ENGINEERING PRACTICE: A DRIVER FOR CURRICULUM CHANGE

Vojislav Ilic
University of Western Sydney, Locked Bag 1797 South Penrith DC, NSW 1797, Australia
v.ilic@uws.edu.au

Abstract - **In the not so distant past, tertiary institutions were pillars of professional wisdom, nourished by technical research, the results of which were disseminated through graduates who helped shape industry to be more competitive, innovative and inventive. However, this process has radically changed, owing to a large extent, to economic globalization and to new technologies moving outside universities, often to specialist businesses that own the rights to the innovation. This is a relatively new phenomenon which, in turn, is precipitating radical changes in the university engineering curriculum.**

One of the effects of globalization is to make engineering practice more diverse, risk averse and complex. Engineers are more likely to need leadership skills hence they need an understanding of broader cultural, political and economic, as well as technical issues. They need to possess good social skills, strong values, and embrace diversity and tolerance. In addition, the lack of communication skills in most graduate engineers was the greatest obstacle to their development as managers and leaders. Many also lack the human relations skills necessary for working effectively in teams.

This paper aims at examining industry driven changes in engineering curriculum and suggests adjustments needed to accommodate the new working environment.

Index Terms - education, industry, learning

INTRODUCTION

Institutions of higher learning have traditionally occupied a special place in the society. It was a place where, if one was to believe the incumbents, one was closer to the deities of the time, with ample opportunities for detachment from everyday chores. Contemplation and wisdom emanating therefrom without much emphasis on utilizing any such knowledge for the good of mankind, was there only to indicate its special place in the cosmos. Gradually, however, this detachment gave way to pragmatism, with educated elite becoming more plebeian. And the society prospered. In our times education is considered by many neither a right nor privilege – but essential to the survival of the species. This view is still gaining momentum and is yet to permeate educational institutions globally. In Australia, the recent joint declaration of the Australian Vice-Chancellors' Committee on sustainability [1] for it to predicate all educational endeavours is one of the many changes sweeping the global education arena. Sustainability is already being practiced in industry – which is looking at the universities to provide graduates with holistic outlook to cope with the new approaches to problem solving [2].

From the technical viewpoint, emergence of new engineering specialisations has it origins in the way industry evolved, with educational establishments busy catching upon details: biomedical engineering, robotics, micro-electro-mechanical systems, nanotechnology to name the most obvious. This in part changed the way universities used to operate – and is now mandating symbiosis with industry in the education process.

This paper aims at examining industry driven changes in engineering curriculum and suggests adjustments needed to accommodate the new working environment.

THE ESSENCE OF CHANGE

It was the well known 20th century sociologist Alvin Tofler who pronounced that the whole of the society is undergoing a change and that the only permanent feature left is the change itself [3]. The essence of this change he calls the "power shift" as the new civilisation takes over from the old in terms of providing the direction of change towards the "knowledge based society". This reaffirms universities as the centres of knowledge dissemination and generation. However, in the 21st century knowledge is an ever increasing means of wealth generation and is therefore intimately involved with commercial enterprises – the industry. Thus educators and industry have vested interests in each other mandating their collaboration.

It is implicit that such collaboration is of benefit to both partners –as well students: ensuring relevance of the curriculum to the educators and providing employers with graduates whose skills are not only wanted – but immediately deployable. To be workable, such a scheme needs official endorsement of the accreditation authorities, which is the Institution of Engineers, Australia (EA) in this country.

INNOVATION AS THE KEY

As Peter North in his recent article [4] observed, decades long deliberations have gone by on the importance of value-adding through technological innovation and the importance of high-value-added technological innovation in reaching into niche markets in a competitive globalised world, albeit without much effect. However, it is apparent that it presents the key to unlocking Australia's technological potential, and should therefore be a part of the educational culture, alongside entrepreneurship, globalisation and sustainability. It again points to the industry-education liaison, nurtured and encouraged by the government, to provide the answers. In their quest to be relevant, universities are guided by the accreditation criteria (reflecting the minimal academic standards) – as well as industry, to ensure employability of their graduates. It is the mechanics of the latter that is of particular interest here.

