THE FUTURE OF GLOBAL ENGINEERING – A PERSONAL VIEW

Barry J Grear AO,
HonFIEAust, FIPENZ, FACE, FAICD, MAIES, JP

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Today I will cover four main themes:

- Demand for engineering activity in the world.
- International Engineering Business
- Activity of the World Federation of Engineering Organisations, and
- What I am observing

In practice, an idea for a structure, project or product may be conceived by an engineer in one country, it may be designed in one or more countries, constructed or produced with components from many countries, operated and maintained where used and disposed of with international support.

In this era of extensive use of the internet and the availability of many internationally recognised engineering “software packages” the concept of an engineer belonging to a “country” is challenged, and may be considered irrelevant. It is, however, important for all engineering associations (and governments) to have confidence in the abilities, standards and experience of engineers working across international boundaries.

For decades there have been hundreds of bilateral international agreements and memoranda of understanding which have brought confidence between countries. In the last 20 years there has been a growing interest in multilateral agreements for engineering graduates, criteria for working independently and for the recognition of experienced engineers.

My experience has been directly related to:

- The Washington accord - the signatories recognise the substantial equivalence of programs in satisfying the academic requirements for the practice of engineering at the professional level.
- The APEC engineer - provides for the mobility of engineers between the signatory economies of APEC who meet substantial equivalence criteria.
- The Engineers Mobility Forum (EMF) – provides for the acceptance of mutual recognition for experienced engineers from the Washington Accord countries. The substantial equivalence is similar to the APEC Engineer.

I believe it is desirable that Australia keep its leadership position in encouraging the continuing convergence between registers.

During the last 10 to 15 years there has been an international upsurge of interest in arrangements for the international recognition of both undergraduate engineering courses and practicing engineers. There are similar agreements for graduate and practicing engineering technologists and engineering officers.

Engineering Companies are getting around the problems by shifting work to where the engineers live rather than shifting the engineers.

Complementary to the interest and activities of the engineering societies, who are active in international standards is the expansion of the government sponsored bilateral and multinational Free Trade Agreements between

Australia and other countries. The World Trade Organisation also shows increasing interest in promoting trade in engineering services.

All these have to recognize that 40% of Australian engineers are working internationally whether they leave their desks or not. So “Mobility of Engineers” is paramount.

However, there are real difficulties in getting agreements on the trade in services, because of licencing and registration requirements related to small geographic areas.

In many jurisdictions there are different requirements for the registration of academic engineers compared to engineers working in an industry or working as a consultant. There is usually a requirement for research or active industrial experience for academics to be registered. Careful consideration must be given as the integration of engineers in academia and industry.

A challenge for the engineering profession in the future is the increasing diversity of the disciplines which are gathered under the banner of engineering. Engineering is a dynamic profession. It has been able to extend its capability through the development of enabling technologies and the increasing interdisciplinary requirements of projects where social and health science specialisation is included.

The profession of engineering is a dynamic one. Changes in the academic, practice and discipline criteria are continually changing. A reflection on the requirements in 2006 compared with 1986 reveals enormous changes. For example, there was no internet then!

We must expect that the graduate attributes will be changing all the time because of the changing of the knowledge in society.

The roles in government, industry, commerce and academia undertaken by professional engineers, engineering technologists and engineering technicians are influenced by the labour market. This means that the engineering societies need to continuously monitor the future requirements for the numbers of engineers in all of its specific disciplines so that the

world community continues to be adequately serviced by the “World Engineers”.

There is a growing world interest in increasing the length of engineering courses by one year or expecting that a Master of Engineering will be required for professional engineers.

A constant theme throughout Australia in the last few years has been the concerns expressed about the shortages of engineers and others in the engineering field.

This concern is in sharp contrast to that in South-east Asia and some European countries where the importance of engineering and technology to national economic wellbeing seems better understood and acknowledged.

In my nearly 50 years in the profession we seem to have been unable to match the production of engineers to demand, and appear to have cycled through times of having too many and too few. This may not be all that surprising when we realise that it may be longer than 15 years from the time that we sow the seeds that interest a child in becoming an engineer, to the time he or she becomes an experienced engineer. Significantly the attitude of parents to a career in engineering is critical.

In comparison with other countries, Australia has a low rate of entry into and graduation from engineering. Internationally, the number of engineering graduates per million lags many other OECD countries.

Furthermore, the number of engineering graduates has remained static at about 5000 students each year, for the past 10 years.

These figures also mask factors that erode the replenishment rate. For example, approximately 1,000 of the graduating engineers are international students, most of whom return to their countries of origin soon after graduation.

Only small numbers of females currently enroll in engineering and there is an immediate need to encourage more women to make it their career choice.

