Current Issues of Engineering Education under Globalized Society

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Abstract

A global world has recently expedited the international collaboration and network among engineering education societies including their scholars. The current issues of engineering education societies have been raised and discussed and those are various topics such as accreditation issues, current trends in engineering and technology education, government policies, innovations, program and project based learning, social sciences in engineering and technology education, university-industry joint programs, human resource development and engineering education, university linkage with K-12, role of engineering education in sustainable development, and the others. Among the variety of issues and topics, the hottest topic is relating to “innovations” of engineering education system. The innovative direction of engineering education in Korea has been reported along with that of USA, whose role has been one of major parts in innovation for the global engineering education system. The recent survey by IFEES (International Federation of Engineering Education Societies) has also been analyzed to consider the current three biggest challenges of global engineering education societies.

Keywords: globalization, issues, engineering education, biggest challenges, innovation

1. Background

Under the knowledge based society in the 21st century the science and engineering knowledge has been doubled every ten years. The environment of our economic society has been also rapidly globalized not only because of the use of internet but also more airplane travelers around the world. Since the population of the world will reach eight billion people by 2020, global issues such as shortage of grains, water, and natural resources are to be solved. The role of technology and engineers will therefore have to be more increased. In the innovations of engineering education system both at each country and at each continent are also required to educate engineers and technologists more efficiently than ever for the coming 21st century.

2. Innovation of Engineering Education

2.1 Engineering Education in the World

There have been many global organizations relating to engineering education and research, whose main roles are somewhat different from region to region and time to time. The first leading group is the American Society for Engineering Education (ASEE, www.asee.org) and ASEE was established in 1893 being committed to furthering education in engineering and engineering technology in USA. It has accomplished its mission 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 members. ASEE’s current activities are focused on three critical areas: 1) transforming engineering education; 2) the globalization of engineering education; and 3) enhancing the reputation of engineering in the United States.

In European communities the principal basis of different actions financed by the European Commission is the study of an accreditation system of degree programs in Engineering. There has been a Bologna Declaration in Europe regarding on accreditation system and the SOCRATES Thematic Networks being started from 1998 have been operational in the European panorama focusing on a recurrent motive, accreditation of the degree programs in engineering. Every year, hundreds of thousands of people in Europe take the opportunity to study abroad or work on European projects supported by SOCRATES Program. A rather novel way of international accreditation of engineering degree programs has been elaborated by the EUR-ACE (Accreditation of European
Engineering Program and Graduate) Project. This project was supported by the European Commission through the SOCRATES and TEMPUS programs in the period Sept. 2004-March 2006 (www.feani.org).

The global colloquium of ASEE in Brazil served as the platform for the inaugural meeting of the International Federation for Engineering Education Societies (IFEES) in 2006. The goal of the member societies of IFEES (www.ifees.net) is to work collaboratively to establish and strengthen effective, quality worldwide engineering education processes to assure a global supply of well-prepared engineering graduates. The group will also enhance the ability of engineering faculty, students, and practitioners to understand the varied cultures of the world and work effectively in them. IFEES has been successfully operational through the organization of ASEE and the IFEES Summit annual meetings.

The first international conference for engineering conference (ICEE) was held in Taiwan in 1994 and the international network for engineering education and research (INEER, www.ineer.org) was also organized to support the conferences, workshops, retreats, awards, cooperative agreements, and the other publications. The 36,000 members in INEER Network presently spread across 98 countries. 14 ICEE conferences and 24 networking events have been held since 1994 along with 3 international conferences for engineering education and research (ICEER) since 2004. Eight books in the INEER Innovation Series have been also published since 2002. INEER became the first and only outside organization to be invited for partnership meeting with rectors of state technical universities of Russian Federation in 2004.

There has been the association for engineering education in southeast and east Asia and the pacific (AEESEAP) since 1973 aiming at 1) facilitating networking and cooperation between institutions engaged in engineering education, industry and other relevant organizations in the region, and 2) promoting the development of systems and standards for engineering and technology education. These goals have been established as a contribution to economic development and for the advancement of the welfare of the people of the region. The Association was founded with assistance from UNESCO and has been working toward these aims since its first seminar in 1973. Because of not very successful operation during the recent years, a meeting of national voting member representatives got together in Tokyo in September, 2008 hosted by JSEE for restoring the Association to full activity. The presidency and secretariat of AEESEAP were handed over to P.R. China for achieving the aims and goals of the Association more effectively.

There have been many other related national organizations such as Japanese Society for Engineering Education (JSEE), Chinese Society for Engineering Education (CSEE), Indian Society for Technical Education (ISTE), Korea Society for Engineering Education (KSEE), and the others. JSEE was founded in 1952 after the World War II to recover the industrial activities from the destruction during the war. JSEE has been a quite active compared to the other national organizations doing a lot of activities holding various international conferences and workshops including AEESEAP executive committee meeting, and WCCEE. The number of members has been increased to around 3,500 and the number of articles presented at the annual conference recently reached at 364.

