Shaping engineering education in the Middle East – a report on four engineering education conferences held at the University of Sharjah

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ABSTRACT: In this paper, a summary report on four international forums on engineering education (IFEE) held at the University of Sharjah in Sharjah, United Arab Emirates, in 2001, 2002, 2003 and 2006 is presented. The International Forum on Engineering Education (IFEE) series in Sharjah was initiated to bring together engineering educators from around the world, especially from the Middle East, as well as students and other stakeholders from the community, to interact and contribute to the enrichment and advancement of engineering education in the region.

INTRODUCTION

Achieving quality and excellence in engineering education is high on the agenda of Middle East regional universities. Most engineering educators in regional universities completed their graduate studies with many serving as engineering educators abroad. Upon joining regional universities, educators face the challenge of adapting to new educational systems that share some qualities with, but also differ in many ways from, universities in technology-generating countries. Some of the areas of comparison include the following:

- *Pace of change and evolution*: engineering education in the Middle East region generally evolves slowly compared with engineering education in technology-generating countries;
- *Technical and generic engineering education*: engineering education at the undergraduate level in this region tends to focus on feeding technical information and is generally uneasy about the broadness of education and the importance of developing generic qualities in engineering programmes;
- *Partnership with stakeholders*: in the Middle East region, a serious rift exists between engineering colleges and the community in terms of science and applied technology, although engineering disciplines differ in this regard;
- *Integration of faculty activities*: the degree of integration of teaching, research and community service in regional universities is reflective of the technology generation activity in the region.

The above four issues were identified, among other issues, as serious issues that need attention and extended discussion in the region. Accordingly, a group of faculty from the University of Sharjah, based in Sharjah, United Arab Emirates, and colleagues from regional universities initiated in 2001 a series of forums titled *International Forum on Engineering Education* (IFEE) to bring together engineering educators from around the world, especially from the Middle East region, as well as students and other stakeholders from the community, to interact and contribute to the enrichment and advancement of engineering education in the region. The main long-term objectives of establishing this forum series was to establish engineering education as a major focus of the engineering discipline in the region. The first four forums, all held at the University of Sharjah, were devoted to addressing the four issues listed above, under the following themes:

- IFEE 2001: The Changing Role of Engineering Education in the Information Age - Innovation and Tradition;
- IFEE 2002: Generic Attributes in Undergraduate Engineering Education - Issues and Development;
- IFEE 2003: Building Partnerships with Government, Industry and Society;
- IFEE 2006: Integration of Teaching and Research with Community Service.

In this paper, a summary addressing each of the four IFEE themes is presented and discussed with appropriate conclusions drawn. The authors acknowledge the contributions of the engineering educator delegates to the four forums on engineering education [1-4].

IFEE 2001: THE CHANGING ROLE OF ENGINEERING EDUCATION IN THE INFORMATION AGE - INNOVATION AND TRADITION

In the wake of modern challenges that are reshaping engineering education, the focus of engineering colleges and departments must be on quality and excellence in designing and delivering educational programmes and developing strategic collaborative links with industry, the community and other educational institutions. Building and maintaining quality and excellence is a major challenge for new universities competing in the increasingly global environment.

Universities in the Arabic and Islamic worlds in particular must balance tradition and innovation in designing and delivering educational programmes. Achieving the balance between innovation and tradition must be viewed as an opportunity that adds unique values to educational programmes but not an obstacle that hinders development.

The engineering profession has experienced substantial change over the past two decades. In terms of the enrolment of high-achieving students, some traditional engineering specialties and disciplines have experienced decreasing interest while others have gained substantially. In addition, combined and double degree programmes combining the disciplines of engineering together or with other disciplines, such as business and information technology, have become increasingly attractive to students. These combined programmes are also being developed and marketed to attract more and quality students to engineering programmes.

With increasing community awareness and the enactment of more stringent regulations, traditional models of engineering education, which emphasised the ability of engineers to conquer their surroundings, have also been rejected. Instead, the engineering programmes of today and tomorrow are expected to address social concerns and the environmental impacts of development. In order to achieve this goal, universities around the world are actively integrating the principles of sustainable development into their educational programmes, especially engineering education programmes. Sustainable development is aimed at balancing economic and social development, environmental protection and generational equity.

