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Competencies for Global Engineers and Technologists

By Dr. Fola Michael Ayokanmbi

Abstract

Globalization and the growth of offshoring have changed the landscape of the engineering and technology profession and will have a major impact on engineering and technology education. The 21st Century engineering professional now requires competence beyond technical skills. Strategic partnerships with industry and governmental agencies ought to be aligned with institutions of higher learning to synergistically determine what is needed to successfully practice as global engineers and technologists. It is imperative that engineering and technology schools engage and develop strategies to address the challenges and opportunities posed by the offshoring of engineering and technology jobs. As the internationalization of engineering and technology education become a necessity, students must acquire the multicultural intelligence skills that would enable them to communicate and appreciate other cultures around the globe. Globally competent engineers and technologists must possess the capabilities and attributes that are required for excellent performance in today's multicultural and global society. This paper examines the impact of globalization on engineering and technology education and discusses the competencies required to ensure that engineering and technology students are prepared for success in the global workplace.

Introduction

An increasing number of US manufacturing jobs, including high-end and highly-skilled jobs, are outsourced to countries with substantially lower labor costs in order to achieve cost savings and competitiveness (Bidanda, et al., 2006). Moreover, the impact of globalization and increased cross-border mobility of engineers and technologists has profoundly affected engineering and technology education. However, there is a growing concern that the U.S. engineers, technologists, scientists, and researchers are not prepared for professional practice in the global workplace (Grandin and Hirleman, 2009). The rapidly global economic environment makes it imperative that engineering and technology educators must ensure that their graduates are prepared to be productive global citizens and professionals by incorporating international experiences in the undergraduate curriculum.

The current global economy requires that the preparation of students for engineering and technology practice include a global perspective. Thus, the need to broaden engineering and technology education so that future engineers and technologists are prepared to work in the global workplace is paramount. Thomas H. Kean and Lee H. Hamilton, the chairman and the vice chairman of the 9/11 Commission, respectively, suggest that study abroad should be made "a cornerstone of undergraduate education" (Kean and Hamilton, 2008). The Strategic Task Force on Education Abroad, a task force of national leaders in international education, suggests that more U.S. students must 'devote a substantive portion of their education to gaining an understanding of other countries, regions, languages, and cultures, through direct personal experience' (Oaks, 2010). The overall efforts of engineering and technology schools to incorporate international experiences in the undergraduate curriculum are still in their infancy. However, the relevance of engineering and technology education in preparing students to work and live with cross-cultural teams in a global community

is beginning to be recognized. Practical experience through internships in study abroad programs is an effective way to prepare engineering students for international work assignments (Bidanda, et al., 2006). Table 1 shows the percentages and number of study abroad students in the United States from 2001-02 to 2007-08, respectively (IIENetwork, 2010). As Table 1 suggests, 3.1 percent of the 262,416 students that took part in study abroad programs in the 2007-08 academic year were in engineering programs, while 21.5 percent and 20.2 percent of students who participated in study abroad program in the same academic year majored in social science, and business and management, respectively.

In *Engineering for a Changing World*, James Duderstadt (2008) emphasizes that a global perspective for engineering practice requires the capacity to work in multidisciplinary teams. He recommends that American engineering schools should "focus on quality, producing engineers and technologists capable of adding exceptional value through innovation, entrepreneurial skills, and global competence." According to Patricia Galloway (2008), "a solid understanding of globalization is key to an engineer's success in today's global society." The Global Engineering Excellence Initiative (GEE), a consortium of eight international universities (Eidgenössische Technische Hochschule Zürich, Switzerland; Georgia Institute of Technology, USA; Massachusetts Institute of Technology, USA; Shanghai Jiao Tong University, China; Technische Universität Darmstadt, Germany; Tsinghua University, China; Escola Politécnica da Universidade de São Paulo, Brazil; and the University of Tokyo, Japan), sponsored by Continental AG, conducted the first worldwide scientific study to analyze the growing impact of global engineering on the global marketplace (Grindel, 2006). One of the four challenges identified by the consortium as being critical to the engineering and technology education of the next generation of engineers and technologists is the need for global competence.

Recognizing a growing demand for internationally-experienced engineering graduates, a group of leading universities around the world (35 universities in the U.S. and 10 universities in the U.K., Central and Eastern Europe, Asia, Latin America, and the Middle East) established the Global Engineering Education Exchange (Global E3) in 1995, to provide engineering students in member universities with a study-abroad experience (Global Engineering Education Exchange, 2010). The Institute of International Education (IIE) is the U.S.-based administrator of Global E3 and provides opportunity for students, scholars, and professionals to study, teach, and conduct research abroad.

