education globally and the access to engineering education for everybody in the world
- enhance the quality of engineering education responding to actual needs of the society
- share teaching methods and curriculum plans
- increase transparency and recognition of titles, also through the accreditation systems and international accords
- foster and favour mobility of students and professionals
- promote ethics and gender, ethnicity, race, and disability issues in engineering education
- increase awareness towards environmental issues and sustainable development
- improve humanistic skills and cultural attitudes of engineers to work in different cultural settings of the world (we refer to as the "the Renaissance Engineer of tomorrow"), re-affirming the role of engineers as the true innovators and developers of new ideas which was their prerogative in the renaissance times
- to foster imagination and innovative thinking in the new generations of engineers

Five areas of activities/thrust areas were identified in order to contribute to shaping "the global engineer" agreed during the first meeting of the Executive Committee held in Rio de Janeiro in 2006. The five areas were drafted as follows:

- Area 1 – *Engineering Education Infrastructure*
- Area 2 – *Research & Development*
- Area 3 – *Entrepreneurship*
- Area 4 – *Student Attraction and Success*
- Area 5 – *Lifelong Learning*

In addition, IFEES is looking with great attention to the most recent developments of engineering education and research policies in different regions of the world, such as those established by the European Commission. In this last case IFEES will analyze and take into highest consideration policies like:

- The policy stated by the education ministers of the so-called "Bologna follow-up" countries (now 46) in the London Communiqué of May 2007[8] and concerning the European Higher Education Area in a global context, where it affirms (Chapter 2.20): "We adopt the strategy *The EHEA (European Higher Education Area) in a Global Setting* and will take forward work in the core policy areas: improving information on, and promoting attractiveness and competitiveness of the EHEA; strengthening cooperation based on partnership, intensifying policy dialogue and improving recognition." This work ought to be seen in relation to the OECD/UNESCO *Guidelines for Quality Provision in Cross-Border Higher Education.*
- The opening of the widest R&D program of the European Union, the 7th Framework Program, to the participation of almost all so-called third countries, i.e. to countries from all areas of the world.

Our vision and hope is for IFEES to become a qualified partner of the European Commission and in doing so assist in creating worldwide recognition of engineering education as a research field. IFEES is ready to embark on such an innovative path.

To fully implement its action plan, IFEES needs the support of all engineering education societies, stakeholders, corporations, and, last but not least, student associations.

4. First Year's Global Initiatives

IFEES was created with the clear intent that it be an action-oriented organization, where its members can propose and participate in global initiatives. The structure of the leadership of IFEES also supports the four action areas described above. The Executive Committee consists of the President, President-Elect or Immediate Past President, a Secretary General, four Vice Presidents and 6 other members. Each IFEES Vice President will have principal responsibility for leadership for one of the areas and one or more initiatives. Proposed initiatives undergo a review process and are placed under one of the four Areas to make sure they align with the

[8] The London Communiqué, EU Education Minister Council, May 2007

Mission, Vision, and Strategic Plan. In the next section, IFEES initiatives that are underway are described.

4.1 Global Engineering Deans Council

The Global Engineering Deans Council (GEDC) is a key initiative of the International Federation of Engineering Education Societies (IFEES) in 2008. IFEES approved the creation of the GEDC at the first IFEES Global Engineering Summit on September 30th in Istanbul, Turkey.

There are currently big and small institutions with different missions and visions for the various engineering programs, and emphases on research, etc., to meet the diverse engineering manpower and innovation needs of national economies. As the global pressure for engineering solutions to growing problems and issues continue to increase, engineering educators intrinsically feel the need to better prepare engineers to meet the new challenges. Stakeholders are increasingly expecting engineering colleges to act as leaders in innovation and to provide solutions to society's challenges. In a global, knowledge-driven economy, technology innovation is critical to competitiveness, long term productivity growth, and the generation of wealth. Major changes will be necessary in engineering education, research, and practice to prepare engineers for a rapidly changing world.