2.2. Innovative Direction of Engineering Education in USA

In 2004, the National Academy of Engineering (NAE) of the United States released a report entitled “The Engineer of 2020: Visions of Engineering in the New Century, which concluded with the fact that an engineer in 2020 must be flexible and capable of operating in a world where “social, cultural, and economic forces will continue to shape and affect the success of technological innovation”. The qualifications of an engineer in 2020 are being more specifically described as having strong analytical skills, practical ingenuity, creativity, good communication skills, business and management leadership, high ethical standards, professionalism, dynamism, agility, resilience, flexibility, and lifelong learning skills. In 2005, the report of NAE also suggested critical issues to be handled by engineering education societies for educating the 2020 engineers. Those critical issues are pre-engineering degree seeking program, Bachelor of Arts in engineering degree, ABET in undergraduate and graduate program, interdisciplinary fusion program in graduate and undergraduate schools, STEM (Science, Technology, Engineering, Mathematics) program in K-12, two years college program, and the others.

The transforming and innovative direction of engineering education in USA also follows the report of 1999 by Professor Howard Gardner of Harvard University stating the multi intelligence of 21st engineers. The multi intelligence includes verbal/linguistic intelligence, logical/mathematical intelligence, visual/spatial intelligence, bodily/kinesthetic intelligence, musical/rhythmic intelligence, interpersonal intelligence, intrapersonal intelligence, and naturalistic intelligence. The requirements of the multi intelligence and the transforming direction for 2020 engineers by NAE report suggest that the time of “one size does fit all (uniform
The roadmap for ASEE to urge U.S. engineering educators to be put into practice was recently introduced by Dr. James Melsa, the past president of ASEE, as follows:

1) Improve engineering education to better prepare graduates to compete and contribute in the global marketplace.
2) Promote and support foundational engineering education scholarship that will result in a new body of knowledge that will drive and guide new program development and innovations in engineering education.
3) Continue research and collaboration on innovation in engineering education and application of that research to improve our programs.
4) Develop an active community for sharing best practices confirmed by scholarship, possibly in the form of a national database.
5) Provide regular, practice-proven or research-based faculty development and training in engineering education.
6) Increase rewards and incentives for faculty to pursue excellence in the scholarship of discovery, integration, application, and teaching related to engineering education.
7) Welcome active participation and voice for industry in the education of engineers. A greater premium needs to be placed on industry experience in the recruitment and retention of faculty. We need to strengthen exchanges between industry and academe-having practitioners teach and teachers practices.
8) Establish a downstream mechanism for assessing the impact of ASEE roadmap and keeping it current.

2.3 Innovative Direction of Engineering Education in Korea

Korea has produced around 70,000 engineering and science graduates per year, which are very close to those of USA and considered to be too many graduates from engineering colleges. This result in low quality of engineering graduates and in fact have caused the serious complaints about it from the industry. There have been also reports that the average investment on facility and experimental laboratory, and professor recruitment are low compared to OECD nation's average level. The evaluation system of Korean professors has been more focused on the achievements by research and development activities rather than by educational services and contributions. The most top five to ten percents of high school graduates based on Korean SAT test recently prefer to major in law, medical, and business schools than enter the engineering and technological colleges.

Although there have been such current problems in engineering education in Korea, the country has been rapidly developed in science and technology after the Korean War in 1950 through largely three stages in the process of technological innovation. The first stage is called “Imitating Phase” during the years of 1960’s and 1970’s, when the technology mostly relating to textiles & consumer electronics, automobile, steel, shipbuilding, and machinery was concentrated and developed. The second stage is called “Internalizing Phase” during the years of 1970’s and 1980’s, when the technology relating to the next generation of automobile, ship building, steel, DRAM, CDMA, TFT-LCD has been actively developed. The third stage is called “Emerging Phase” after 1990’s and the technology relating to SoC, PDA, 4G mobile set, fuel cell, BT, NT, optics, next generation vehicles, and the others is being continuously developed.

Because of the current status of engineering education and technological innovation phases described above in Korea, KSEE along with the other related organizations including engineering dean’s association (EDA), national academy of engineering of Korea (NAEK), accreditation board for engineering education of Korea (ABEEK) has led the various transforming programs, workshops, forums, and conferences for engineering education. KSEE was established in 1993 by engineering college professors, industry, R&D institutes, and government, for its missions; 1) development of EE for producing excellent engineers, 2) setting up solid infrastructure to transfer technology and maximize the R&D ability through the network among industry, academy, and research institute, 3) development for systematic R&D strategy and policy and putting those into practices.

KSEE has suggested four major innovative directions of engineering education in Korea by realizing both the new knowledge based society for the 21st century and the current transforming phases in science and technology. The first direction is to transform the basic infrastructure of engineering education system including the reduction of graduates from engineering colleges, more investment on laboratory equipments and increase of faculty to student ratio, and faculty development program. The second one is to adopt the new idea of paradigm
shift in engineering education including the education of fusion technology, humane and social sciences, the soft skills, and the tailor-made and the global partnership programs. The third one is to attract more talented pre-college young students into science and engineering including various programs to make K-12 students be interested in engineering and sciences and great supports from general people and parents. It also needs to advertise that the jobs of engineering and science are very stable with reasonable salary not always with 3D’s (dirty, dangerous, difficult), and very interesting ones because the new things are more often to be developed. The fourth one is to increase and support the various researches on engineering education and research areas. The researches will aim for the fully developed first class nation, the knowledge based society, the knowledge created society, and the contribution to the problem solution.