Worldwide it is only environmental engineering that has close to 50 percent. The World Federation is planning a major conference in Tunis next June to consider this issue. This is a critical issue for the future of both the engineering profession and the community it serves.

Worldwide, Engineering qualifications have become highly regarded by employers because of their emphasis on risk management, ethical practice and sustainable outcomes. In this way, graduates from engineering courses have become a new source of managers and leaders for many organisations and professions. I expect this pattern to continue and grow.

Engineers Australia has responded to this challenge through its Professional Development and Continuing Professional Development programs.

The Professional Development Program (PDP), which focuses on the professional development needs of recent engineering graduates, is a formally recognised agreement between Engineers Australia, the employer and the individual engineer. The program is delivered in the workplace, with external assessment and support from Engineers Australia. Participation in a PDP is open to engineering practitioners employed in all fields, types and sizes of enterprises.

Internationally the leaders of the European Union are planning to discuss the establishment of a European MIT in order to slow the brain-drain to the USA. One proposal is to make the EIT into a network connecting universities and industry to facilitate technology transfer.

This is an area where our Universities are responding well internationally.

The World Federation of Engineering Organisations (WFEO) is the international body representing the worldwide engineering profession. The national organizations that constitute WFEO include about 10 million engineers worldwide in their membership. The objective of WFEO is to use the skills and knowledge of the engineering profession for the wider benefit of humanity.

One means for accomplishing this goal is to produce advice for governments and other agencies, prepared independently of any commercial bias, that will assist those Governments and other agencies in achieving national goals.

All nations wish their citizens to be able to live with a reasonable level of economic prosperity, to enjoy educational, health and social services that enable them to live their lives in dignity and without hardship, and to do so in a manner that ensures that negative impacts of human activity on the environment are acceptable, and increasingly minimized.

Many components of good quality health, educational and social services, and clean technologies to protect the environment must be purchased by nations from the international market place. To be able to afford reasonable standards of social and environmental services, nations therefore, need to build their economic prosperity.

The World Development Report 2005 demonstrated that poverty elimination and economic growth (indexed as GDP/capita) are highly correlated.

The poorest nations operate primary production-based economies. The second and third stages are development of an industrial economy. In an open world economy manufacturing has always migrated to the source of cheapest labour of adequate skills so the second stage involves low quality low-paid jobs using often outdated equipment that is uneconomic to run and too polluting in its effect for more prosperous economies to continue using it. This stage can be highly polluting and involve lowest standards of occupational health and safety. In the third stage capital for better equipment and better training of workers is deployed, and the remuneration of workers increases. The fourth stage is the transition to a knowledge-based service economy. Many parts of Europe are transitioning towards this style of economy. The pay rates are high, the most advanced technology is deployed, environmental impacts start to lessen and better social services can be afforded. In contrast, some of the largest population countries in the world, China and India, are in the second stage of development. They have rapidly increasing demands for resources, and are experiencing environmental problems of some magnitude. This is a major concern both for those nations and globally.

Economic efficiency also requires a country to rapidly deploy new technologies from elsewhere, and to attract capital to purchase those technologies. Many developing countries do not have sufficient capital of their own and therefore need to attract foreign direct investment (FDI). This in turn requires adherence to intellectual property laws, but also low levels of corruption and fair taxation and or tariffs. Political instability and access to finance are important factors but electricity supply and adequate roads are also rated as a significant obstacle by the World Development Bank.

Achieving the environmental aspects normally involves engineers again - spending capital for activities such as flood control and pollution remediation schemes.

Thus, whenever capital is made available it is vital that the nation has the technical capability to make good technology decisions. The world is littered with examples of unsuitable technology being foisted on developing countries because there was not wise buyer capability.

The need is for:

- technically literate government officials (engineers and scientists who have learnt public policy) who can advise on key policies.
- technically literate businesspeople (engineers, technologists and scientists who have learnt business) who can attract capital and use it wisely.
- engineers to spend public capital well on the most useful infrastructure projects,
- engineers who can maintain capital assets (too often forgotten),

The WFEO has been able to vigorously represent the engineering profession in the global policy setting tables especially with regard to issues of sustainable development and human welfare. This means interacting visibly and effectively with the United Nations and its specialised agencies as well as the international and regional development banks and financing agencies. With the whole-hearted endorsement and support of WFEO Members there has been significant achievement.