The key challenges faced by engineering deans, rectors, and directors of internationally recognized engineering schools include the following "how tos":

a) Deliver locally-pertinent and globally-relevant engineering education?
b) Make engineering more attractive to top students, who are being drawn away from science and technology disciplines, and make engineering more attractive to our future generations of students?
    - Stagnant engineering enrollments in higher per capita income cities/regions/nations
    - Growing engineering enrollments in rapidly growing economies
c) Improve the quality of teaching and learning, and increase the output of engineers?
d) Recruit and retain quality faculty members (there is a shortage in many countries)?
e) Strengthen "capacity building" such as staffing, funding and infrastructure in engineering schools?
f) Improve the quality of governance practices in engineering schools?
g) Develop adequate models for facilitating partnerships between engineering schools and industry (consensus on evaluation metrics to be used by stakeholders)?
h) Develop adequate funding models for engineering schools?

The GEDC initiative is timely as it is a great way for engineering deans to learn about engineering education on a global scale by providing a worldwide forum for exchange of information, discussion of experiences, challenges, and best practices in leading an engineering school. Through such exchanges, the GEDC will provide a means for engineering deans to partner with one another in innovation, collaborate with industry and other stakeholders, and build a network that would support engineering deans to play a leadership role in developing regional and national policies to advance economies. The GEDC's vision and mission statements below certainly address these issues.

Vision:
To enhance the capabilities of engineering deans to transform their schools in support of their societies in a globalized world.

Mission:
To serve as a global network of engineering deans, and to leverage on the collective strengths, for the advancement of engineering education and research.

The GEDC has the potential to become a serious global effort with meaningful impact for engineering education. It will hold its first Executive Committee meeting on May 8 and 9, 2008 in Paris, France. The Executive Committee is made up of deans, rectors, and directors of internationally recognized engineering schools**.**

4.2 The IFEES Global Engineering Education Summit

IFEES held its First Global Engineering Education Summit and Assembly at Boğaziçi University in Istanbul, Turkey on September 30, 2007, co-located with the ASEE Global Colloquium and the Turkish Engineering Deans Council Conference. The theme was *Moving from Concept to Action* and approximately 150 leaders of engineering education societies, industry, government agencies, the private sector, and engineering student leaders participated in the Summit, which was organized by Maria Larrondo Petrie, Executive Committee Member of IFEES and Executive Vice President of the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI); Federico Flueckiger, Past President of the International Society of Engineering Education (IGIP) and Administration Council of the European Society for Engineering Education (SEFI), Ali Kaylan, Co-Chair of the ASEE Global Colloquium and Boğaziçi University; Hasan Mandal, Chair of the Turkish Engineering Deans Council, and Hans J. Hoyer, Deputy Secretary General of IFEES. It was organized into 4 sessions:

- ***Setting the Stage – Global Challenges and Opportunities Facing Engineering Education***. In this session Hasan Mandal, Chair of the Turkish Engineering Deans Council, gave the opening address [8]; Claudio Borri, the President of IFEES, presented the IFEES Vision and Strategic Plan [9]; Bruno LaPorte, Manager of the Human Development and Knowledge for Development Group of the World Bank Institute, spoke about the role of engineering education as one of the foundations of a knowledge based economy [10]; and Upton van der Vliet of the European Commission presented the global dimension of European Union Higher Education and Research [11].
- ***Quality and Program Recognition***. In this session, centering on accreditation, quality assurance, and global program recognition, Mehmet Durman, Chair of the Commission of Academic Assessment and Quality Improvement in Higher Education in Turkey, presented a historical perspective of quality assurance in Turkish Higher Education [12]; Giuliano Augusti, coordinator of the EUR-ACE Implementation Project, President of the European Network for Accreditation of Engineering Education (ENAEE) and Former SEFI President, discussed the new EUR-ACE engineering education accreditation system [14]; and Bill Kelly, representing ASEE, presented the Washington Accord [13].
- ***The Future Engineer-Industry Requirements to Engineering Education Institutions***. A keynote presentation by M. P. Ravindra, Senior Vice President of Education and

Research of Infosys [15] was followed by an industry and private sector panel with Lueny Morell, University Relations – Latin America, Hewlett Packard Company; Xavier Fouger, Director of Learning and PLM Academy at Dassault Systèmes, and Maria Rimini-Döring, Head of Corporate Research and Advance Engineering Human-Machine Interaction at Robert Bosch GmbH