The Ministry of industry, Energy, and Commerce of Korean government recently designated and partially sponsored engineering education innovation centers (EEIC) at fifty engineering colleges to practically carry out the engineering education reforms throughout the nation. There are four key tasks by EEIC such as 1) building infrastructure, 2) building up teaching competency for innovative engineering education, 3) strengthening student aptitude, and 4) research and development for innovative engineering education. The major programs to be more developed in the area of building infrastructure are to develop laboratory teaching materials and education program, study on education strategy of new advanced technology, extend and develop industry-university cooperation model, develop e-learning contents, do research on the policies related to engineering education innovation, and the others. In the area of building up teaching competency for innovative engineering education, the suggested programs are the workshop on teaching method for engineering and the teaching clinic for EE, publication of teaching guide on EE, research on improving curriculum, searching and sharing lecture media files, standardization for engineering faculty assessment, development and supports for faculty media, and the others. The major programs for strengthening student aptitude in EEIC are also suggested as learning clinic services such as writing clinic, communication clinic, and presentation clinic, supporting study group and guiding student career portfolios, publication of learning guide and supporting learning community, development for creative learning curriculum and leadership development curriculum, and the others. The fourth major program, R&D for innovative EE, of EEIC includes the researches on improving teaching curriculum, project based curriculum, teaching method applicable to each major, diagnosis & improvement for capstone design project, and the developments on methods for faculty assessment, knowledge database for engineering curriculum, evaluation system based on competency, model curriculum for each major, and the others.

2.4 Recent Survey Report by IFEES

There were 21 organizations around the world from North and South America, Asia, and the Europe responded to the survey by IFEES asking several major questions. This report summarizes the most two interesting survey results by IFEES. The first result is from the question; what is your organization’s motivation to become an IFEES member? The second result is from the question; what is the biggest challenge your organization is facing now? The survey results were analyzed and summarized based on the number of votes, which actually express their interest in IFEES’ future direction for international EE activities.

The various motivations to become an IFEES member are being described below and the number in the parenthesis represents the degree of interests by responding organizations;
1) advancement in bridging and establishing industry-university partnerships (4.05)
2) network with other organizations, faculty and deans from around the world (4.2)
3) catalyze curriculum innovation collaborations and partnerships (3.76)
4) promote research and innovation collaborations and partnership (3.52)
5) provide our members (faculty, students) with international experiences (3.43)
6) involvement in student retention initiative (3.0)
7) encourage continuous e-learning initiative (2.81)
8) learn about funding resources to support engineering education initiatives (2.48)
9) learn best practices in managing our organization from others (2.05)

According to the analysis, advancement in bridging and establishing industry-university partnership is the primary reason to be a member of IFEES, and they would like to develop this alternative as a primary goal for IFEES policy in the future. Overall average, 3.25, represents that most of the IFEES members agree on these ‘motivation alternatives.’

The top three biggest challenges being faced by IFEES members are analyzed as follows;
1) global accreditation issues (4.26)
2) global engineering education under free trade agreement (4.05)
According to the analysis, most of IFEES members see the ‘global accreditation issues’ as the biggest challenge. 15 out of 21 members marked strongly agreed that global accreditation issue is the main challenge.

3. Conclusion

In this paper, the current innovative direction and activities by the major engineering education organizations around the world including ASEE, KSEE, IFEES, AEESEAP, have been investigated and introduced. There are various current issues and problems the world EE communities shall cooperate to solve and tackle in the coming years. The current biggest three challenges in the global EE communities by IFEES survey were found to be 1) global accreditation issues, 2) global engineering education under free trade agreement, and 3) innovative curricular development based on entrepreneurial relations at each country.

References


Biography

Dr. Kwang Sun Kim is the Honorary Chairman of Korea Society for Semiconductor/Display Equipment Technology and the Professor of School of Mechatronics Engineering, Korea University of Technology and Education (KUT). He served as a dean of planning affairs of KUT from 1996 to 2000, and as a dean of graduate school of KUT during 2000-2002 and 2004-2006. Before he joined KUT as an assistant professor in 1992, Dr. Kim had various experiences in working at the Ministry of Defense of Korea during 1978-1984 as a deputy section chief, at Yale University as a research faculty in 1988, both at Gibbs and Hill Inc., USA, and at Samsung Aerospace Inc. as a system engineer from 1986 to 1992. He was awarded the National Medal by the President of Korea for his contributions to scientific and technological fields in 2006. Dr. Kim was also nominated by the American Society of Mechanical Engineers as a fellow of ASME in 2007 and is presently an international director of KSEE. He is also a general chair for ICEE/ICEER2009 to be held in Seoul during 23-28 August, 2009. Dr. Kim received B.S. degree in Mechanical Engineering from Hanyang University (1978), M.S. (1983) and Ph.D. (1986) degrees in Mechanical Engineering from the University of Kansas, USA.