Engineering and the Global Marketplace: Educating "Technicians" or Problem Solvers?

Saeid Y. Eidgahy – Hamid Y. Eydgahi
Jefferson Community College – Lima Technical College

The swift degree of change has virtually influenced every aspect of human life, global industrial and business entities, limitless communication systems, automation beyond imagination, and competition from all corners have challenged the world as never before. To survive competition requires nothing less than organizational revolution including higher education.

Engineering education has a pivotal role in this global process. Questions such as up to the moment technological education and the latest facilities are the heart of the educational process; but are these adequate? The highest skilled "technicians" are important, but global problem solvers are necessities. This paper explores the idea that educating engineers in a multi-discipline environment has become essential.

Actual curricular models will be explored in an effort to delineate future directions. Engineering education, world-wide experiences and emerging global needs must be merged for a successful future. Specifically, the following will be presented:

- Global industries;
- Communication and delivery systems;
- Principles of multi-discipline engineering education;
- Education models; and
- Synthesis.

It is the authors' intent to present several approaches with varying objectives; however, participant input will also be sought as an integral part of this discussion.

Global Industries

Technical education has been broadly defined as education preparatory to entering an occupation which requires a degree of higher education.[1] The swift degree of change has influenced virtually every angle and phase of our lives. Today's bounds in technology guarantees to transform the way we teach more critically than any other dominance in the past one hundred years. Moreover, led by the success of global manufacturing, improvements in communication and delivery systems, the competitive environment has perhaps become unpredictable to the point that challenges the even well run manufacturing organizations.[2]

While today manufacturing is being subjected to major changes, both economically and socially; it can only be satisfied through major advances in productivity throughout the entire manufacturing organization. Such benefits require substantial reengineering involving comprehensive innovation throughout not only the system of manufacturing, but also the entire education system which are primarily driven by advanced technologies such as CAD, CAM, CIM, MRP and others.

Communication and Delivery Systems
Due to an explosion of information technologies, an ever increasing number of communication and delivery systems are being introduced into the educational arena. In this segment, four major approaches to higher education delivery systems are outlined: independent organizations, collaborating organizations, conventional universities and autonomous institutions.

Independent organizations provide distance education that leads to qualifications or accreditation awarded externally and independently by a conventional public institution.[3] These include organizations offering programs based on various types of national school curricula or linked to public exams for students no longer within formal school systems. In the United States, the Regents' External Degree Program in New York is an example.

Collaborations provide among them, integrated multimedia courses for students over a wide geographical area. Examples include the Capricorn Interuniversity Teleducation Program created several years ago by universities in Argentina, Bolivia, Brazil, Chile, and Paraguay to promote and develop teleducation within member institutions.

Another example is the Commonwealth of Learning (COL).[4] Heads of fifty British Commonwealth countries met in 1987 to establish a facility, using distance education techniques, through which colleges and other institutions in Commonwealth countries could work cooperatively. The goal was to foster a network and to share expertise. The long term goal is to make it possible for any learner anywhere in the Commonwealth to take any distance teaching program from any bona fide college in the Commonwealth. The concept goes beyond the physical movement of students from one country to another into a much wider concept of mobility of ideas, knowledge and learning, in order to free knowledge from national boundaries and ideological confines and to share it through an ambitious exchange of educational resources.

Conventional institutions not only provide on-campus teaching for traditional students, but also administer their own distance-learning programs for external students. For example, the University of New South Wales in Australia offers external degree programs for 5,000 students, whereas it only has 3,000 internal students. The Correspondence Program at the University of Waterloo in Canada offers correspondence versions of dozens of its regular programs. Students receive instruction by a combination of written material and audio tapes, prepared by an instructor who teaches the conventional version of each course.

Autonomous institutions, established for external students, make use of a variety of distance teaching methods to provide specially-prepared multimedia courses. Such institutions have informal responsibility for evaluation and accreditation. An example is the National Technological University (NTU) in the U.S. which was established in 1984 at Fort Collins, Colorado, awarding graduate engineering degrees with the cooperation of forty schools of engineering.[4] By 1990, more than 1,100 distance education students were admitted to graduate engineering programs with the support of corporate sponsors. In 1991, NTU linked forty colleges with 325 sites for receiving courses, providing a prime example of cooperation between government, university, and business. By 1994-95, NTU offered more engineering master's degrees than any other institution in the United States. Curriculum is developed by the faculty representatives in each discipline. Chair of the curriculum committee reviews courses that colleges may offer. Much of the work of faculties and committees is done via computer networking.

