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## **Discussion Paper:** **Restructuring University Engineering Courses Within Australia**

Submission from the  
National Committee on Engineering Design (NCED)  
via  
The Mechanical College of Engineers Australia  
to  
[the Advisory Board on Education of Engineers Australia](#)  
to  
the President & Council of Engineers Australia  
and, hence to  
Members of Engineers Australia

### **Background**

Some criticism has been leveled at the diminishing level of science within engineering courses and the science capability within engineering graduates within Australia.

This is a fair observation.

Our profession is one in which there is a continuously expanding realm of knowledge and skills.

Within the fixed four year time frame of a current engineering university course, it is expected that this expanding knowledge be accommodated. It cannot; not without sacrifice of existing content.

The problem is exacerbated by the current economic policies of encouraging the acceptance of more students per facility and per lecturer. A student now receives less personal attention and less access to engineering facilities than a generation ago, although it is recognized that efficiencies of input have increased with the electronic age.

The sacrifice of content mentioned has many consequences.

Core science units have been either reduced or eliminated from engineering courses. This has been countered to some extent in two ways.

Firstly, there has been a greater level of science capability expected from students accepted into undergraduate courses with an expectation of a higher science content level being delivered by high schools. This is being done, but not to the level required for the completion of an engineering course.

Secondly, only the specific science topics needed for the selected area of engineering are retained. Otherwise it is assumed that the students will acquire the

necessary science, for example a particular mathematical concept, whilst studying the relevant engineering topic.

The most obvious sacrifice however is that knowledge, courses, are increasingly compartmented and focused on particular areas. This is fine in a research environment. It is catastrophic in a design sense and for our community where knowledge needs to be gathered together to form new products and new solutions. To create, to design, implies by definition the act of bringing knowledge together, not segregating it.

This is in stark contrast to the trend of university courses and the manner in which universities are being inexorably pushed by current requirements.

It is necessary for us, as a profession, to dictate a standard of professional capability for new graduates. Such a standard will provide a means by which universities can resist the economic push to accept more students and more content into their courses without sufficient funds or time to accommodate those increases.

This professional standard would recognize the integral importance of design in the process of gaining knowledge, not just in the use of knowledge. This recognition would bring prestige and funding back into the design streams, to design academics and reassert the importance of design within our profession.

In summary of the existing problems, within the existing four year engineering courses;

- Science and engineering fundamentals are being reduced.
- Increasing fields of knowledge are being crammed into the existing time frame.
- Design units, design application, design philosophy and design prestige are being reduced, academically and professionally.
- Increasing specialization and subject segregation, is occurring.
- Economic imperatives are becoming increasingly strong with no means of balance against quality of engineering knowledge and skills.
- There is no independent assessment on a national basis to assess the quality of student knowledge or university performance.

## **Proposal**

It is proposed that engineering degree courses in Australia be expanded to two three year degree courses.

The first degree being that of Bachelor of Engineering Science, BEngS.

The second degree being that of Bachelor of Engineering in a particular specialty, eg BE (Mech). This second degree course may eventually and probably be four years.

Double degree courses, as current, with their dilution of engineering content, would discontinue. Students wishing to do a 'double degree' would do the BEngS followed by a business, commerce, law or other chosen degree.

### **Bachelor of Engineering Science**

This degree would form a prerequisite for the Bachelor of Engineering.

It would enable people to be accepted into the Institution of Engineers, and be 'Engineers'.

It would enable students to study non engineering degrees such as business, law, commerce, accounting whilst being accomplished in engineering and bringing an awareness of engineering into these other professions.

Units in the first and second years would generally be common to all engineering students and would include units to give the students and therefore their subsequent profession a confident capability in the sciences, engineering fundamentals and community interaction.

Units would include:

- Applied mathematics
- Applied physics
- Applied chemistry, organic and inorganic
- Some applied biology, bio-science
- Computing science

- Statics
- Dynamics
- Basic thermodynamics
- Basic fluid mechanics
- Fundamental electronics
- Fundamental electrical power and motors
- Mechanics of materials

Fundamental legal concepts and structures eg contracts  
Basic management concepts  
Safety concepts  
Intellectual property concepts  
Ethics, expectations and standards

Communication, sketching, drafting, imaging, modeling  
Computers, hardware, software, analysis methods, programming

The third year would be an extension of these units, offered and selected optionally by students to tailor their knowledge towards their next area of study, whether engineering or non engineering.

Units and topics would be encouraged to be presented in a design and creative context, as far as possible.

