Towards culturally inclusive global engineering?

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Engineering is now, more than ever before, a global profession. The context in which engineering design problems must be framed is increasingly a global one, and global sustainability needs to be taken up as an important design criterion. Engineers are finding employment in multinational companies in greater numbers, and their work takes them to every corner of the world. But engineering is still far from culturally inclusive. There has been a worrying tendency for the global reach and impact of engineering to be based essentially on North American or European perspectives. I argue that we need to reclaim the term globalization as implying the celebration of rich diversity, not as a recipe for an essentially neo-colonial domination by a perspective drawn from one or two regions, however powerful they may be. The extent to which multicultural as well as international issues should be taken into account in engineering practice raises questions about the extent to which cultural issues permeate the whole of engineering education. However, it is far from clear that developments in higher education in general are necessarily supportive of a variety of perspectives. Indeed, a group of forces and ideas promoting a two-tier global market for education seems to be increasingly influential in national and international discussions. Traditional universities, even as they extend their international reach, may increasingly be maintained only for elite groups, while a bargain basement type of training emerges for the masses at the local level. I offer some reasons why this arrangement would be both socially disastrous and professionally damaging to engineers. Australians may be able to offer a useful contribution to the development of a broader perspective on engineering. The engineering context in which our students and academics work has allowed us, in a range of innovative approaches, to experience and give voice to cultural diversity. This variety includes some approaches that my own university has adopted in order to incorporate international issues and awareness in our programmes. I offer some ideas about how we should be preparing engineering students to think through global issues so that, as individuals, they are culturally sensitive and inclusive and can take justifiable pride in their profession’s international role.

1. Introduction

With the Sydney Olympics almost upon us at the time of writing, it sometimes feels that the celebration of cultural diversity in Australia is becoming an obsession. The extent to which we have a distinctive contribution to make to this forum remains to be seen, but it is important to recognize that global engineering is much more than merely ‘flavour of the month’ for Australian engineers. We are very conscious of the fact that modern technologies have overcome many aspects of the ‘tyranny

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of distance’ which virtually isolated Australia until after World War II. At the same
time, significant levels of post-war immigration (which continues, albeit scaled-
down) have imparted a strongly multicultural character to modern urban Australian
society. Engineers were involved in that change in a myriad of ways, but the question
to be addressed today is, to what extent has that participation been incorporated
into our professional practice?

Around the world, including in Australia, the practice of engineering changed
rapidly over the 20th century, particularly during its last few decades. Mathematics,
physics and chemistry were the major scientific disciplines that underpinned
traditional engineering specialties; but now the boundaries of engineering have
expanded. Biology and computer science support new specializations such as bio-
ingenineering, computer systems engineering and software engineering. A degree of
diversity, injected by the influence of a wider range of academic disciplines, is
already making its mark on the engineering profession and on engineering
education. There is a greater openness to new ideas and intellectual content. Accept-
ance of growing numbers of women in the profession is another dimension of a more
inclusive engineering culture.

Changes are coming from within the profession itself. Engineering is practice-
based, and at the beginning of the 21st century, engineers are now routinely working
in multi-disciplinary teams. We increasingly recognize the fact that engineering
practice always relates to specific contexts; problems being addressed in industry and
by consultants are no longer formulated as ‘engineering problems’, but much more
broadly, for example as problems in the area of transport, or water supply, or waste
disposal. Engineers play important roles in the interdisciplinary teams dealing with
such problems; modern engineering practice requires them to work and to com-
municate effectively with a range of other professionals and non-professionals, and
to be able to discover and respond effectively to community interests and concerns.
Again, our growing competence as professionals in such work environments is
invariably broadening the range of our responses and capabilities.

Given these trends, do we need to strike out further in the direction of provid-
ing explicitly ‘international’ education for engineers? Cultural diversity is a fact of
professional life. Engineers are being employed in ever greater numbers by multi-
national and transnational corporations and are routinely working across national
and cultural boundaries. Engineering projects may take them, for varying periods
of time, out into the field—which might be any corner of the globe—or into design
workshops, laboratories or head offices which may also be located far from their
own homes and countries of origin. Historically, engineers have been a roving breed;
but the international scope of their work is greater than ever before and there is, I
believe, more awareness of exposure to different cultures, with all that that implies
of differences in language, belief systems, levels of affluence, education and technol-
ogical competence, etc. Does engineering education at present prepare graduates
adequately for this?