The key to a viable change in the educational ethos is the endorsement by the Accreditation Body. As mentioned above, EA as the national arbiter of professional quality, sees the following as the purpose of accreditation [5]:

- Certification of individual academic programs for delivery of Stage 1 competencies (i.e. entry level to professional practice);
- Guarantee to students of the professional standing and value of their degree;
- Comparability and graduate mobility on the global scale;
- Setting standards of best practice;
- Public identification of programs – independently evaluated;
- Statement of requirements and necessary resources for provision of engineering education.

While this is achieved through a combined measure of prescriptive elements (program structure and content, assessment standards, operating environment and quality assurance processes) and academic outcomes (manifest through the direct measurement of graduate capabilities) – the emphasis by EA is on the latter approach. The net outcome is predicated on meeting the "stakeholder requirements" (employers, students, university, funding bodies and professional institutions).

This is enshrined in the Graduate Generic Attributes endorsed by EA:

- Ability to apply knowledge of basic science and engineering fundamentals;
- Ability to communicate effectively, not only with engineers but also with community at large;
- In-depth technical competence in at least one engineering discipline;
- Ability to undertake problem identification, formulation and solution;
- Ability to utilise a systems approach to design and operational performance;
- Ability to function effectively as an individual and in multi-disciplinary and multi-cultural teams, with the capacity to be a leader or manager as well as an effective team member;
- Understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development;
- Understanding the principles of sustainable design and development;
- Understanding of and commitment to professional and ethical responsibilities;
- Expectation and capacity to undertake lifelong learning.

INDUSTRY AN ESSENTIAL PARTNER

[6] observed that, at least in the USA, " ..in an era of unprecedented technological advancement, engineering practice continues to evolve but engineering education has not changed appreciably since the 1950s. This schism has prompted industry, government, and other key constituents to question the relevancy and efficacy of current programs". This is an ever evolving process, providing the essential feedback to engineering curriculum developers.

It is well known that engineering students in Australia need to have a minimum of 12 weeks of industrial experience before their application to graduate can be considered. While coming towards the end of their studies, such an involvement with industry if of lesser pedagogical benefit if there had been opportunities during earlier times for students to work with in industry partner in an "extended" classroom arrangement.

Some universities in Australia have long and well established tradition of involvement of industry in the education process, such as the Sydney University of Technology (UTS) with their "sandwich" courses of having their 6 monthly academic period followed a period of equal duration with an industrial partner. It is also well known that all graduates of such a program readily found employment immediately upon graduation. Such an arrangement is an ideal which may not be suitable for all institutions of higher learning to entertain.

This paper advocates interaction with industry in all applied subjects in a curriculum that suit both parties. The formula can only be a success if it provides a win-win situation for everyone involved. One such example is the Mechanical Design unit with the practical part spent with an industry partner working on a project provided by the partner and approved by the subject coordinator. This approach was found to be highly successful at the University of Western Sydney. Similar approach was taken by the Carnegie Mellon University's institute for Complex Engineering Systems also proving a resounding success [7].

In this as well as workplace situations, ability to communicate becomes a meaningful task, and teamwork is taken as a matter of course. Involvement of engineers from industry as guest lecturers is also an effective way of companies reaching out to students by capturing their attention in relating the theoretical basics learned in the classroom to demonstrable applications.

In order that such an approach can be initiated, it is essential that a proactive stance by university academics be encouraged and intimate involvement with industry through consultancies, research, internships, company directorships, membership of various professional joint committees and organisations such as Engineers Australia, ASME, IMechE etc.