Regional universities and societies are actively involved in absorbing the impacts of the information and globalisation age, characterised by the rapid pace of communication technology advancement, the expansion and intrusion of mega-corporations, as well as availability of information. The Internet is rapidly replacing the library as the source of science and technology information. The Internet educational industry is booming and regional universities are trying to adapt to new technologies while struggling to maintain traditions and preserving culture in the face of information flooding, rapid technological changes and competition for leading international universities that are expanding locally.

Middle East regional universities are not leading in their response to these changes but are merely responding and trying to cope. Exhaustion, stagnation and self-assurance are more relevant descriptions of many local universities than leadership, trend-setting, excellence and radiance.

With the above issues in mind, the participants of IFEE 2001 were invited to discuss issues under many themes. A summary of the themes presented during IFEE 2001 include:

- Creative approaches to teaching and learning;
- Effective teaching and learning: case studies;
- Curriculum design, development and implementation;
- Online delivery, flexible delivery, distant education and open learning;
- Globalisation and engineering education;
- Integration of generic skills into engineering education;
- Environmentally educated engineers;
- Integration of sustainable development into engineering education;
- Use of technology in education;
- Student support systems;
- Student learning and evaluation;
- Gender equity in engineering education;
- Continuing education;
- Projecting and meeting the needs of employers;
- Quality and excellence in delivering programmes and courses: assessment models;
- Student/instructor interactions in the university and beyond;
- Role of alumni;
- Role of advisory committees;
- Administration of teaching and learning programmes;
- Accreditation in a changing environment;
- Broad or specialised undergraduate programmes;
- Graduate studies and the culture of engineering education;
- Peer and student evaluations;
- Interdisciplinary collaboration in engineering education;
- Changing community views of the engineering profession and demands;
- Admission criteria.

Below are some of the key themes that emerged from the forum.

- A perspective on engineering education at the start of the new millennium that is based on considering engineering education as a key element of the wealth of any country and is, therefore, an integral component of national policy and economy. To fulfil that role with excellence, engineering education must offer more than science and engineering knowledge, but also entrepreneurship and technological advancement;
- A paradigm shift in engineering education from *knowledge-based* to *learned competences*, *skills-based* and *outcome-based*;
- The role of accreditation at the local and international levels, such as the US-based ABET accreditation, in assuring the quality of engineering programmes. Accreditation also assures employers and graduates, and allows for mutual recognition arrangements between countries;
- The need to progressively open up engineering education to change perceptions of engineering as being disconnected with social and environmental values, and disengaged from the community. Rather, it is important to emphasise the need for engineers to be leaders in their societies in areas other than technical excellence. In this regard, the need for engineers to act as role models who excel in areas other than engineering was emphasised.

The main issues of IFEE 2001 were pointing in two clear directions, which are as follows:

- The need to reconsider the focus on technical knowledge to supplement programmes with an adequate focus on developing and nurturing the essential generic attributes of engineering education;
- The need for engineers to actively participate in society's interests in the arts, humanities and similar areas that are equally, if not more, important to societies than science and technology.

These issues were developed into the main theme for IFEE 2002 and are discussed below.

IFEE 2002: GENERIC ATTRIBUTES IN UNDER-GRADUATE ENGINEERING EDUCATION - ISSUES AND DEVELOPMENT

Professional engineers are required to provide practical solutions to real life problems, communicate their ideas and contributions, work well and cooperatively in various teams, and manage projects, budgets and personnel. Employers of engineers look for responsible and enthusiastic graduates, who are technically competent, but also good communicators and good team workers with good potential for growth and development. In addition, the community expects that professional engineers consider and address the social, environmental and other impacts of their work.