With colleagues at the University of Technology, Sydney (UTS), I have explored
elsewhere the contribution a ‘discourse’ approach can make to developing an under-
standing of the characteristics and limitations of modern engineering practice. This
focus on practice provides the solid intellectual foundation for our approach to engi-
neering education (Johnston et al. 1995, 1996). We are exploring ways in which engi-
neering practice—in particular, the selection of the problems to be solved and the
criteria for ‘successful’ solution—always take place within a cultural context. We are
finding that some of the programmes which underscore this most effectively for our students come under the heading of ‘international’ or ‘global’ engineering. However, rather than simply embrace some rather vague ‘parenthood’ concept, we need to examine its implications and limitations.

2. The context for ‘global engineering’

Looking first at the profession itself, in this paper I want to argue strongly for engineers to reclaim the idea of globalization as a culturally inclusive term, and global engineering as a culturally inclusive activity. I believe this is necessary because much of the political context for the global practice of engineering in the 21st century is being set by three essentially ideological constructs that are central to the rhetoric of modern capitalism. They are: globalization; economic rationalism (‘neo-liberalism’); and corporate managerialism. These concepts only really belong in the business sector, where they increasingly define the work environment for many engineering professionals. However, they are being introduced in all spheres of social and political life, including the universities (Stillwell 2000).

I shall spell out briefly what I understand each of these terms to mean, and then give some indication as to how they are impacting on the economy generally.

I have described globalization elsewhere as ‘. . . the widening and deepening of international flows of trade, finance and information into a single, integrated market . . . [and] a prescription for opening up national and global markets in the belief that this will produce the best outcome for human welfare’. World markets certainly opened up during the 1990s, and global trade was expected to reach US$6 trillion this year. One use of the term has also been to promise that modern technologies would make the typical Western middle-class experience universally accessible (Johnston et al. 2000b: 436–437). As I indicate below, for most of the people of the world this seems more like a cruel jest than an achievable target, but it has still been a powerful force for change.

Perhaps more cynically, globalization has also been defined as: ‘US control of the distribution networks for technology and products’. If we look at the ways in which information and communications technologies have developed, we can see the force of this description. The Microsoft judgement earlier this year suggested that even the US Government was concerned at the concentration of power in these areas. But how likely is it that we shall end up doing everything in a common way, the US way? Is the triumph of US cultural attitudes and approaches inevitable? Given the scale of US exports of film and television content it clearly holds a significant kernel of truth—in 1997 the USA exported over 120 000 h of television programming to Europe alone (Johnston et al. 2000b: 437).

A parallel term to globalization, with which this audience may be more comfortable, is internationalization. It ostensibly gives greater weight to inputs from a wider set of national players, but could also be seen by its critics as implying a predominantly European slant. Why am I challenging what are probably the two main groups in my audience in this way? Essentially because, as an outsider to both groups, I feel the need to draw your attention to the fact that, as presently expressed, neither of these approaches really seems to me to address, in a sustainable way, the global technical, cultural and economic issues we need to face.

The second construct, economic rationalism, is the idea that the logic of market economics should prevail, not only in economics but also as the essential basis for
decision-making in the political and social spheres. Two fundamental objections to it, from an engineering perspective, are its short-term focus and the way it completely ignores issues such as sustainability. An equally fundamental objection to it, from the perspective of political economy, is that it fails to acknowledge the fact that the markets on which it bases its legitimacy are essentially social constructs, with significant national and regional variability (Johnston et al. 2000b: 228–231).

Despite its intellectual weakness and the obviously limited perspective it offers, economic rationalism has become an increasingly potent influence on government decision-making around the world. Its impact on engineers and engineering has been particularly associated with the fact that it is presented as justifying moves towards corporatization and privatization of major elements of national infrastructure. While these moves have commonly led to short-term falls in energy and other service charges in many countries, including Australia, they have also been associated with major de-engineering and with concerns about the reliability and long-term security of services.

The old organizational structures often left much to be desired, as critics like Sharon Beder (1998) have clearly demonstrated. However, in the process of modernizing organizations that provide essential national and international infrastructure, we need to go beyond simplistic approaches and take a long-term view that accords with the character of the technology we create. The development of appropriate measures to encourage accountability, without oversimplification of the tasks and responsibilities of those involved, is not a quick or simple task. It needs to take into account a proper variety of perspectives and of social aims.