- ***Global Strategies Addressing Engineering Education Challenges and Opportunities***. This session focused on the deans and students perspectives: Seeram Ramakrishna, Dean of Engineering at the National University of Singapore and Fellow of the Association of Southeast Asian Nations (ASEAN), presented the motivation behind the IFEES initiative to form a Global Engineering Deans Council [16]; and Andrej Bulat and Nicolò Wojewoda, representing BEST and SPEED (Student Platform for Engineering Education Development) -European and Global student Organizations, presented the student perspective of how to expand student participation [17].
- ***The Future of IFEES.*** This section focused on the perspectives from different regions: Duncan Fraser and Funso Falade of the African Engineering Education Association [18], Guy Haug a former official of the European Union Commission [20], and Yuri Petrovich Pokholkov of the Russian Association of Engineering Education [19].
- ***What's Next? The Future isn't what it used to be.*** The Closing Dinner Session Keynote was given by Chris Luebkeman, Director of Arup Foresight and Innovation.

The 2nd IFEES Summit will be held in Cape Town, South Africa from October 19-20, 2008, and hosted by the University of Cape Town and the African Engineering Education Association (AEEA). The theme will be "*Excellence and Growth in Engineering Education in Resource Constrained Environments – Learning from one another and Working together to produce Quality Engineers to address challenges facing every part of the world in the 21st Century.*"

4.3 The India-US Collaborative for Engineering Education (IUCEE)

The American Society for Engineering Education (ASEE), along with IFEES and academic and business leaders from leading US and Indian universities have launched an initiative to build Indo-US collaborations in order to make engineering education and research more relevant to the needs of the global society and to the aptitudes and aspirations of the new generations of youth. Engineering educators of US and India are in a unique position to address these challenges by working together. Strong bonds have already been developed between US and India, because of the large number of Indian engineering graduates who migrate to the US and make valuable contributions to the US research enterprise and to the US economy. Several of these engineers have become entrepreneurs and have played a major role in the Information Technology revolution and in a variety of non-technology oriented industries such as hospitality. Many of them are also leaders in engineering education in the US. This synergy between US and India provides the opportunity for the two countries to collaborate on building the next generation technical workforce using new paradigms.

Led by its Executive Director, Dr. Krishna Vedula (University of Massachusetts at Amherst), Hans J. Hoyer (ASEE and IFEES), R. Natarajan (Vice President of the Indian National Academy of Engineering), M.P. Ravindra (former Executive VP of Infosys), and Ashok Saxena (Dean of Engineering at the University or Arkansas) the collaborative focuses on the preparation of the next generation of engineering faculty in the US and India, who can educate their youth with

strong technical skills as well as relevant soft skills while motivating them with a powerful vision of engineering for the well-being of the global community. The collaborative seeks to further define the objectives of the initiative and to develop a game plan for moving forward via two workshops (one in India and one in Washington) in 2007.

The outcome of the two workshops was a strategic action plan for dramatically increasing the number of engineering faculty in the US and in India who collaborate on research and teaching and who will be able to better prepare engineers for the global economy. It will be a road map, based on successful best practices, for educators in the US and in India on how to:

- Increase research collaborations among faculty in emerging technologies, thereby producing more Ph.D.s
- Stimulate academic institutions to pursue more research on how students learn engineering.
- Develop and offer new certificates/degree programs based on this research for current and future engineering faculty
- Facilitate faculty exchanges between academic institutions and businesses of both countries as a cornerstone for these collaborations
- Assist faculty in reforming engineering curriculum with emphasis on hands-on project based learning, innovation and entrepreneurial skills, soft skills, life long learning skills, as well as relevance to industry
- Support widespread use of communication and digital technologies for effective delivery of curriculum
- Create a faculty culture of continuous quality improvement based on data and outcomes
- Increase participation by women and underrepresented minorities in engineering
- Generate funding and build partnerships with the private sector for these activities

IUCEE has been successfully launched, gathering support and contributions from the private, professional and public sectors in the US and India. The First Faculty Leadership Institute will be offered in 2008, at the Infosys campus, Mysore, India. The one-week workshops on specific topics will explore new teaching pedagogies and will include overview of latest research in the field, and opportunities for collaboration. Each topical workshop will have ~ 30 carefully invited and selected faculty participants; ~5 of these will be potential trainers/faculty in Regional Indo US Engineering Faculty Institutes.