Engineering and Technology Curriculum and Global Competence

The increased mobility of engineers and technologists poses new challenges to engineering and technology education and training, and engineering and technology schools face the possibility that their graduates may not possess competencies recognized as valuable by international employers (Lucena, et al., 2008). Therefore, the need for engineers and technologists to cope with globalization calls for new pedagogical solution to develop the intercultural competencies required for professional practice in the global workplace, and engineering and technology education

Table 1. Fields of Study of U.S. Study abroad Students, 2001/02 – 2007/08

Field of study	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Social Sciences	21.9	21.3	22.6	22.6	21.7	21.4	21.5
Business & Management	17.6	17.7	17.5	17.5	17.7	19.1	20.2
Humanities	13.8	13.3	13.3	13.3	14.2	13.2	13.3
Fine or Applied Arts	8.5	9.0	7.6	7.6	7.5	7.7	8.4
Physical or Life Sciences	7.6	7.1	7.1	7.1	6.9	7.3	7.2
Foreign Languages	8.5	7.9	7.5	7.5	7.8	7.2	6.2
Health Sciences	3.0	3.1	3.4	3.4	3.8	4.1	4.5
Education	3.9	4.1	4.1	4.1	4.1	4.2	4.1
Engineering	2.9	2.9	2.9	2.9	2.9	3.1	3.1
Math or Computer Sciences	2.2	2.4	1.7	1.7	1.5	1.5	1.6
Agriculture	1.1	1.5	1.2	1.2	1.3	1.5	1.2
Other	5.2	6.4	7.8	7.8	7.2	6.6	5.4
Undeclared	3.8	3.5	3.4	3.4	3.4	3.1	3.3
Total	160,920	174,629	191,321	205,983	223,534	241,791	262,416

should provide access to direct experience in intercultural learning. The curriculum should include a component that provides engineers and technologists with an understanding of global issues. Being rounded in scientific and technological disciplines is necessary, but not sufficient in the global economy. Hirleman, et al., (2007), indicates that engineering education is comprised of three axes: technical, professional, and global skills; and concluded that global skills can enhance overall engineering curriculum outcomes. The rapidly changing landscape of the global engineering practice requires multicultural intelligence skills. Engineering and technology education graduates must be able to work in a constantly changing global economy. This makes it imperative that the engineering and technology curricula are expanded to include global competence. A number of approaches have been proposed to address the lack of global competence.

The National Association of State Universities and Land Grant Colleges' Committee for International Education (NASULGC) characterizes a globally competent student as (a) having a diverse and knowledgeable worldview; (b) comprehending international dimensions of his/her major field of study; (c) communicating effectively in another language and/or cross-culturally; (d) exhibiting cross-cultural sensitivity and adaptability; and (e) carrying global competencies throughout life (DeLauder, W.B., et al, 2004). Lohamann, et al., (2006) suggest three strategies for producing globally competent engineers and technologists: (1) coursework in international studies, (2) second language proficiency, and (3) international experience. Hudzik and Larsen (2003) suggest that learning, living, and working in another country and culture is one of the most effective methods for teaching new cultures and languages. The University of Rhode Island's International Engineering Program is a 5-year program in which students study a foreign language and culture each semester along with an engineering curriculum. The fourth year is spent abroad and includes a paid internship with a reputable engineering firm. The program leads to a B.S. in engineering and a B.A. in German, French, Spanish or a minor in Chinese and Asian Studies (The University of Rhode Island, 2010)

The emergence of the global marketplace necessitates that the engineering and technology education curriculum must include a global component. Potential employers need globally competent engineers and technologists to effectively compete in the global marketplace and their success will depend on their ability to identify and maintain an adequate number of qualified global engineers and technologists. Global engineers and technologists are required to possess a set of competencies that are required for excellent performance in meeting global challenges. The competencies must be valid and operational across cultures and geographic borders. Hence, expanding engineering and technology education competencies is becoming an important issue. Global competency must be integrated into the curriculum, rather than through a minor area of study or a certificate program in international studies, in order to ensure relevance to a student's major in engineering and technology. It is imperative that engineering and technology students are provided with opportunities to study, work, and conduct research abroad. The engineering curriculum is so intense that little opportunity is provided for language learning, culture study or semester abroad (Grandin and Hirleman, 2009). One of the most difficult issues facing engineering and technology educators is the problem of course elimination versus required courses in global competencies.

Global Competency Model

A competency model helps in identifying capabilities and attributes needed for success in today's multicultural and global economy (Wu and Lee, 2007). The goal of a competency model is to foster desired behaviors and skills to ensure successful cultural adaptation. Hirleman, et al., (2007) contends that global competency enhances engineering curriculum, and should be taught by engineering schools.

