

19 Grey St
East Melbourne
Victoria 3002
1st February 2012

Committee Secretary

Senate Education, Employment & Workplace Relations Committee

Parliament House

Canberra

Subject: The shortage of engineering and related employment skills

Dear Sir,

We are responding to the invitation to make a submission to the Committee considering the above topic. Our submission is appended. The submission relates to the primary topic of the inquiry and in particular to items (c) and (e). The subject of this inquiry is of major importance for Australia (and many other countries) as there is a global shortage of engineering graduates. It has existed for many years and is likely to continue unless major changes in the education of engineers are implemented.

Two of the signatories (Emeritus Professor David Beanland and Professor Roger Hadgraft) have recently completed a commission from UNESCO to write a book on the topic "Engineering Education: Transformation and Innovation". It is awaiting publication. This project has created the need for significant research which has extended our knowledge and thinking about why engineering education needs to be transformed and how this objective can be realised. A small trial of a "transformed" program is to be commenced in the School of Mechanical, Manufacturing and Aeronautical Engineering, whose Head (Professor Aleksander Subic) is the third signatory, at RMIT University in 2012.

Engineering Education must be transformed because:

- The attraction rate of students is very low.
- The failure and drop-out rate over the course is approximately 40% across Australia.
- The attraction of female students into engineering remains low at approximately 12%.
- The graduates of engineering programs tend to strong on technical knowledge and deficient on the personal capabilities required to be effective engineers.
- The number of engineering graduates in Australia has been approximately half of the number required in each year of the last decade.

While we are unable to provide a copy of the material developed for UNESCO until it is published, we can provide some insight into its conclusions and would be willing to expand upon them during the hearing sessions if the Committee would find that helpful.

The problem of a shortage of engineers is common to most countries. It is a major problem as engineers are the creative problem solvers who are essential for the effective application of the technologies upon which our societies have become dependent. We are critically dependent upon the expertise of engineers in matters relating to transport, structures, water, electrical power, environment, infrastructure, defence, communications, information technology, mining, manufacturing, aeronautical, automotive, marine and medical engineering. They are the source of innovation which is so important for our economic development. Their expertise is critical for every development project.

However the many engineering degree courses that are offered to students fail to attract and retain sufficient students because:

- Engineering is not a well understood profession.
- Its importance and its positive contribution to society is not appreciated.
- Its critical role in achieving environmental sustainability is overlooked.
- The primary and secondary education systems fail to prepare and motivate students to undertake science, technology and engineering.
- There are insufficient secondary and primary teachers with an understanding of technology.
- Engineering has failed to attract a reasonable proportion of female students.
- The engineering courses are considered to be too difficult because of the high failure rate.
- Engineering courses fail to motivate students.
- Pathways into engineering programs are not well established.

The major criticism of engineering degree courses is that they fail to adequately develop the graduate attributes that have been internationally agreed in the Washington Accord, to which Australia is a signatory. They focus upon the development of detailed technical knowledge in increasingly narrow specialisations, while engineering projects require a broad and an increasingly complex interaction of knowledge from many disciplines. The specified graduate attributes include: independent learning, communications, leadership, teamwork, ethical behaviour, environmental and community responsibility. These are not adequately emphasised, developed and assessed even though they are skills that are vital to professional engineering employment and practice.

Major changes that can address the engineering curriculum and program deficiencies include:

- the utilisation of project based learning throughout all years of the course,
- the use of student-centred learning to replace staff-centred teaching,
- the use of may available web-based learning resources to encourage independent learning,
- a focus upon the development and assessment of the desired graduate attributes.

This will require major changes in our universities. This is only likely to occur with the commitment of Government, the Institution of Engineers, the Academy of Technological Science and Engineering, and the employers to the changes required to transform engineering education. Achieving change of the required magnitude in universities is not a simple proposition. The objective can be achieved with a collaborative approach with no increase in recurrent costs if assistance is provided with the necessary capital costs associated with transformation.

Changes of this magnitude have been implemented in the education programs for medicine. They are now required in engineering education.

We trust that these comments assist with your investigation of this issue of significant national importance. We would be pleased to enlarge on any aspect of this issue and its resolution, if that would be of assistance.

We believe that this problem is basically a supply side problem. Unless the education system is modified there will be no resolution of the problem. That is a challenging problem. However it must be addressed. It can be solved with appropriate intervention.

Yours sincerely,

Emeritus Professor David Beanland

Professor Roger Hadgraft

Professor Aleksander Subic