The table below shows the tentative schedule of the Leadership Institute.

Indo US Engineering Faculty Leadership Institute in Summer 2008
Tentative Schedule: Infosys Mysore Center

	Topic	Lead Presenters, Affiliation	Dates
1	Effective Teaching; Cooperative Learning; Effective Faculty Development, Outcomes based education; Quality and Accreditation	Rich Felder and Rebecca Brent, N. Carolina State University	May 26 to 28
2	Preparation for India's membership in Washington Accord	Ashok Saxena, University of Arkansas	May 29 to 30
3	Learning Factory, Effective Teaching; Continuous Quality Assurance Building Industry Academia Partnerships	Jorge Velez-Arocho and Rosa Buxeda, Univ of Puerto Rico; Lueny Morell, Hewlett Packard	June 2 to 6

4	Strategies for Effective Course Design and Delivery	Veena Kumar, Rutgers, The State University of New Jersey	June 9 to 13
5	Computer Engineering	Joseph Tront, Virginia Tech University	(Parallel
6	Computer Networks	P.R. Kumar, University of Illinois Urbana Champagne	Workshops)
7	Wireless Communications	James Kurose, University of Massachusetts, Amherst	
8	Signal Processing	Sidney Burrus, Rice University	June 30 to July 4
9	Algorithms, Tutored Video Instruction	Richard Anderson, University of Washington	(Parallel
10	Software Engineering	Leon Osterweil and Lori Clarke, Univ of Massachusetts	Workshops)
11	Computer Security and Modern Compilation	Jack Davidson, University of Virginia	
12	Principles of Effective Teaching and Learning	P.V. Krishnan, GIW Industries, USA	
13	VLSI Design	Andrew Mason, Michigan State University	July 7 to 11
14	Engineering Design Projects in Service to Community	William Oakes, Purdue University	(Parallel
15	Project Management; Data Base Design; Security	Vijay Kanabar, Boston University	Workshops)
16	Electric Energy and Power	S.S. Venkata, University of Washington	
17	Engineering Education for Building Knowledge Economies	Andreas Blom, World Bank,	July 9 to 10
	Focus on Governance	Bruno Laporte, Kurt Larsen, Anuja Utz, World Bank Inst	(invited only)
18	Academic Leadership	M.P. Ravindra, Advisor, Infosys Technologies Ltd	July 11
19	Hands-on Engineering using Labview	Dhanabal Solaikutty, National Instruments	July 14 to 18
20	Project Based Learning, Sustainable Product Design	Alice Agogino, University of California, Berkeley	(Parallel
21	Product Life Management using CAD	Xavier Fouger, Dassault Systemes	Workshops)
22	Developing Leadership Skills	Zacharias Cherian, Agilent Technologies, India	July 17 to 18

5.0 The American Society for Engineering Education's perspective on IFEES

The formation of IFEES comes at an opportune time for ASEE. Engineering education is facing the need for fundamental changes. With the rapid change in technology, decreasing supply of engineers, the impact of globalization, and the complexity of problems to be solved, we must find ways to better educate the engineers of the future. As Dr. James L. Melsa, ASEE President, states in the September 2007 issue of *Prism,* "We are currently preparing students for jobs that don't yet exist using technologies that haven't yet been invented in order to solve problems we don't even know we have."

ASEE's mission is to further education in engineering and engineering technology by promoting excellence in instruction, research, public service, and practice; exercising worldwide leadership; fostering the technological education of society; and providing quality products and services to its members. ASEE seeks to encourage local, national, and international communication and collaboration to achieve its mission. As an international organization, IFEES provides a forum for ASEE to collaborate with its worldwide partners on critical issues in engineering education. ASEE has an interest in and commitment to each of the key strategies IFEES has defined to achieve its overall vision.

ASEE has more than 12,000 members, including deans, department heads, faculty members, students, and government and industry representatives. It is organized into 40 divisions and constituent groups that represent professional interests across all aspects of engineering and engineering technology. ASEE has several councils that may be of global interest, the Engineering Dean's Council, Engineering Technology Council, Corporate Member Council, and Engineering Research Council. In fact, the Engineering Dean's Council is serving as a model for the IFEES Global Engineering Deans Council. The contributions made by the ASEE membership through the proceedings of the Annual Conference and Exhibition, *Prism*, *Journal of Engineering Education,* and *Advances in Engineering Education* (ASEE's new online journal) can be shared through this worldwide partnership. In addition, ASEE has a number of initiatives that may be of value to the IFEES membership. These initiatives include *Engineering Go For It!* the ASEE biennial publication targeted at pre-college audiences, the K-12 and Pre-College

Division and Center, pre-conference ASEE Workshop for K-12 Engineering Education, Women in engineering Division and Minorities in Engineering Division.

