# 5 Things Industry Can Do to Help Educate Better Engineers

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## Abstract

Engineering has played a critical role in the history of civilization. The world's challenges – water, food, energy, environment, health, housing, climate change and others - continue to require the creative and innovative solutions that only skilled engineers can provide. Moreover, in the flat world of today, where interconnectedness and skilled talent drive economic development and new business models emerge, innovation and science and technology education/ capacity building become THE foundational elements in developing and sustaining knowledge based economies. Engineers continue to play a key important not only in solving local problems but also in knowledge creation and knowledge transfer. On the other hand, in a globalized world, "private industry lives and sometimes dies by a demanding credo that honors results and constantly tests people and ideas against a public that can vote with its economic might" [Gordon, 2007]. The engineering professional industry needs requires a skill set beyond what universities are currently producing. Some critical questions arise: Are universities, engineering programs responding effectively and efficiently to the challenges and opportunities of the world of today and of tomorrow? Since both industry and universities are both interested in developing talent as well as knowledge, how can universities and industry strategically partner to better address the challenges and opportunities of developing the engineering professional that countries and regions need to develop and sustain their economies?

This paper describes several ways how universities can collaborate with industry to educate better students, who will in turn better serve the needs of industry as well as national, regional, global needs. It will briefly describe activities such as industry's role in curriculum innovation, student and faculty experiences, continuous quality assurance and accreditation, research and innovation.

## Engineering Education in a Flat World

In the *World is Flat*, author Tom Friedman [1] suggests the world is in its third wave of globalization, one that is governed by people and communications. He states that the flattening of the world happened at the dawn of the 21st century; and that countries, communities, individuals, governments and societies can and must adapt to the challenges that this "flat world" presents. Thus, globalization is making both

developed and developing countries think about effective and efficient strategies that will advance their economies and social development. Many countries around the world have made significant strides in the past 10 years in laying the foundations upon which market economies and democratic societies can flourish. Examples include Taiwan, Singapore and Ireland. These countries, as well as others, have recognized the role of science, technology, innovation and education for sustained economic growth. These countries have realized that "The empires of the future will be empires of the mind." [Winston Churchill].

When you consider that economic studies conducted before the information-technology revolution show that as much as 85 percent of measured growth in U.S. income per capita was due to technological change [Rising Above the Gathering Storm report, USNAS, 2005], a strong case can be made for seeing engineers as the key knowledge workers for capacity building and sustainable economic growth in both developed and emerging economies. To be globally competitive, countries not only need a larger number of engineers and technology workers, but the skill sets, competencies and values that these individuals possess are different from what universities have traditionally developed in students. Moreover, there's an increasing role of innovation and entrepreneurship in all dimensions of business strategies. Industry needs to hire graduates that possess excellent technical skills and have broad professional skills.

What are these technical and professional skills? Over the last decade these skills have been documented extensively in reports like the US National Academy of Engineering Engineer 2020 Report [2006], the new outcomes based ABET accreditation criteria [www.abet.org], in individual companies' white papers (e.g., Siemens) and other interested bodies like the Knowledge for Development program from the World Bank Institute. These reports confirm that practicing engineers face problems as a way of life and thus, they require skills and competencies to help them define and address these. Engineers must not only be knowledgeable about science and technology but also have the skills, competencies and values to address problems and opportunities in effective and creative ways. In the interconnected world of today, these may be local problems or they may be global problems. Thus, there's a need for professionals that not only possess strong analytical skills but also

- Exhibit practical ingenuity; posses creativity
- Have good communication skills with multiple stakeholders
- Are knowledgeable of cultures and languages
- Possess business and management skills; leadership abilities
- Have high ethical standards and a strong sense of professionalism
- Are dynamic/agile/resilient/flexible and lifelong learners
- Possess the ability to frame problems, putting them in a business, socio-technical and operational context

One important conclusion can be drawn from these reports: there's a big gap between the skill set needed for the profession/job and what engineering graduates actually possess upon graduation. This gap continues to increase as the demand for talent-intensive skills continues to rise.

