

MEGATRENDS IN ENGINEERING EDUCATION TODAY

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Abstract

In 1982, John Naisbitt published *Megatrends*, summarizing themes he detected from content analysis of media reports. Since 2000, the editors of the *International Engineering Education Digest* have been conducting a similar scan and summarizing the results in a monthly electronic publication distributed as a service to engineering educators and others around the world. In this paper, we take a fresh look at the events of the past few years and attempt to discern the most important trends which can influence the education of future engineers.

Introduction

In 1982 John Naisbitt introduced a new technique of gleaning trends in our society in his best-selling book *Megatrends* – content analysis. He based his futurist predictions on a detailed analysis of what the news media were reporting, by taking time to connect individual events to begin to understand larger patterns. His premise was that the most reliable way to anticipate the future is by understanding the present.

This paper looks at recent and current events in engineering education at the international scale, as reported over the past four years in the *International Engineering Education Digest*, and attempts to connect them in ways that reveal megatrends in engineering education. From the rush of universities to get into for-profit distance education ventures, to the worldwide drive toward harmonization of degrees and their quality assurance mechanisms, to downturns in engineering enrollments due to student disenchantment with the profession, to career disruptions due to outsourcing, the topics repeated in the

monthly issues of the *Digest* provide a pattern that helps to illuminate current megatrends, and to project them into likely future directions.

Using over three years of the *International Engineering Education Digest* as a data source, and with the luxury of hindsight, eight major themes emerge from the world of engineering education:

- Entrepreneurship and connections with industry
- Outsourcing and the external environment shaping engineering education
- Student mobility
- Diversity issues
- Capacity building
- Private higher education
- Funding of higher education
- Quality assurance

These individual themes are complex enough, but when taken together they are intertwined, interactive, synergistic, and strike to the core of not only engineering education around the world, but also of higher education in the new millennium.

Entrepreneurship and connections with industry

Entrepreneurship education programs for engineering students in the US have become familiar and the academic content refined. Now the movement has spread internationally, with programs being initiated in most parts of the world. Teaching students to consider alternatives to traditional employment is also now seen as an important part of economic recovery programs in less affluent countries. Many of these programs rely heavily on the use of mentors, and include the skills of intrapreneurship – using entrepreneurial skills within a company – creating early bonds between the practice of engineering and the industries that employ engineers. The bad news is that connections between researchers and industry are increasingly being scrutinized more carefully by government agencies and watchdogs that act in the name of public health and security, as well as transparency. Actions are being taken and policies written in several countries to prevent conflicts of interest in product development and in the peer review of research.

Take-away for engineering educators: Changing the engineering curriculum to introduce exciting design skills early on is a successful way of retaining students in a program. Likewise, teaching entrepreneurship skills touches the core of why many students want to

study engineering in the first place, and may be another way to increase the attractiveness of the profession to under-represented groups.

Outsourcing and the external environment shaping engineering education

Offshoring of technical jobs, while still retaining its ability to provoke outrage, is now just as often seen as a permanent characteristic of the employment landscape in developed countries, not as a practice that politicians are going to cure. With the expansion of the European Union in May 2004 to include ten lower-cost countries from the east, and Brussels promoting worker mobility, European engineers and technical people have more reason to be wary of threats to their employment coming from within. Evidence that off-shoring moves at quicksilver speeds is the fact that India, which only a few short years ago raised the specter of offshoring as a threat to technical jobs, now has fears that it might be losing its own competitive edge to China. Other external developments which are impacting engineering education include arguments about the future of the US space program, volatility in computer science employment, continued stagnation in math skills in US students, and the promises of nanotechnology.

Take-away for engineering educators: One of the major faculty development priorities for engineering educators should be to gain first-hand and recent experience in business and industry, both large and small, so that they can prepare students for this climate where traditional job descriptions are daily subject to dismemberment.