Although ASEE has much to offer to IFEES, there is also much that ASEE can learn from its worldwide partners. IFEES will provide opportunities to collaborate on solutions to societal problems, access to new teaching methods, opportunities for students and faculty to learn in a global environment, and to explore new strategies for educating tomorrow's engineers.

5.2 Student associations' perspective (Student Forum and SPEED) on IFEES

IFEES aims to shape the future of engineering education so that it ensures the sustainable development of mankind which cannot happen without involving those who will be the active players in tomorrow's society. One of the most important stakeholders of engineering education are the students, tomorrow's engineers.

Students' involvement embraces the advantages of a fresh and diverse pool of ideas being the key factor for the improvement and evolution of the educational systems worldwide. Furthermore, in order to ensure the continuity, applicability, and functionality of the reforms and operation frameworks within engineering education set by global entities such as IFEES, students' motivation and empowerment is crucial [21].

"How can students be involved, and how can their input be considered on a global scale?" is the question that arises at first sight. The answer stays within the worldwide student associations that take the responsibility and active role in shaping and improving the process of engineering education.

In Europe, student involvement in decision-making processes has increased over the last years starting with university level (input of student unions), continuing with national level (national student unions), and ending with cross-national level (representative European Students' Union) [21] and non representative student associations, such as BEST.

BEST has been providing a solid and coherent input to Engineering Education policies at the European level and beyond, since 1995. With the mission to provide services to students, BEST focuses in providing complementary education, educational involvement and career support to the European students. BEST is active in 30 countries with 2,000 members and reaching 900,000 students [22]. BEST impacts the development of engineering education by concurrently embodying a live link between students and their education, and a platform where European stakeholders of Engineering Education meet and improve Engineering Education, all these according to the BEST Educational Program, run by BEST Educational Committee.

BEST Educational Program plays these roles as it strives to increase the awareness of students of technology on educational matters, in order to help them with their self-development, and offers to all stakeholders in European Engineering Education a knowledge base with the ideas, opinions, and suggestions of students [24]. BEST Educational Program actions include active work with European Engineering Education associations (such as SEFI, EuroPACE in Thematic Network Projects (e.g., Higher Engineering Education for Europe (H3E), Enhancing Engineering

Education in Europe (E4), Teaching and Research in Engineering in Europe (TREE), Real Virtual Erasmus (REVE), Virtual Mobility Before and After Student Exchange (VM-BASE) [25,26,27,28,29,30]) that are supported by the European Union. Furthermore, BEST organizes events on education, which are specialised events that assemble students, academics and often company representatives, and aim to encourage the student participants' ideas on important educational topics. Such input is made available to all interested Engineering Education stakeholders. During this saga, BEST has organized 29 events on education, and has served 10 Thematic Network Projects.

During the 5th ASEE Global Colloquium on Engineering Education in Rio de Janeiro, Brazil, BEST joined forces in the creation of IFEES aiming to provide a beneficial input for the worldwide engineering education, and to serve as an example of good practice for other existing student associations, or to inspire new student initiatives in the field of engineering education. Giving the example of Europe, one may not extrapolate and assume there are continent-wide student organizations dealing with the improvement of engineering education in each region of the world. There are many isolated activities across the globe concerning broad engineering education themes and also global networks but oriented only towards specialized fields.

To address the challenges of engineering education development worldwide, and ensure the student involvement in this evolution, there is a need for a global initiative built across continents and student organizations which would facilitate the correlation of student input.

Identifying this need, a new worldwide student initiative has been starting to take shape, under the acronym of SPEED [31]. The challenges and the opportunities of such initiative are being handled by an increasingly numerous group of internationally diverse students, a new breed of global engineers, who look beyond the borders of their education and cultures and connect in spite of the variety of believes and backgrounds.