Corporate managerialism is an approach to decision-making that assumes that strongly hierarchical corporate models of governance are appropriate across all areas of the economy and in every sort of organization. In many ways it seems to hearken back to the equally simplistic notions of the American Technocrats of the 1920s. Their focus was on efficiency and effectiveness, and they were very successful in increasing productivity in mass-production manufacturing environments. In more complex environments, with multiple competing objectives, their ideas were a disastrous failure. Complex environments like universities, where the use of simplistic performance metrics is commonly counterproductive, turned out to be very much better suited to more collegial and consultative management styles. There is a certain irony in the promotion of managerialism as an organizational model, in that within leading global corporations a much more open and consultative style seems to be taking root, exemplified by the ‘learning organization’ approach championed by Senge (1990).

If I have serious reservations about these three elements of the context for global engineering, there are other elements which, potentially, offer a far more positive construct.

2.1. The challenge of sustainability

Sustainability perhaps most clearly demonstrates the global dimension of the challenges facing the engineering profession. Moving towards sustainability is a core concern for societies around the world. What precisely sustainability will mean is still a matter for discussion, but some of the central resources and other issues are starting to emerge with some clarity. Helping people to meet their needs, without compromising the resources available to future generations, is part of the story. There is less general agreement on the extent to which biodiversity needs to be
maintained and the natural and built environments conserved. The adoption of sustainability as a guiding principle for engineering professional practice will certainly require extensive rethinking of present approaches. It will also require much more serious exploration of future issues.

For some years the body that represents all the engineering disciplines in Australia, the Institution of Engineers, Australia (or IEAust), has been strongly asserting the importance of sustainability as a critical prerequisite for a stable and peaceful world. It has also started to explore what this means in practice for the profession (IEAust 1992, 1997). (Regrettably, as our Government’s intransigence at Kyoto showed, and as I have discussed at length elsewhere, Australian energy policy is still driven by a narrow focus on energy exports (Johnston 1996).)

Sustainability is not simply a technical concept—although engineers will need to play a key role in achieving its technical demands. If we were looking for everyone on earth to achieve the average quality of life of the one and a quarter billion citizens of the industrialized ‘north’, which includes the USA and Europe (and Australia), we would have to increase the efficiency of resource use very substantially. ‘Factor Four’ studies by Weizäcker et al. (1997) and others indicate that in many areas a four times increase in resource use efficiency could be achieved through more effective use of existing technologies. However, recent thinking suggests that a factor closer to 10 is needed. This will require radical change indeed, and will pose major challenges for engineering system designers!

For most of the four and a half billion people living in the economically less developed ‘south’, the key design issue is to help them to be more in control of their own lives, to free them from the crippling poverty and insecurity that dominate their world. The difference is indicated by the income differential. For the north, 1995 average per capita income was over US$16 000, while for the south as a whole the average per capita income was just over US$3000, and in the least developed countries it was US$1000. While the problems commonly have a strong political dimension, the sorts of technologies that engineers develop can increase or decrease the control that poor people have over their circumstances. As Winner (1986) points out, the culturally specific nature of design criteria means that artifacts can have politics. One of our aims should be to develop global engineering in ways that assist all societies to look forward with confidence to the future.

One example of the sort of engineering practice required to help people in poor countries take more control of their lives approach is given by the work of APAC (Appropriate Technology for Community and the Environment), a non-government organization based at UTS. APAC has focused on micro-hydroelectric projects and food security projects in the island nations to the north of Australia. A key part of its activities has been supporting villagers to raise funds and agree on project control structures and providing training, so that technologies can be implemented in ways that the villagers themselves manage and maintain (Johnston et al. 2000b: 406–407). These approaches also help to maintain village solidarity, itself a major stabilizing factor. However, such approaches are distressingly rare, even within aid programmes.