Principles of Multi-Discipline Engineering Education

Technology is changing the workplace, and the American work force must change with it. No longer do technicians work independently, with only cursory connections to the rest of the company or corporation. Employers are looking for more quality-minded and customer-oriented employees who can accomplish multiple tasks while working with self-managed work teams. This new workplace is also characterized by rapid telecommunications, sophisticated information systems, and advanced technological mechanisms; which require a new technician who has a thorough understanding of the mechanics, electronics, computer hardware and telecommunication software that drive the technology.[5]

We, as a culture, have been trained to solve problems in a fragmented fashion. "From a very early age, we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable; but we pay a hidden, enormous price. We can no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole. When we try to 'see the big picture,' we try to reassemble the fragments in our minds, to list and organize all the pieces." (p.3).[6]

The Technology, Science, Mathematics Integration Project, with support from the National Science Foundation, developed a set of technology activities called the Technology, Science, Mathematics Connection Activities.[7] They are designed to correlate planning and classroom instruction among the three disciplines. The activities do not constitute a curriculum, but are units that set up technological problems for students to solve. In the process, students learn concepts from each of the three disciplines and apply what they learn to the design, construction, evaluation and redesign of the technological solution. Each activity is divided into several sections. Students are provided with a design brief that introduces the problem, specifies any design constraints or limitations to the problem solution, and explains how the students' solutions will be evaluated. The Technology, Science, and the Mathematics Components provide detailed suggestions for instruction and certain content for each subject area.[8] The curricular concept of integrating or connecting school subject areas has gained significant attention in recent years as a plausible solution to developing a more relevant approach to teaching and learning.

Educational Models

Responding to the widespread demand for a multifunctional engineering technician, New Jersey Center for Advanced Technolgical Education is developing a Mecomtronics Engineering Technology Associate Degree program to produce a technician who, as a team player, is skilled in mechanics, computer, telecommunication and electronics. This program approaches the development of curriculum and instructional materials from an interdisciplinary, project-centered point of view and encourages both collaborative teaching and learning. It is anticipated that the innovative curriculum, instructional materials and delivery of courses will result in the restructuring of existing engineering technology programs.[5]

Competitive performance is the nature of the global corporation. To outperform, while reacting/proacting positively to rapid change, problem solving skills are all competencies required for not only growth but also survival. The Transfer Integrated Design Engineering Education (TIDEE), a collaboration between Tacoma Community College, the University of Washington and the Washington State University, is a non-traditional curriculum where certain competencies are developed.[9] Interestingly, in addition to technical skills, it also includes categories of teamwork, information gathering, problem definition, idea generation, evaluation and decision making, implementation, communication and process improvement; all in the first two years of a four-year engineering program.

More than a year ago, Jefferson Community College (Ohio) implemented a new associate degree program in Manufacturing Systems Technology. Realizing that emerging needs are changing rapidly and there is a national trend toward cross-disciplinary engineering education, this new program incorporated components from various programs. The curriculum drew from the following programs: Mechanical Engineering Technology (Manufacturing Process, CNC, FMS, Mechanics and Hydraulics); Electrical Engineering Technology (DC/AC Circuits and Machines); Design Engineering Technology (CAD and GD & T); Computer Science (C, FORTRAN and Robotics); as well as Mathematics, Physics and Communications.

In fact, a review of the Society of Manufacturing Engineers' (SME) Manufacturing Education Plan clearly outlines integrative and flexible academic components.[10] The following were identified as emerging skill needs: Communication skills, teamwork, personal attributes (e.g. integrity), manufacturing principles and processes, reliability, project management, business skills, quality issues, change management, ergonomics and materials. Clearly, such comprehensive and cross-disciplinary needs can no longer be satisfied through traditional engineering and/or technology programs. For effective learning to take place, we must combine discrete concepts into knowledge groups.

Synthesis

Our society faces significant challenges including global competition and an information explosion. Industry, government agencies and educational institutions all have critical roles in meeting these challenges. Engineering must prepare the next generation of problem solvers. For two hundred years, we have segmented our engineering curriculum; the world is demanding new approaches. The authors have presented only one solution; multi-disciplinary engineering education. We hope the principles outlined here will contribute to a substantive discussion for educating future engineering professionals.

References

[1]Eidgahy, S. Y. (1997). *Reengineering technical education: An evolutionary view.* ATEA Journal (24) No. 2.

[2]Lau, R. S. M. (Spring 1996). *Strategic flexibility: A new reality for world-class manufacturing*. SAM Advanced Management Journal.

[3]Bates, A. W. (1980). *The planning and management of audio-visual media in distance-learning institutions*. Milton Keynes, UK: IET.

[4]Rossman, P. (1992). The emerging worldwide electronic university. Westport, CT: Greenwood Press.

[5]NJCATE (1997). *Educating the technician for the global workplace of the 21st century.* Edison, NJ: Author.

[6]Senge, P. (1990). *The fifth discipline: The art and practice of the learning organization.* New York: Currency.

[7]LaPorte, J. E. and Sanders, M. E. (1995). *Technology, science and mathematics connection activities*. Lake Forest, IL: Glencor.

[8]LaPorte, J. E. and Sanders, M. E. (1993). *The T/SM integration project*. Technology Teacher (52) 6.

[9]Lingwall, J. A. (1997). *Out front in engineering education.* Community College Journal (April/May).

[10]Society of Manufacturing Engineers (1997). *Manufacturing education plan: Phase I report*. Dearborn, MI: Author.

SAEID Y. EIDGAHY is the Dean and a Professor of Engineering Technologies, Applied & Computer Sciences at Jefferson Community College in Steubenville, Ohio. Dr. Eidgahy's previous research accomplishments have included such areas as professional development within engineering education and the effectiveness of educational technologies in instruction.

HAMID Y. EYDGAHI is the Dean of Engineering and Industrial Technologies at Lima Technical College in Lima, Ohio. He has an undergraduate degree in Mechanical Engineering and an MBA, and is currently working on his Ph.D. He held a number of engineering and project management positions for more than ten years before joining education.