A survey on the relative importance of global competence was conducted amongst the attendees to the NSF Summit on the Globalization of Engineering Education held in 2008. The respondents identified the five most important attributes that are important for excellence performance in global competence:

1. Appreciation for other cultures.
2. Proficiency in working in or directing a team of ethnic and cultural diversity.
3. Ability to communicate across cultures.
4. Opportunity to practice engineering in a global context through international internship, a service-learning opportunity, a virtual global engineering project, or some other form of experience.
5. Ability to effectively deal with ethical issues arising from cultural or national differences.

Cultural Competencies

The growing multicultural world has challenged the global workforce to consider cultural competence as a priority. Cultural competence is an ongoing process in which the global engineers and technologists have to continuously strive to achieve the ability to effectively work within the cultural context of the environment in which they work. To be effective, global engineers and technologists must understand and appreciate basic cultural differences and similarities around the world, and be aware of many factors that differentiate business practices, such as time orientation, power, individualism, competitiveness, and thinking styles (Feuille and Griffiths, 2010), and understand cultural differences in communication regarding such things as status, formality, saving face, directness, the meaning of "yes", non-verbal cues, etc., (Parkinson, 2009).

Campinha-Bacote (2002) suggests that the cultural competence process

involves the integration of cultural awareness, cultural knowledge, cultural skill, cultural encounters, and cultural desire. An awareness of a global engineer's own cultural and professional background, through the recognition of his/her biases, prejudices, and assumptions about individuals who are different, would enable the global engineer to avoid cultural imposition, that is, the tendency to impose his/her beliefs, values, and patterns of behavior on another culture. Cultural knowledge involves seeking and obtaining a sound educational foundation about diverse cultural and ethnic groups. Obtaining cultural knowledge about cultural beliefs and values involves understanding their worldview. Cultural encounter is the process of directly engaging in cross-cultural interactions with people from culturally diverse backgrounds. Directly interacting with people from diverse cultural groups will refine or modify one's existing beliefs about a cultural group and will prevent possible stereotyping that may have occurred. Cultural desire is the motivation to *want to*, rather than *have to*, engage in the process of becoming culturally aware, culturally knowledgeable, culturally skillful, and be familiar with cultural encounters.

Communication Competencies

Global mindset is the foundation of global communication competence and the ability to learn to be a global citizen (Chen, 2005). Global communication competence allows people from different backgrounds to communicate effectively and successfully in the globalized society. Knowledge and skills of global communication competence not only help to transform individuals into multicultural persons (Frederick, 1992), they are essential in cultivating ability of tolerance and mutual respect for cultural differences (Belay, 1993).

There are three dimensions of communication competencies: cognitive, affective, and operational (Kim, 2000). Cognitive competence refers to the ability to ascertain meaning from verbal and nonverbal language. It allows an individual to adjust effectively to communication differences in highly diverse environment. Affective competence determines an individual's willingness to accept and respond to unique and divergent communication, influencing his/her ability to facilitate the development of communication context in the global environment. Behavioral competence enables an individual to engage in meaningful interactions with those of many cultures. Effective communication requires that communication style and content are adapted so they are appropriate to the needs of the intended audience and the environment.

Learning a new language is a key in developing a deep understanding of another culture and a way of reaching across cultural boundaries, and it is important that a global engineer is able to speak a second language at a conversational level. It is most desirable that a global engineer is able to speak a second language at a professional level.

Ethical Competencies

Ethical issues can be magnified when cultural issues come into play. For example, it is common in some cultures or countries for business to be conducted by offering bribes or kickbacks; whereas in the U.S. such conduct is considered to be unethical and illegal. However, a global engineer must behave consistently in accordance with clear personal ethics and values.

Conclusions

As engineering and technology work becomes more global in nature, engineering and technology teams become more diverse and may include members of various ethnic, cultural and national origins. The globalization of markets requires that international organization employ engineers and technologists that are capable of working in and with different cultures and knowledgeable about global markets. Hence, it is imperative that engineering and technology schools engage and develop strategies that would enable engineering and technology students to take advantage of challenges and opportunities offered by globalization. There is a need for a new pedagogical curriculum that incorporates intercultural learning required for professional practice in the global workplace. The relevance of engineering and technology education in preparing students to work and live with cultural teams in a global community cannot be overemphasized. The need for engineers and technologists to cope with globalization requires a pedagogical solution to develop the intercultural competencies for working knowledgeably and living comfortably in a transnational engineering and technology environment and global economy. Globally competent engineers and technologists must possess the skills that would enable them to understand and appreciate cultural differences, and appropriately adapt their communication style and content to the needs of a global team. Engineering and technology schools should provide the opportunity to practice engineering and technology in a global context through international internship or study abroad programs.

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