Student mobility

Since the 2001 terrorist attacks on the US, higher education leaders have been anxiously tracking the process of student visas, knowing that engineering for one has been heavily dependent on international students especially at the graduate level. Horror stories about the requirements imposed by the US government on foreign students wanting to come to pursue university level studies have dominated campus conversations. With several years of data on hand, it now appears that while undergraduate students from around the world perceive the US as a less welcoming place for them, the number of graduate students coming into in the US has not been affected as much as had been feared, although many questions remain about whether the US remains the prime destination for the very best students. Not unrelated to this issue of intake is the topic of study abroad for US students. With some exceptions more students are opting to study for shorter periods of time abroad, and the popularity of traditional European destinations remains. Other developed countries which have increased their costs to students are finding that this threatens their attractiveness to foreign students. The EU is taking steps to become more attractive in light of problems in the US. Meanwhile, ambitious countries such as China and India, long a source of foreign students for the US, are investing heavily in improving their own universities in order to retain their own young people.

Take away for engineering educators: It's a bitter sweet truth, knowing that the time, effort, intellect and money which many have devoted to upgrading the quality of engineering education around the world has now resulted in increased competition to the US from the same people who were helped.

Diversity issues

More studies have been issued demonstrating the serious underutilization of women in engineering in the US, and there are no promising solutions being publicly discussed that would lead to a more rapid solution to the problem. In places where women have access to higher education, but face severe restrictions in employment, barriers to diversification in engineering are formidable. Around the world, racial, religious and ethnic conflicts continue to arise, disrupting education, diverting resources, and impeding the course of development. Universities are frequently drawn into the center of these conflicts, especially when they are considered a legitimate stage for future national political activists.

Take-away for engineering educators: For engineering to reach its full potential as a profession of leaders capable of guiding an increasingly technology- and science-driven world, continued emphasis must be placed on diversifying the membership of the profession and to seeing that employment is offered on level playing fields.

Capacity building

The social side of engineering has been more prominent in the press in recent years. Engineers are being portrayed, appropriately, as more responsive to basic human needs such as poverty reduction and hunger. They are seen as more responsive to environmental concerns, and sustainable development is a popular phrase in describing how current engineers approach the development of new projects to serve mankind. In addition, engineers in developed countries are assisting those in developing countries to build their indigenous technical capabilities in order to attract direct foreign investment, utilize foreign aid funds more effectively, and develop entrepreneurial small businesses – all with the aim of promoting economic development and eventual self-sufficiency for developing countries. Engineers are also heavily involved in converting the results of basic research and development into useful products and services to address the needs of society. Such international organizations as UNESCO and the World Federation of Engineering Organizations have are pursuing technical capacity building in developing countries as a major approach to addressing their needs.

Take-away for engineering educators: Undergraduate engineering students are no different from other students: they have a streak of idealism and a desire to make a difference in the world, shaping it for the better. Introducing students early on to the opportunities for engineers to do good in the world is yet another powerful recruitment and retention strategy.

Private higher education

In many countries where the demand for higher education has outpaced the ability of public institutions to meet it, private higher education institutions are springing up and growing to meet market demands. In many cases these private higher education operations are meeting needs in market niches not well served by traditional public education – such as retraining needed by working professionals, or focused training in hot fields such as computer applications. Often the delivery of education and training by private purveyors utilizes distance education techniques – increasingly over the Internet rather than satellite or microwave delivery typical a decade or two ago. Distance education offerings are more and more available *anytime, anywhere*. They are becoming much more responsive to the desires of employed engineers and their employers, and tend to be *market pulled* instead of *provider pushed*.

Take-away for engineering educators: Disreputable private higher education is mostly a threat in developing countries, which often lack the mechanisms to force these groups to shape up or shut down. There is a need for the various professional societies in the US to continue their work overseas on projects that define quality and set standards to international levels.