GLOBALISATION

Political globalisation saw the establishment of areas of common interests – such as Europe. Economic globalisation saw development of multinational enterprises. Professional mobility has become mandatory. It was inevitable that engineering education would also be affected. The implementation of the Bologna Process (1999) involving 45 European countries aimed to integrate European higher education area. [8] is now being considered as to its global impact involving Australia, Asia Pacific and USA. The AVCC recognises potential beneficial aspects of 'Bologna compatibility' such as "…the internationalisation of the professional labour force, mobility amongst educated people, the desirability of increasing the international experience of staff and students from Australian institutions, with reciprocal arrangements from other countries, and the Australian graduates benefit from access to internationally recognised qualifications". "Students with knowledge of, and expertise in, the global economy will be more competitive. Hence foreign cooperatives and internships and foreign language skills are increasingly going to offer a competitive edge." [9].

While Bologna addresses the labour mobility through adapting common educational standards, The Washington Accord (1989) has been created specifically to ensure harmonization of professional accreditation standards amongst the participating nations.

THE ADAPTIVE CURRICULUM

The above presents a fast changing scenario that challenges traditional conservative education of professional engineers to be adaptive, relevant, global and effective in producing today's professionals. The most appropriate way of addressing this situation is for industry – university partnerships – particularly at the education coal-face involving captains of industry and academics working together in shaping the future professionals. Such liaisons should be actively encouraged by managers in both "camps" to ensure desired outcomes. One such practical format directly contributing to the curriculum development is to have External Advisory Committees staffed by industry representatives. – and chaired by a senior academic. Suggested graduate attributes by these would be employers should then be translated into academic offerings that would ensure relevancy of their university training.

As much as students are required to have a period of industrial practice before graduating, academics involved in their undergraduate instruction should be encouraged to undertake industry internship also to keep themselves abreast of industry developments in their areas of expertise.

While periodic Accreditation of Courses is the minimum agreed standard, an effective pro active stance by an educational establishment would obviate the need for such formal mechanism - a case already in some well known institutions in the US.

CONCLUDING REMARKS

It is advocated that the pedagogically most effective practice to prepare engineering students for their chosen career is to encourage interaction between engineering curricula developers and industry. At its most effective, it would encourage joint effort by both enterprises to educate the future engineers each providing what it can do best, thus not only avoiding unnecessary waste of resources, but contributing to the wealth generation of the participating industry partner. The student benefits by establishing a network of industry contacts while still at the university and while working alongside company employees. Development of the elusive "engineering sense" is yet another desirable by-product.

How this can best be realised largely depends on the support of managers of individual institution of higher learning and the networking capacity of its staff. In the experience of this author, industry is always willing to take part in collaborative ventures which show promise of positive returns – because its very survival depends on it.

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REFERENCES

[1] AVCC. Sustainable development high on universities' agenda. *Media Release 8 August, 2006*

[2] Gale, S. Project Leader, Hatch Engineering (private communication)2006

[3] Tofler, A. *Power shift: knowledge, wealth and violence at the edge of the 21st century*. Bantam Books. 1990.

[4] North, P. Unlocking Australia's technological potential. *ATSE Focus, No 14 , September.* 2006.

[5] Allen, M. EA National Director of Education and Assessment *(private communication) 2007.*

[6] Lang, J.D., Cruse, S., McVey, F.D. & McMasters, J. Industry Expectations of New Engineers: A Survey to Assist Curriculum Designers. *Journal of Engineering Education, Vol. 88, No.1 pp 43-51,* 1999.

[7] Wesner, J.W., Garrett, J.H., Jr, Subrahmanian, E., Westerberg, A.W. and Amon, C. Carnegie Mellon's Multidisciplinary Engineering Design Projects Course Serves a Variety of Students and Project Sponsors. *Proceedings of the 2004 AMSEE Annual Conference & Exposition, Session Number 3125, 2004*

[8] AVCC. The Bologna process and Australia: Next Steps. *AVCC Response to Discussion Paper. May 2006.*

[9] Devon, R. & Liu, J. (2002). Global change and the management of engineering education. *World Transactions on Engineering and Technology Education. Vol, 1, No. 1, pp 85-89*