2.2. Cultural factors in technology development and transfer

Another area where global engineering has a very positive role to play is in technology development and transfer. A central part of engineering practice for many decades has been the development of new technologies in one industrial context, for
example the USA, Germany or Japan, and their transfer to, adaptation and adoption, in other places and cultures. One of the difficulties in analysing the development and transfer of technology is the enormous range of socio-technical systems of production and use involved. At one end of the range are small-scale activities, often in remote areas, and problems such as communications, drinking water purification, or handicraft and agricultural production for small groups. At the other end are large-scale industrial activities, with which engineers are generally more familiar (and perhaps more comfortable). The whole spectrum of technology transfer is important but the approaches required at each end of the spectrum are rather different, and it is essential to be clear where the focus is at any time.

Technology transfer has cultural as well as technical and resource aspects. Even in transfers to relatively developed countries, these cultural issues can present serious difficulties. In considering the cultural aspects of technology transfer, McGinn (1991: 52–70) distinguishes between micro contexts, for example within an individual firm, and macro contexts, which may include an entire regional or national society, or even the whole world. He suggests that the cultural dimensions need to be taken into account to develop an adequate understanding of the causes and consequences of specific technological developments. In the cultural system of the society he includes typical levels of education, and religious attitudes and beliefs.

Cultural issues are relevant for both developing and developed countries. In industrialized regions such as North America and Europe, social and cultural factors can still make transfer of production technology difficult, as recent experience in Eastern Europe has demonstrated. Effective transfer may require quite different management attitudes and practices, forgetting old ways and learning new ones. It may also require the presence on the production floor of skilled technicians or even professional engineers, to provide continuing training and skills development for the operators. This level of technical support seems likely to be important for the continuing process innovation that has characterized the best Japanese practice. In third world countries, the characteristics of the transferred technology can be very much less compatible with existing skills and support resources. In Papua New Guinea, for example, the numbers of each make and model of motor vehicle are too small to support effective service training and spare parts supply, severely limiting service life and increasing balance of trade problems (Johnston et al. 2000b: 418–419).

To summarize this analysis of current and possible constructs for ‘global engineering’, at this juncture it seems obvious to me that the term has both positive and negative connotations and potentialities. I see the engineering profession as having a fundamental ethical responsibility to assist in local, national, regional and global moves towards a more socially and ecologically sustainable society. System design criteria at all levels need to change to take sustainability into account as a fundamental design criterion. And I see this as requiring a fundamental change of educational as well as technical focus.

Before I go on to discuss the implications for engineering education, I want to look briefly at the debate that has been going on in Australia and elsewhere on the future of higher education generally, and how this impinges on ‘international education’.
3. Traditional universities and international education

Australia’s 37 public universities are the direct descendents of nearly a millennium of European traditions. Their closest forebears are probably the 19th century Scottish universities, and their nearest cousins the state universities of the USA and the countries of what was once the British Empire. Religious and private institutions have only a token presence in Australia. However, universities, the educational institutions in which engineers are educated, are under challenge in Australia and around the world. The problem is exacerbated in Australia by what some authoritative commentators have described as a public policy vacuum. While enrolments have risen steadily, the Australian government has squeezed the higher education sector sharply over the last decade, even though initial data from a major Australian study shows that the national government is actually making a profit out of higher education. Around 40% of the government’s A$5 billion annual investment is immediately returned to it as income tax. The balance funds an A$3–4 billion ‘export of education’ industry, and most of the nation’s research effort (Gilbert 2000). Australia’s export of education is made up of two components—overseas students coming to Australia, and programmes being offered overseas by Australian universities. Since World War II we have encouraged overseas students (mainly from the English-speaking middle and upper classes of countries in South East Asia, the Pacific and the Indian sub-continent) to study at Australian universities. More recently, the situation has been complicated by an ongoing conflict between two government departments. The Department of Foreign Affairs and Trade is keen to make it easy for foreign students to come to Australia to study. However, the Department of Immigration and Multicultural Affairs sees this essentially as a back-door route to immigration to Australia, so it has made it increasingly difficult for potential students, particularly Chinese students, to get visas.

One way around this problem has been for Australian universities to offer courses offshore, and this can help to ensure that material is focused on local needs and that graduates are not simply produced to become part of the brain drain. UTS has been offering engineering programmes in Hong Kong and Singapore for some years, and there are some interesting issues involved. While much Australian content is directly suitable for offshore offering, there are significant costs in adapting material. Also, while spending a week or two overseas is initially exciting, the novelty soon wears off and Australian academics become reluctant to spend blocks of time away from home. Shortening the visits, and paying increasing attention to provision of distance-mode learning materials, have helped to make the impact on academics’ time more acceptable. Even so, the demand is increasing, and is now so great in some professional areas that UTS is looking to translate some whole programmes into Mandarin for offering in China.