Funding of higher education

In the wake of general economic downturns in countries around the world, higher education has suffered significant losses in financial support. Budgets at government supported universities have been cut almost universally – one of the few areas that legislators can cut in hard financial times, since many other areas of their budgets are entitlements mandated by fixed laws. These cuts in external support have generally led to universities passing more of the costs of education on to their students, through tuition and fee increases. In countries where higher education has been essentially free to students – including many socialistic developed countries and many poor developing countries – costs are being passed on to student for the first time. Increased tuition and fees in countries where such student charges have been in place for some time have led to student and faculty protests – and such protests have been even more pronounced in countries where costs are being passed on to students for the first time.

Take-away for engineering educators: Is this the time for all educators to become more politically united and active on behalf of restoring appropriate levels of funding to higher education and research?

Quality assurance

As globalization sweeps around the world, stimulating the flow of engineers and their services across national borders, accreditation and other forms of quality assurance have grown in importance. Some form of credentialing is often demanded before an engineer is allowed to move from one job market to another, or to offer services in another country from a home base. Formal accreditation is often the preferred form of quality assurance in such cases, and accreditation systems for engineering education are being established or strengthened in many parts of the world. Such high level pronouncements as the Bologna Declaration in Europe, and a similar recent declaration by the Ministers of Science and Technology of the Organization of American States, have led to the rapid development of quality assurance mechanism within countries or regions. There is also a strong movement toward mutual recognition agreements between such countries once local accreditation systems are in place – leading, for example, to the expansion of such cross-border educational equivalence pacts as the Washington Accord.

Take-away for engineering educators: Engineering is probably closer than any other profession to converging worldwide on standards of educational quality. This creates an increased incentive for US engineers to insist that their students have an international component as part of their undergraduate education.

Our research technique

The *International Engineering Education Digest* is published electronically every month by Dr. Russel C. Jones, a longtime engineering educator, and Dr. Bethany Oberst, a senior university official for many years. The *Digest* presents summaries of appropriate and timely articles from the many papers, conference proceedings, magazines and journals that they read regularly. The *Digest* is copyrighted by World Expertise LLC, with all rights reserved. All back issues can be found at www.worldexpertise.com.

While the editors use personal judgment in selecting items that they feel are of appropriate interest to engineering educators, the *Digest* entries are straightforward summaries of the items. For the current paper Jones and Oberst have identified megatrends in engineering education, and higher education more broadly. In the conclusion which follows the authors make some observations about likely trends in the future, based on the hindsight provided by the *Digest* items of the past several years.

Concluding observations

- Although the economists of the World Bank and the International Monetary Fund have failed in improving the status of people in poor countries through attempts at stimulating economic growth with foreign aid, we must find effective ways of ‘teaching people how to fish’ instead of sending them fish. Engineering education and technology development can provide the base for capacity building which leads to economic benefits from engagement in the global economy, as well as to the effective local utilization of foreign aid resources guided by indigenous engineers.

- Engineering students increasingly need to be educated for international practice, including an awareness of all these trends described above and how they will surely change the practice of engineering over the course of their professional lives. Programs of study should include education in languages, cultures, and mores of foreign countries. International experience through study abroad and internships are a must. Faculty need to show the way, with their own international activities.
- Communication and information technologies have greatly increased the need for effective quality assurance systems for all engineering education programs around the world. Mutual recognition agreements to move toward acceptance of educational equivalency are a must to allow appropriate mobility for practicing engineers.
- Problems with the funding of higher education, the rise of private educational institutions, and the increasing mobility of students are trends that threaten the dominance of traditional higher education institutions. Those traditional universities must adapt and change if they are to be competitive in the future.
- Attraction of appropriate quality and quantity of engineering students remains a problem. Offshoring and unstable employment patterns exacerbate the problem, but the inflexibility and difficulty of the engineering curriculum are also major factors. One major element that can contribute to solving the worldwide problem of attracting enough good engineering students is the diversification of the pipeline to include many more minority students and women. And that means moving beyond traditional comfort zones to recognize that the biggest barriers to access are rooted in deeply ingrained social and cultural systems that require serious grass-roots efforts to overcome them.

Reference

All back issues of the *International Engineering Education Digest* are posted on the web at <http://www.worldexpertise.com>

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