According to the Economist [October 7th 2006], the value of 'intangible' assets (skilled workforce, patents, know-how) has increased from 20% of the value for S&P 500 companies to 70% today. But, two things are making it hard for companies to adjust: one, loyalty (headcount reduction, cut off in layers of management, high turnover); and two and most alarming, the mismatch between what schools are producing and what companies need (both in numbers and skill sets. The skilled professional needed in the flat world is getting harder and harder to find. A recent McKinsey Quarterly Report [2007] indicate that of all global environmental, social and governance issues companies face, educational systems and talent constraints are the most critical for business success. Employability of graduates from developing nations is a challenge. Data from the January 2008 McKinsey Quarterly Report show that only 10 out of 100 engineering graduates are employable in Russia and China; 13 in Brazil; 25 in India and 20 in Mexico.

The overwhelming conclusion is that higher education, and specifically engineering education, needs to be reengineered, reformed, reinvented to better serve its constituents, to develop the kind of engineering graduate it needs to recruit. Industry – one of the primary customers of the university system – urgently needs, wants change. Universities, engineering programs - the primary supplier of engineering professionals - need, should change to better respond to the challenges and opportunities of a flat world.

## What Can Industry Do to Help Educate Better Engineers for a Flat World?

As one of the most important constituents in higher education, industry can play a significant role in addressing the need for universities to change. Industry is interested in both knowledge and talent development. Industry can also assist in developing strategies as well assess outcomes.

> *"Ties to industry are important in providing the best opportunities for engineering graduates, for bringing practical, real-world problems into the classroom and laboratory, for engaging faculty to apply their expertise and for providing a platform for the institution to address industry challenges, thus providing an opportunity for national and global leadership in engineering."* Gary S Was, University of Michigan

> *"Partnership between industry and university has become even more important in the global marketplace… Engineers will have to acquire the ability to communicate as they work in the demanding international marketplace… corporations are hoping to depend more and more on government and university…"* Norman Augustine, CEO Lockheed

What are some ways in which can industry help challenge academia innovate curricula and make it more relevant to professional practice? Here's five specific ways industry can help educate better engineers:

*Strategic Planning*

Strategic planning is imperative for business success. It should also be to universities, colleges and programs. Industry can help universities in their strategic planning processes. From understanding the process itself and sharing best practices and models, to help establish mission, vision, strategies, priorities, identify resources to assess outcomes. Universities need to collect data to better understand and interpret the institution, make intelligent decisions about current operations or plans for the future, to continuously improve the efficiency and effectiveness of the institution. Information is vital to institutions to understand internal operations and the effectiveness with which they are using their resources. Strategic planning ensures universities in a reflection process that enables focused research on their operations that provides information which supports planning, policy formation, and decision making. These processes are essential for accountability and industry can be mentors and collaborators.

*Curriculum Innovation*

One of the most important outcomes of higher education is to educate the human talent for society. In order to educate students, universities develop curricula, hire faculty, engage in knowledge generation activities (e.g., research), catalyze student and faculty professional development activities and establish academic/administrative processes to support their missions, etc. But it has been curricula that has received historically the most attention as the way to educate students. Yet the process to change how curricula is developed and delivered has evolved very little. It seems that curricula and teaching is still locked n the 19$^{th}$ century tradition. So, if there's a need to innovate and reform curricula and the teaching learning experience to better address the challenges of a flat world, who better than industry to help bridge the academic and productive worlds. For example, industry can help programs define the profile of the graduating student, that is, help identify the skills and competencies student must possess to be successful on the job. Industry can provide students with real life projects mentored by industry and provide both students and faculty with internship opportunities in a real life engineering setting. Industry can also share state of the art technologies, a glimpse of future technologies being developed in corporate labs that could influence curricula, as well as share capacity building/professional/training materials to complement the curriculum.

*Innovation and Entrepreneurship*

Corporate research laboratories are at the forefront of technology, therefore, another way industry can assist universities to innovate the curriculum is by sharing new science and technology trends and jointly examine/build initiatives and projects that integrate research and education in these new areas.

Innovation and invention represent the livelihood of companies in a flat world. Companies have to innovate or die – thus, entrepreneurship and innovation is a culture well engrained in the mindset of successful companies. Advances in technology and this entrepreneurial culture need to find a way into engineering education and provide a means to develop talent that can not only use technology, but also help create it. Developing and making effective use of new research results requires a well-educated and diverse workforce that is able to interact with the entire S&T population.

Industry can provide means to engage faculty and students in innovation and in the transfer state-of-the-art research results and emerging tech areas into undergraduate and graduate curricula. By providing collaborative research programs to students and faculty, they can experience real life industry entrepreneurial drive for taking inventions to products and services.