The involvement of students with such mindset in the global processes dealing with engineering education can bring a significant contribution, inspiring for further engagement as well as an increased connectivity of people and ideas that ultimately drive us towards global awareness and understanding, social cohesion, sustainability and reunion with nature.

SPEED [32] was created during the 5th ASEE Global Colloquium on Engineering Education (GCEE) 2006 and, although still a "baby organization," it has already achieved some concrete results - namely planning and executing the whole student related program and Global Student Forum (GSF) for the 6th ASEE GCEE 2007, creating student program and GSF for the 7th ASEE GCEE 2008 in Cape Town, coordinating international student research groups, as well as building a solid network among student and between student organizations from 6 continents. The aims and vision of the organization were drafted during the first GSF in Rio de Janeiro, Brazil, 2006 and continued to be shaped during the second GSF in Istanbul, Turkey, 2007. SPEED aspires to connect different stakeholders of education, provide input and create a change on the field of engineering education, and link "local-regional-international" across all stakeholders of engineering education into a "global" entity.

The three strategic directions, identified for the further actions of SPEED, are achieved initially by promoting the need for change in the development of engineering education among local student leaders and secondly, by interconnecting them and transforming them in regional student leaders (using the student unions or other local student committees). Thirdly, SPEED strives to create a platform for student leaders, to facilitate their engagement into cooperation and research on engineering education matters and finally to connect them with representatives from other NGOs, businesses and the industry sector, academia, societies and politics.

Throughout these activities, SPEED follows its motto: "Think globally – act locally!" in order to make a change that is applicable to the local realities, but keeping in mind the global perspective.

5.3 Industry Perspective on IFEES

Even though industry and academia have different dynamics and are in essence quite different in nature and operation, both seek the same goals: knowledge and people development. Industry needs:

- Leading edge products and services
- Satisfy customer needs
- Educated workforce
- Latest technologies
- Effective execution of technical and management process
- Provide value to stakeholders
- Increase employment engagement
- Management of ethics issues
- Aware of global trends
- Reduce operation costs

While universities need:

- Good curricula
  - input for curriculum development
  - Accreditation
  - Advisory Boards
- Good teachers and researchers
  - Recognition of their scholarly work - papers and patents
  - Research grants & research collaborations (for M.S., Ph.D. theses)
- Top students
  - student internships
  - recruiting
- Budget
  - External funds to complement state allocation (for public institutions)
- Adequate Facilities
  - For their academic research and administrative processes (different needs and management processes) at very low prices or donations
- Good citizens in their communities
  - Need public advocacy for education, research, professions…

Yet the fact is that around the world, oftentimes and due to many factors, both sectors engage in these important goals independently and in parallel. Much is lost by this situation. So, why not partner and collaborate to achieve more effectively and efficiently these goals? Industry particularly is interested in an engineer/technology professional who will effectively integrate and contribute to corporate goals. Industry is also interested in research and technology partnerships that advance the state of knowledge faster, bringing together top minds in technology areas. Industry is also looking forward to contributing to communities' needs and support philanthropic initiatives.

Companies that have realized the potential of industry-university collaboration – seeking the same goals, best practices, resources, and talent to enhance the capacity of each other – have discovered that they can achieve their goals easier while at the same time, contributing to a greater good, that is, enhancing engineering/science education. Industry-university collaborations take many dimensions, from research and development to technology adoption, account management, internship opportunities for faculty and students, and talent recruiting.

Inspired by a successful practice of the ASEE, founders of the IFEES included and are seeking participation of businesses interested in engineering education. Discussions are currently underway in IFEES to establish a Corporate Membership Council (CMC) under the overall umbrella of the organization. The provisional mission of the CMC is to foster, encourage, and cultivate the dialogue between industry and engineering educators to assure a global supply of well-prepared engineering graduates. Meeting twice a year and offering participation in other events throughout the year, the CMC provides the ideal conduit for communications from industry into the top levels of international engineering and engineering technology education. Motivation for such an association to include commercial companies can easily be seen as one of the natural mechanisms to collect financial support from future employers or technology providers. The early activities of IFEES have shown however that the mutual value of collaboration essentially emerges through other forms of joint work and outcome that could be classified in three categories:

1. Capacity creation:
    a. *Recruitment*: improve attractiveness of engineering disciplines by defining, testing, sharing and enabling best practices and collaborative initiatives to attract under-represented segments of populations, reach families with low or no awareness about engineering or engineering education
    b. *Retention:* jointly invent and deploy ways of sustaining student enthusiasm and tenacity to improve retention in engineering learning disciplines
    c. *Volume*: share visibility, ideas, and efforts in defining locations at global scale, and disciplines where capacity increase is justified by employment opportunities.