Professionally successful engineers possess more than technical skills and experience. They have extra, non-technical skills that allow them to transform their contributions into recognisable accomplishments. Successful professional engineers have well-developed interpersonal skills, can work with others in an easy and cooperative manner, and are recognised and respected by their peers. They are capable of communicating their ideas and contributions in a clear way. These engineers also have well-developed business and finance skills. They fit within their organisations and are recognised as contributors to the overall success of their organisations. Some of these extra qualities are listed below and classified as generic skills.

Generic qualities and skills desired in engineering programmes include the following:

- The ability to apply knowledge of basic science and engineering fundamentals;
- The ability to effectively communicate with engineers and non-engineers;
- Competence in an engineering discipline;
- Competence in information technology;
- The ability to identify and formulate problems and solutions;
- The ability to work in multidisciplinary and multicultural teams;
- The ability to understand and consider the social, environmental and cultural responsibilities of professional engineering;
- Commitment to the professional and ethical responsibilities of engineering practice;
- Commitment to the principles of sustainable development;
- Commitment to a life-long process of learning.

In the past, engineering education was focused on the technical aspects of engineering. As we enter the 21st Century, the roles of engineers have changed and a paradigm shift in undergraduate engineering education is becoming appropriate. No one doubts that the formation of technical skills must remain at the core of engineering education. However, the concept of the core must be expanded to include the non-technical and professional aspects of engineering practice.

IFEE 2002 thus focused on improving the development of generic capabilities in undergraduate engineering education through systematic approaches that address the development of such capabilities throughout engineering programmes. As such, the Forum's delegates were invited to discuss issues like profiling existing efforts to develop generic attributes in engineering programmes as well as present ideas on balancing technical, *hard* engineering skills and non-technical *soft* engineering attributes.

The main themes of IFEE 2002 were as follows:

- Integration and development of generic skills into engineering education;
- Measuring success in the development of generic attributes;
- Projecting and meeting the needs of employers;
- Curricula design and meeting the new accreditation requirements;
- The community's changing views of the engineering profession.

The discussions concluded with a call for engineering faculty to take serious steps to formalise the development of non-technical and professional attributes alongside the development of technical engineering skills. In addition, certification and documentation were proposed to track and formalise the development of generic and professional skills alongside technical skills. In order to accomplish the above, delegates called upon decision-makers in universities offering engineering programmes to take serious steps to debate these issues and initiate the required process of change. It was noted that this change would require the investment of significant resources and proper staff development programmes.

The delegates recommended that engineering departments in the region start by profiling the existing generic attributes that are emphasised in their programmes. Faculty members could also be encouraged to clearly state the technical, non-technical and professional teaching and learning objectives in their course outlines. It was also recommended to involve engineering employers, professional engineers, non-engineering professionals and the community in partnerships to develop the generic attributes of engineering graduates.

At the end of IFEE 2002, the delegates proposed the theme for the next IFEE gathering in 2003, which was to be focused on the relationship between engineering departments/colleges and the community.

IFEE 2003: BUILDING PARTNERSHIPS WITH GOVERNMENT, INDUSTRY AND SOCIETY

The delegates of IFEE 2002 concluded that in a regions where technologies are mainly imported rather than locally generated, the relationships between engineering colleges on the one side and government, business and industry on the other side are critical and worthy of discussion as the main theme of IFEE 2003. In addition to contributing to developing technologies and new applications, universities are well positioned to be involved with government and industry in a variety of collaborative educational and professional activities, including research and development, consulting, professional training, joint programmes and continuing professional education. Society can greatly benefit from such collaborations that can lead to better and more practical educational programmes, excellent career potentials for graduates, industry satisfaction with a skilful workforce, and targeted opportunities for continuing and professional education, as well as joint projects involving students, faculty and practicing professional engineers. As such, IFEE 2003 delegates sought to identify ways to achieve the benefits of collaboration and partnerships with sensitivity to culture and societal values in the region.

Modern engineering accreditation criteria emphasise the need for engineering graduates to possess strong design and professional skills. In order to instil these skills, engineering programmes must rely on the cooperation of practicing professional engineers to participate in the educational process, and rely on government and industry organisations to sponsor students' projects and provide internships opportunities as part of a healthy and mutually beneficial relationship. As employers of engineering graduates, government and industry have a major stake in the quality of engineering education and must, therefore, actively advise, support and participate in shaping the quality and direction of engineering education programmes.