Companies like Microsoft and HP have competitive external research programs that support basic research and curriculum innovation in many areas (www.hpl.hp.com/open_innovation; www.research.microsoft.com). These programs allow world known researchers, professors and their graduate students will tackle some s of the most challenging scientific and technical problems today.

> "*This level of competition has never happened at HP Labs before. It's like the Olympics of research, where the best professors from the best universities around the world were selected to work with researchers at HP Labs," says Prith Banerjee, director of HP Labs and Senior Vice President for Research, HP, August 2008.*

*Outcomes assessment and accreditation*

Of all the issues affecting higher education today, accountability and accreditation are top priorities. There's dissatisfaction with rising costs of higher education, questioning the quality of instruction and public questioning whether college graduates are being properly prepared for the work world. There are also access and equity issues and pressing accreditation/governmental mandates.

Accreditation, defined as the process of external quality review created and used by higher education to scrutinize colleges, universities and programs for quality assurance and improvement, aims to assure both quality and accountability, in the public interest. Quality assurance and accreditation are important not only to assure quality in education, often times to allow access to external (public) funds, for ease transfer of courses and programs, but most importantly, to provide employer confidence. Accreditation is a means for employers to verify that graduates are acquiring the necessary competencies, knowledge, skills and abilities to enable them to practice appropriately at a professional level.

Moreover, high-quality and pertinent engineering education, and quality-assurance mechanisms are imperatives for creating a knowledge-based economy. Quality-assurance systems with peer-review accreditation promote high-quality education programs and make degrees portable to other parts of the region and of the world. Quality-assurance systems can also provide the basis for cross-border recognition systems, permitting the flow of services and goods across national boundaries and creating a net 'brain gain' for the country or region.

How can industry help in continuous quality assurance mechanisms and accreditation? By becoming members of industry advisory boards at the college or program level, industry can provide valuable input and validate accreditation criteria, especially engineering graduates' skills and competencies, an essential criteria in outcomes based accreditation. Industry can also be part of the interlinked assessment loops – the long term, mission-related assessment loop; and the short-term, student learning assessment loop.

Industry can play a key role in brokering and nurturing partnerships across the multiple dimensions of the academic world. Industry can lead the dialogue for education and innovation policy making with high level government officials. Industry can be effective conveners of likeminded companies interested in supporting education and innovation university initiatives. Multinational companies can provide links and strategic partnerships in support of engineering education and innovation in multiple global sites.

## Conclusion

Technology and knowledge form the basis for meaningful economic development. Success in knowledge-based economies depends largely on the capabilities of people – especially engineers - who are credentialed in meaningful and consistent ways. Therefore, the need to innovate and reform engineering education is vital and undeniable to meet the local/regional challenges as well as global demands. The engineering professional industry needs requires a skill set beyond what universities are currently producing. Higher education, in general, is responsible for formally preparing the next generation of business leaders, technical professionals, government officials and educators. Engineering education, in particular, plays a central role in our increasingly technology-based societies. The education of engineers must prepare them for the multi-disciplinary nature of the problems they will face. The need to reduce the gap between the academic world and the real world of engineering is urgent, as Bernard Gordon, the founder and CEO of Analogic Corporation, and the impetus behind the US National Academy of Engineering Gordon Prize, states

> *"Engineering is an unforgiving and demanding environment and for students to succeed as engineers, they must go far beyond theories, simulations and exam-taking."*

Industry – as employer of engineering graduates - is an important stakeholder in education and can help educate a better engineer. The private sector can help universities undertake strategic planning, innovate curricula, partner for innovation and entrepreneurship, provide infrastructure, student and faculty professional development opportunities, early adopt technology, assist programs in accreditation, and broker and nurture multi-stakeholder partnerships for win-win outcomes

Industry-university collaboration to address the challenges of a flat world can be a catalyst in educating a better engineer. In the end, it is in the best interest to society to develop the skilled engineer that is capable of helping nations sustain economic growth across the planet.

> "*Without the parallel thought processes, the able to retarget ides to a variety of implementation and application areas, the ability to access many minds with a global perspective, and the ability to link with and federate with the efforts of others who have been working in the same field, under-competitiveness is the most likely outcome."* Wayne C. Johnson, 2004 Glion Colloquium

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