While we have been busily engaged in such ventures, we are aware that longer-term trends are emerging. Where is higher education going? There is considerable debate in Australia, and indeed around the world, about the likely future shape and role of universities. Global investment in all forms of education was estimated at around US$1.5 trillion in 1999, and this has been forecast to double by 2006, and to double again by 2012. As part of this process, the market for advanced education and sophisticated training is also expected to increase exponentially (Gilbert 2000). It is not clear that traditional universities anywhere will benefit from this growth, indeed some observers see it as a major threat. The threat comes partly from the cost and relative inflexibility of educational delivery by traditional universities, and
partly from a perception that they simply will not be able to meet the envisaged scale of the demand. Is the university, as an institution in modern society, becoming an anachronism? Are we facing a paradigm shift in what we understand constitutes higher education? One of the human problems with paradigm shifts, if that is what we are seeing, is that the adherents of the old paradigm are first marginalized and then excluded.

What sorts of institutions might be able to meet the increased demand and, more particularly, to what extent will engineering education make up a part of this demand? It is hard to see roles emerging over the next decade or so for four times as many engineering graduates as are produced at present! Of course, much of the investment will be in continuing professional development and in retraining existing professionals moving into new technical areas. The questions remain: In a climate of global engineering, what sorts of engineering graduates will institutions of higher education need to produce? What sorts of education and training will these graduates need? What institutional structures will serve them best?

Some observers see a pattern emerging in various parts of the world; it is even detectable in Australia. Two different types of institutions are being proposed as the inheritors of the mantle of the traditional university. At the top end of the spectrum are the very rich research universities, with multi-billion dollar endowments, which can afford to fund the high-cost, cutting-edge research that is seen as immensely attractive to the most able and ambitious scholars around the world. International education of engineers is already subject to considerations of prestige; the danger that this emphasis might become dominant should not be taken lightly by the profession.

At the other end of the spectrum is privately provided higher education for the masses, with low-cost, extremely flexible delivery of educational material. The best promoted current exemplar of these ‘for profit’ universities is probably the University of Phoenix (Chipman 2000). Such institutions are expected to buy in teaching material from world authorities in each of the most popular areas. This material is then to be transmitted over low-cost media like the Internet to delivery points, for example in local shopping malls. Campus costs are minimal, with facilities limited to those that the mall can provide. Tutorial support is provided cheaply by casual employees. Are ‘local’ engineering education offerings to be reduced to this?

To the extent that education is simply a matter of transmission of information, the ‘for profit’ model seems efficient and indeed persuasive. However, I have a major problem with it. It seems to me that this is a model for training, not for education, because I believe that it depends on a confusion of knowledge and information.

Information is now certainly readily and cheaply available to most of the population in the developed nations of the world. It is a proper basis for skill development and training. However, I understand knowledge as something that each individual needs to construct for him or her self, using his or her own head and body. The process of education is more than acquiring general or specific information, it also involves developing the powers of reasoning and judgement and generally of preparing oneself intellectually for mature life. Training has a much narrower focus, and is about the use of discipline and instruction to develop specific habits, thoughts or behaviour. It seems to me that what the ‘for profit’ corporate universities are really about is training; and I have two problems with this approach. The first is a practical, indeed instrumental one, that I do not see a focus on training as anything
like adequate preparation for the rapidly changing world into which these graduates will be emerging, or re-emerging. My more fundamental problem is that I see a university as having an important societal role in supporting its staff and students to test conventional wisdoms and to advance unconventional critiques of established social, political or technical paradigms. This freedom is an essential basis for all disciplines to move forward, and for the continuing development of an open democratic society! It is not clear that governments around the world feel so passionately about the desirability of an independent-thinking populace; that is one of the reasons we need to be able to change them fairly regularly.

4. International engineering at UTS

Is there a viable alternative to these rather depressing models for the future? Perhaps the most useful effect of these challenges is that conventional universities are re-examining their core values and looking to improve their performance. Australian universities are now formally adopting sets of ‘graduate attributes’, expectations for our students’ academic, personal and professional achievements and development. They are also more vigorously asserting their educational roles and fundamental values, and cultural inclusiveness (often termed ‘plurality’ or ‘diversity’) is one to which all universities subscribe more strongly than ever.