The most important focus of the UN in development in the coming decade is the Millennium Development Goals. WFEO has led the "Science, Technology and Innovation (STI) Task Force. In September 2005 Heads of Governments including Australia endorsed the action plan which WFEO members will pursue. Their communiqué said:
"*As the Millennium Project's report makes clear, our agenda is still achievable globally and in most or even all countries — but only if we break with business as usual and dramatically accelerate and scale up action until 2015, beginning over the next 12 months. Success will require sustained action across the entire decade between now and the deadline. That is because development successes cannot take place overnight and many countries suffer significant capacity constraints. It takes time to train the teachers, nurses and engineers, to build the roads, schools and hospitals,*

and to grow the small and large businesses able to create the jobs and income needed. Many of the poorest countries will need major capacity-building investments to put in place and maintain the necessary infrastructure and to train and employ qualified personnel. Sustainable economic growth will require significantly increased investments in human capital and development-oriented infrastructure, such as energy, transport and communications. In addition, small and medium-sized firms require a favorable legal and regulatory environment, and expanded access to financial capital, including microfinance. This is crucial for providing decent jobs that both provide income and empower the poor, especially women and younger people. To increase countries' indigenous capacity for science and technology, including information and communications technology, Governments should establish scientific advisory bodies, promote infrastructure as an opportunity for technological learning, expand science and engineering faculties, and stress development and business applications in science and technology curricula."

Sadly in my opinion there are still too many people who have never turned on a light switch, never walked on a made roadway let alone ridden on one.

This leads on to my final point, the poor condition of infrastructure world wide.

I suggest it is because there is minimal involvement of engineers in the political process.

I am interpreting infrastructure broadly. An ever-increasing global population that continues to shift to urban areas will require widespread adoption of sustainability. Demands for energy, drinking water, clean air, safe waste disposal, and transportation will drive environmental protection and infrastructure development. Society will face increased threats from natural events, accidents, and perhaps other causes such as terrorism.

Dealing with these issues requires intra-disciplinary, cross-disciplinary, and multi-disciplinary collaboration on projects and in research and development. More advances in areas such as information technology, intelligent infrastructure, and digital simulation will be needed.

Engineers in the developed world are regularly producing "Infrastructure Report Cards" and are raising the alarm about the lack of investment in maintaining and improving our civil engineered systems, assigning dismal

grades for many areas. Engineers are painfully aware of the repercussions for public health, safety, and welfare when the infrastructure gets short shrift.

Engineers also know that they could do better in speaking out in the social and political arena, and in becoming leaders in the policy-creating and decision-making process, so that the process is based on a sound technical foundation. Engineers know they must become the political and public service decision makers. Report Card grades will not rise without such input. I also recommend that our next report cards go further and in the light of the current political, economic and social environment of the day propose the solutions and not leave it as a statement of the problem.

The public is becoming increasingly aware that development need not come at the price of a compromised and depleted environment for them and their children. The public has begun to see sustainability, not as an unattainable ideal, but as a practical goal. To answer that call, engineers must increasingly transform themselves from designers and builders to life-cycle project "sustainers."

As I mentioned earlier, to effectively practice engineering at the professional level is beyond the scope of the traditional bachelor's degree, even when coupled with the mandated early-career experience. Education must meld technical excellence with the ability to lead, influence, and integrate, preparing the engineer to weigh the diverse societal issues that shape the optimal approaches to planning, design, and construction.

Technology and market forces bring additional pressures on how engineers play out their roles. Knowledge-based engineering software increasingly shifts routine engineering tasks from the realm of the engineer to that of the technologist and technician. How will this trend play out in the years ahead? Will engineers move further into a systems role, coordinating the work of more non-engineers in leading the overall project?

On the demographic front, the world is well on its way to a population exceeding 10 billion people in 2050. Today, people occupy more space on the planet than they did 30 years ago, and they are straining the earth's environment, particularly the needs for energy, fresh water, clean air, and safe waste disposal. Over the past 30 years, gradual global warming has profoundly impacted the more than half of the world's population that lives

within 50 miles of coastal areas. These areas have become much harsher places to live because of sea level rise, increased storm activity, and greater susceptibility to flooding. Growing population, shrinking resources, and climate change have put us on the path to sustainability and have put sustainability at the forefront of issues requiring global attention.

Large, multi-national corporations have continued to expand and become major economic forces on a global scale. The total revenues of these corporations exceed the GDP of many nations, and the interrelated nature of their global production and supply network has given them great influence over environmental norms and standards across nations. These multi-national corporations are now major drivers of global environmental standards, and the opportunity for promoting tougher standards in all countries has grown. Economic forces help drive such environmental improvement, but less stringent environmental standards still prevail in some lesser developed countries.

What aspirational role will engineers play in that radically transformed world?

> *In a time of drastic change, it is the learners who inherit the future. The learned usually find themselves equipped to live in a world that no longer exists.* (Eric Hoffer, self-taught philosopher)