Universities offer government and industry great opportunities for collaboration and possible synergy, including international experience of faculty and talents of students in addition to advanced research, consulting, training and information facilities. IFEE 2003 aimed to bring together engineering educators and professionals from government, industry and society to discuss avenues towards encouraging active collaboration and building partnerships among the stakeholders of the engineering education process. The forum organisers encouraged participants to share their practical experiences, present case studies, and discuss creative approaches to establishing and nurturing effective partnerships among university-industry-government-society.

The above-discussed issues formed the main discussion themes for IFEE 2003, which were as follows:

- Effective avenues for university, government and industry collaborations;
- Effective training of engineering students;
- Continuing professional engineering development;
- Curricula development and meeting the needs of government and industry;
- Government and industry-sponsored engineering design projects;
- Collaborative and funded research and educational programmes.

Furthermore, the delegates presented diverse views on the collaboration subject and expressed their optimism and concerns. This included the following:

- One of the most important relationships among the parties relates to education and employment. Engineering colleges need to graduate readily employable engineers who are up-to-date in terms of knowledge and possess clear technical and relevant non-technical generic skills. Government, business and industry need to continue to provide proper employment opportunities;
- Engineering societies need to proactively promote the profession;
- Employers must take a more active approach in terms of training engineering students while studying and immediately after graduation;
- Universities need to actively offer appropriate continuing training opportunities for practicing engineers;
- A major limitation relates to the fact that technology is generally not generated locally, meaning that fewer opportunities exist for engineering faculty and industries to engage in high level, research-based consulting projects. Engineering faculty may tend to offer common consulting services as means to supplement their salaries and for community service;
- The need to establish and activate university-industry liaison or consultative bodies that bridge the gap between the parties and reduce the isolation of engineering education from market needs.

After three successful IFEEs that facilitated discussions on various important issues relating to engineering education, the delegates proposed that there be a pause to allow for reflection and integration. As such, the following forum was staged in 2006, IFEE 2006, and was focused on integration.

IFEE 2006: INTEGRATION OF TEACHING AND RESEARCH WITH COMMUNITY SERVICE

Teaching, research and community service are the main duties of faculties and universities. The purpose of teaching is to facilitate the learning of knowledge, and the purpose of research is to increase knowledge and identify its useful applications. The mission of universities is to serve the community through teaching and research. The university mission is mainly accomplished through the efforts of its faculty.

The traditional career model for faculty has been to pursue all three functions: teaching, research and service. The service component includes university development, professional practice and community service. With constantly shrinking resources, faculty find themselves pulled in various directions due to external and internal expectations and pressures. Students expect and deserve quality teaching time, both inside and outside the classroom. The public expects faculty to excel in teaching and to contribute to the development of the community. University administration demands excellence in teaching, research and service. Accreditation and funding agencies and reviewers also require excellence in teaching, research and service. Faculty members expect a fair system that is based on merit, rewards contributions, allocates appropriate workloads and balances resources with expectations.

The purpose of IFEE 2006 was to discuss, from an engineering perspective, all issues relevant to the mission of universities in terms of teaching, research and service, and how best to integrate teaching and research into community service. The main themes discussed during IFEE 2006 were as follows:

- Philosophies, rationale and objectives for integrating teaching and research with community service;
- Strategies for integrating teaching and research with community service;
- Examples and case studies of the successful integration of teaching and research with community service;
- Partnership of stakeholders for successful integration;
- Incentives and rewards for integrating teaching and research with community service;
- Balancing teaching, research and community service;
- Other related topics.