In engineering education in Australia, a national review (IEAust 1996) urged the need for substantial broadening and educational modernization of courses. The Faculty of Engineering at UTS had been planning for some time to move to a more flexible programme, with a strong common core of professional engineering subjects, offered to all our undergraduates. These subjects were designed to model and support the sorts of cross-disciplinary team practice that characterizes much of modern engineering practice. They focus on active development of the skills and attitudes that underpin reflective, self-directed, lifelong learning. Our approach is described in detail elsewhere (Johnston et al. 2000a) and we see it as an approach with long-term appeal and value for students.

Internationalization has for many years been one of the six key themes at UTS. This is particularly appropriate, given the cultural diversity of our staff and students. In New South Wales, the Australian State in which UTS is located, over 40% of people were born overseas or had one or both parents born overseas. Two-thirds of those born overseas were from non-English-speaking backgrounds, and 19% of UTS academic staff and 26% of support staff speak a first language other than English. In the UTS Engineering student body, 47% of students identify as being from non-English-speaking backgrounds (compared with 36% in the university as a whole). Over 90 languages other than English are represented among our 2500 engineering undergraduates, including Cantonese, Vietnamese, Mandarin, Greek and Arabic (UTS 2000).

The theme of internationalization applies across the University, and there is a well-established and very successful Institute for International Studies which provides educational support for Australian students planning to work and/or study abroad. There is a range of assistance for overseas students studying at UTS, including an International Studies centre and an English Language Study Skills Assistance unit (ELSSA, which helps local as well as overseas students with the development of their academic English skills).

How have we translated internationalization and diversity into educational
programmes which address the issue of global engineering? Some years ago the UTS Faculty of Engineering, in co-operation with the Institute for International Studies, developed a combined degree that is particularly relevant to global engineering practice. The Bachelor of Engineering, Bachelor of Arts in International Studies (BE/BA) programme allows students to study another language and culture, as well as a normal engineering programme. Our students normally also do a Diploma of Engineering Practice (DipEngPrac), which involves two engineering internships. Each of the two 24-week periods of engineering experience is preceded and followed by academic subjects that support students in preparing for the experience and in reviewing their experience and their learning. For BE/BA students, the senior of these internships has commonly been taken in a country whose language and culture they have studied. One approach we have worked on with some success is to encourage international firms with offices in Australia to provide work opportunities overseas. This year, for example, two BE/BA students are working in the Tokyo office of an Australian company, which was delighted to find and recruit Australian engineering students who spoke Japanese. Other destinations have included China and a number of Latin American and European countries. Placements have ranged from urban computer hardware and software development to remote community infrastructure improvement.

The international origins of many of our students also mean that, among the majority who undertake the regular engineering undergraduate programme, a significant number can arrange to work or study overseas without too much difficulty. Many of them take up the opportunity. The University and the Faculty have made every effort to encourage and assist such international experience. Subsequently, and in order to capitalize on such experiences (and ensure they are not simply a ‘working holiday’), the subject International Engineering encourages students to reflect on their overseas work experience (Johnston et al. 1996). It is clear from their reports that students quickly recognize that cultural awareness and sensitivity are very significant attributes for working successfully in a global environment. For example, one class discussion in the most recent offering of the subject concerned a project in a country where respect for seniors was a very strong cultural value. Although the project group was unimpressed with the senior member of the local team, they found that until they allocated him a role that was seen to be respectful of his position, they were unable to make effective progress. Our students appreciate that textbook case studies, while valuable, can rarely convey the full range and nuances of cultural diversity that engineers will encounter in the field.