It is envisaged that higher degrees could emanate from this degree, where the area of study was to be purely research or analysis. However, a higher degree requiring creative input would require a prerequisite BE.

### **Bachelor of Engineering (in Specialty)**

This degree would take the student into the creative, design, area of his or her chosen specialty and to comprehensive study within that area.

This degree would allow a greater diversity of specialist areas of engineering to be followed, more so as our knowledge continues to grow.

However, it would also allow for a degree in a greater breadth of units, rather than just greater depth, giving rise to a degree in engineering design.

This breadth of design emphasis would be determined by student choice and by the university's capabilities. The area of design chosen may be in a more specialist area such as naval architecture, aeronautics, electric motor design, composite material structures, or more general design area such as product design, machine design or structural design.

### **Post Graduate Degrees**

The BE degree would lead onto a higher degree in either research and analysis of a detailed area; or a higher degree in further study and resolution of a new and novel design of a product, article, structure or method.

This latter concept of a higher degree within a design context, would not rely on the publishing of papers, but the successful manufacture or construction of a resolved article or product.

This would have many positive outcomes. It would provide prestige to academic staff in the design area, thus further fostering good design and design awareness. This would raise salary levels within design academia. The increased prestige and funding would provide incentive for practicing accomplished design engineers to be involved in university instruction, again further fostering creative endeavour.

The higher degrees would be further distinguished and the prestige of design enhanced by the identification of a PhD as a research degree, which it is, and the degree of Doctor of Engineering (DEng) to be used more widely and implemented as a design degree.

To retain this distinction for the benefit of Australia, the European concept of the pre-nominal 'Ing' or possibly 'Eng' be implemented by the Institution of Engineers as an award for practicing designers who have attained a DEng and have designed original products of merit over say a 10 year period. This recognition will help keep good design engineers practicing as design engineers, with this professional and community recognition.

The Institution would provide this assessment and recognition.

### **Assessment for Maintaining Professional Competence**

The proposal for assessment would occur at several levels and would be orchestrated by the Institution of Engineers, i.e. Engineers Australia.

### **Bachelor of Engineering Science**

For the BEngS, the universities would still set their own assessments for award of their degree.

However, that degree would not be recognized as acceptable for entrance into Engineers Australia as a Member unless the students in the final year from that university passed a nation wide exam on engineering fundamentals, with a high pass rate by a high percentage of students.

Also, individual students failing that exam would not be admitted to Engineers Australia as Members.

One exam only would be run each year. Students who failed or were unable to attend would be able to sit for the exam in a subsequent year.

The examination would consist of items like simple force diagrams, stress analysis, mathematical concepts, hydraulic concepts, basic electrical and magnetic circuits etc, which all engineers, within our community, would be expected to know.

## **Bachelor of Engineering**

The BE would not be assessed via student examination by Engineers Australia. Course monitoring would be done as currently.

The higher degree award of DEng, where a design is assessed, would be done by peer assessment by members of Engineers Australia, who may also be design academics not attached to the applicable university.

The award of the pre-nominal 'Ing' or 'Eng' after 10 years of meritorious design achievement following a DEng award, would be assessed in the same manner as the DEng.

This sets the Institution of Engineers as the final authority on the recognition of the ultimate level of professional knowledge, not the universities. This moves the assessment away from the economic imperatives that may otherwise influence an academic institution.

## **Conclusion**

This proposal provides a means of accommodating expanding fields of knowledge within our engineering profession.

It allows the core science and general knowledge areas of engineering to be solidified, providing a base for engineers to move into other professions, or into the more specialized, intensive or creative areas of engineering; without dilution of basic engineering knowledge.

It provides more time, more prestige and potentially more funding for the development of the creative side of engineering.

It helps to provide recognition that engineering is a creative profession as well as an analytical profession, particularly within the academic environment.

It sets an independent standard for judging the adequacy of basic engineering instruction by engineering universities, assessed by an independent body representing the profession, without the prejudice of economic imperatives.

The proposal provides for Engineers Australia to assess and award what would become the pinnacle of professional engineering achievement, a DEng followed by a pre-nominal 'ING' or 'Eng'. This would also provide great prestige to the university at which the doctoral study was done.

The community would benefit economically from the above proposal through superior, exportable, products, design skills, services and techniques.

The outcome would be knowledge of greater economic value to our community through better exportable products and design services, a profession with a surer

science footing, more highly regarded within our community and within the international engineering profession and engineering universities.

The proposal would manifest itself as superior, Australian, creative engineering.

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