2. Curricula update:
    a. *Agility:* help faculty understand emerging skills and practices that become standard in engineering jobs, including skills resulting from globalization and virtualization of the engineering profession. Instruments to that end include fellowship, sabbaticals, academia attendance in industry conferences

b. *Deployability:* establish transfer mechanisms of new engineering methods as practiced in innovative businesses to curricula. Typical actionable means are: faculty training by industry, educational content distribution, and student internship with educational scopes of work.
c. *Scalability:* working together between industry and academia to define faculty education programs in new engineering practices

3. Educational innovation for competitive education practices:
    a. Businesses have been exposed very early to acute transformation forces resulting from globalization, to increase their competitiveness –or simply survive- in this context. The recognition that learning is a key response to these challenges drove significant innovation in distant/blended learning, high speed knowledge update, knowledge certification within partners and stakeholders networks and affordability of large scale education programs, to name a few. Sharing understanding, co-inventing new techniques, transferring know-how about these innovations can greatly benefit from collaborative work between businesses and faculty within the IFEES.

Two key characteristics of the IFEES create favorable conditions for achieving better results within all these categories: (i) the association is truly international hence reflecting the increasingly global operating field of companies, and (ii) the association members are association with their own larger audiences and therefore with a stronger potential for a broader impact. This is why technology providers such as Hewlett Packard or Dassault Systemes, service providers such as Infosys, or employers in manufacturing such as Bosch or Boeing, have expressed their interest and started their investment in the IFEES. These companies value industry-university partnerships, as Wayne Johnson, Vice President for Hewlett-Packard University Relations states:

> *"Through its global network of relationships with academic, governmental, and industrial entities, University Relations increases HP's capacity for innovation, expands business opportunities and contributes to global market development. UR works to align the technology interests and talent needs of HP with those of leading research institutions around the world. This activity not only extends HP's knowledge supply chain, it also serves to shape and improve educational programs globally. HP receives financial, technological and human-resource returns through public/private partnerships, sales support efforts and community-building that the UR team drives."*
>
> *Wayne C. Johnson, Vice President HP University Relations Worldwide*
> *2006 Annual Report*

6.0 Conclusion

Throughout the history of civilization, engineering has played a critical role in economic development. Engineers are key not only in solving local problems but also in knowledge creation and knowledge transfer. Thus, engineering education plays a very important role in developing the engineering professionals that will not only solve local, regional challenges but also succeed in the highly technical and globalized economy of today and tomorrow. IFEES brings together all engineering education societies around the world to address the major

challenges engineering education faces in both the developed and developing world. By strengthening societies, learning from each other, sharing best practices and jointly addressing challenges, IFEES hopes to enhance quality of engineering education responding to actual needs of the society.

As IFEES is evolving and increasingly reaching out to engineering education societies throughout the world as well as opening dialog with colleagues in some countries that do not currently have such an organization, have only recently established such an organization (a good example is the African Engineering Education Association and Kazakhstan Engineering Education Association formed only recently) or are interested in establishing such an organization (such as the example of Namibia where colleagues are taking some initial steps to form a natural organization and are beginning to build connections with the AEEA, ASEE, IGIP, and SEFI). IFEES sees a tremendous potential for long-established organizations to play a supportive role to the countries that only recently have established their own organization and are in the process of doing so. It is this kind of effort and interactions between societies that has the tremendous potential of contributing in a meaningful way to the strategies and capacity building of emerging societies who can benefit from the successes and failures of well-established peer engineering education societies. As IFEES is increasing conscious of and sensitiveness to the need to establish a "space" globally that is unique to the profession, it is committed to "using its connections to initiate collaborations among the membership of its societies to help them achieve their global aspirations." (Jack Lohmann, Vice Provost and Professor of Georgia Institute of Technology)

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