On the basis of their personal experiences, that class also explored some of the difficult ethical problems that Transparency International (TI 2000) was set up to address. They learnt that the end of the Cold War saw the beginnings of serious efforts to address corruption in international business and engineering. Approaches like the setting up of ‘islands of integrity’ have started to demonstrate real progress in this context. Thus, even before they graduate, our students should appreciate that, unless corruption is addressed effectively, international aid projects are unlikely to generate sufficient rates of return to pay for themselves, and will simply be an additional drain on the people they were meant to assist. However, corruption still presents significant challenges to engineers working in the global economy. Our students were clearly pleased to have an opportunity to explore this and other issues arising from their experience. They could then start to move towards work practices with which they could be comfortable in the longer term.
More generally, what other sorts of practical preparation do engineering graduates need to practise successfully in a global context? As well as the broad skills and knowledge required for local practice, they also need international awareness: a familiarity with cultures, languages and skills requirements, and markets. One commonly undervalued area is documentation; it is an area that receives considerable attention in UTS engineering and which is particularly important for global practice. This raises once more the issue of cultural dominance. For much of global engineering, the language of professional practice is English. Engineers whose first language is English are fortunate in that they have direct access to nearly two-thirds of the world’s technical literature. However, this still means that, for them, one-third of the literature, which may include essential information, is inaccessible without translation. (European engineers are no doubt well aware of the problems translation presents (McGregor 1997).)

In our programme we point out that the use of a controlled or restricted vocabulary is one widely used measure to minimize ambiguity and assist in translation. Differences in local use of English also pose problems, as even skilled users of English such as academics going abroad can appreciate. Especially in oral communication, the whole message can be missed while the listener tries to sort out the meaning of a confusing word. Common terms like ‘staff’ and ‘faculty’ mean different things on opposite sides of the Atlantic. (Even trivial differences in usage, like bookshop rather than bookstore, may stop you finding the website you want.) Local cultural understandings are also significant. In some remote communities ‘on’ and ‘off’ may simply be read as ‘turn the switch the other way’. ‘Water’ and ‘no water’ are more effective communication.

We also stress that cross-cultural visual literacy can be important for engineers working in remote areas. In some cultures the concepts being portrayed may be unfamiliar, scale may be a problem, and it may not be possible to interpret exploded views. Simple and uncluttered pictures, with unnecessary detail eliminated, may help. Where human figures are needed they should omit indications of race or gender. Symbolism should be consistent and standardized where possible. These extremely elementary guidelines address problems that may not otherwise be amenable to ‘intuitive’ solutions offered by representatives of different cultures.

More generally, a culturally inclusive approach needs to avoid anything that might be taken to imply cultural superiority. Informal comments can be confusing and may even be interpreted as patronizing. Humour is always difficult to translate, and a courteous and polite style is generally most effective.

UTS engineering is making a very determined effort to take into account multi-cultural as well as international issues in its educational offerings. We are consciously aiming to prepare our students to think through the problems, so that they can participate in ‘global’ engineering, whether locally or abroad, with confidence and with justified pride in their profession.

5. Conclusion—a global role for international engineers?

I have tried to cover a rather wide canvas in my paper, but how else can one even start to do justice to a topic of such central importance? The issues facing engineering education, and indeed higher education generally over the next decade, could have a major impact on the quality of life around the world for much of the century.
I see the engineering profession as needing to strike a balance between two extremes. At one extreme is the concept of engineers as heroic beings at the centre of the universe, performing dramatic feats, but with scant concern for the social and other costs involved. The Three Gorges Dam now being built in China is widely seen as an example of this sort of approach. At the other extreme is a concept of engineers as essentially powerless servants of business or other interests, servants who are responsible only for carrying out narrow technical tasks. In modern times, engineers doing high-level computer analysis seem particularly liable to becoming captive to this perspective.

Neither of these extremes allows our profession to make the contribution that a compassionate, humane society would require of it. However, unless we can focus strongly and effectively on developing graduates who are able to deal successfully with both the technical and the broader social, political, economic and ecological challenges, working effectively across disciplines and cultures, we could see universities emasculated, even replaced by a highly stratified system with a small quota of élite education on the one hand and uncritical training for the masses on the other. We cannot and must not allow this to happen!

References


About the author

Stephen Johnston, after some years in industry as a mechanical engineering designer, joined UTS in 1971. He was Head of the School of Mechanical Engineering from 1991 to 1996, and is now Director of the Faculty’s Engineering Practice Programme, overseeing the engineering internships that are central to the UTS Engineering programme. His increasing interest in the broad context of engineering practice led to his becoming the lead author of a text on Engineering and Society, now into its second Australian and first international editions. Stephen won the Boeing Medal for Excellence in Engineering Education in 1999 for ‘His intellectual and scholarly leadership [which] has provided a stimulus for the reconceptualisation of engineering education and for the recognition of engineering practice as a legitimate field of academic study’.