The above are highlights of some of the issues and challenges that relate to the role of universities in the community and the role of academics in universities. In response to these changes, IFEE 2006 delegates confirmed the main themes of the Forum by identifying the paths of the evolution of engineering education in the following directions:

- Integration of teaching, research and community service: this approach saves time and effort by integrating all three

functions into multipurpose activities without compromising quality;

- Redefining scholarship in universities: excellence in teaching, university development, professional practice, and community service is being gradually recognised alongside research excellence;
- Some universities have opted to give faculty the choice to focus efforts on one or two of the three university functions (teaching, research and service) and the flexibility to change the focus with time. In this way, not all faculty are required to contribute equally to all functions. Faculty positions that are mainly research, teaching or service in orientation are sometimes created with appropriate incentives offered in each track;
- The distinction between teaching, research and service universities is being re-examined regionally and internationally.

SUMMARY AND CONCLUSIONS

There exists a great will and enthusiasm among engineering faculty in the region to achieve excellence in engineering education. Unfortunately, such a positive energy may not always be matched with the necessary opportunities to flourish and grow at a normal pace. The issues are complex and have to do with the nature of engineering education and the status of development of the region in terms of science discoveries and technology generation.

Engineering faculty are willing to increasingly focus on excellence in engineering education provided that universities recognise such efforts as essential, and reflect such recognition in staff development and promotion. Participants at the four IFEE events suggested that regional universities better focus on excellence on engineering education and strategic and collaborative academic research rather than focus aimlessly at individual and self-motivated exploration research.

Participants at the four IFEE events discussed a comprehensive list of important issues that are of general concern. Perhaps it is convenient at this stage of IFEE development to focus on specific issues in engineering education. At the present, preparations for IFEE 2008 are underway with the Forum most probably focusing on accreditation.

Finally and with increasing attention being paid to engineering education in the region, positive collaboration among regional parties is a must. At IFEE 2002, a proposal was put forward to establish a regional association on engineering education. It may be time to start such an association to unify efforts and follow up on related activities in the region. Figure 1 shows the growth of participation in the IFEEs.

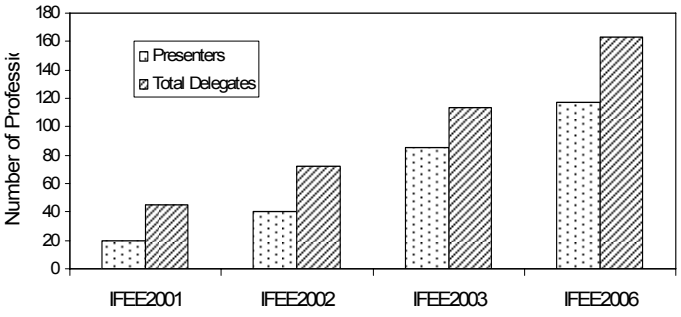

Figure 1: Growth of participation in the IFEEs.

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Conference Proceedings of the
9th UICEE Annual Conference on Engineering Education
under the theme: *International Quality in Engineering Education*

edited by Zenon J. Pudlowski

The *9th UICEE Annual Conference on Engineering Education*, held under the theme of *International Quality in Engineering Education*, was organised by the UNESCO International Centre for Engineering Education (UICEE) and was staged in Muscat, Sultanate of Oman, between 11 and 15 February 2006, with the Caledonian College of Engineering (CCE) acting as the host and principal co-sponsor.

This volume of Proceedings encompasses a wide selection of various papers submitted to this Conference, which detail important international approaches to engineering education research and development related to the Conference theme, as well as other specific activities.

The 48 published papers from authors representing 21 countries offer a commendable collection that focus on fundamental issues, concepts and the achievements of individual researchers. The papers have been organised into the following groups:

- Opening Addresses
- Keynote Addresses
- Case studies
- Important issues and challenges in engineering education
- Innovation and alternatives in engineering education
- Multimedia and the Internet in engineering education
- Quality issues and improvements in engineering education
- Specific engineering education programmes

It is worthwhile noting that, as well as the international input into the Conference, contributions have come from academics representing the Caledonian College of Engineering (CCE). The diversity of subjects, concepts, ideas and international backgrounds in this volume of Proceedings demonstrate the global nature of UICEE-run Conferences, as well as its relevance within the worldwide affairs regarding engineering and technology education.

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