

4+1>3+2?

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***Abstract:** The focus of engineering education has dramatically changed in Europe as a direct result of the Bologna process. While the intention of this was to create a more uniform educational system, another outcome has been that professional engineers are now expected to graduate with a Masters Degree rather than a Bachelors Degree. The University of Melbourne has been the first Australian university to proactively approach this issue by introducing the Melbourne Model, which comprises of a three (not four!) year Bachelors Degree (not a BEng!) followed by a two year Masters Degree (3+2). In an environment conditioned to focus on the quality of undergraduate programs, one initial reaction might be that the degree has been watered down. However, this is far from the case because the emphasis is clearly on the students completing five years of study in total. Melbourne University has in fact raised the bar. Never-the-less, their decision to proceed along this pathway has been perceived as risky and expensive, with few Australian universities following as a result. However, there is a real need to refocus on Masters Programs if our graduating students are to be formally recognised globally as world leaders in their professional capacity. The Faculty of Engineering Computing and Mathematical Sciences (ECMS) at the University of Adelaide will therefore introduce an alternative pathway to Masters in 2010, requiring only one additional year of study upon the successful completion of a four-year Bachelor of Engineering degree. This paper is very much a show and tell work in progress, with only very early indicators of the program's potential success. While it is believed that there are a number of advantages to the Adelaide Four plus One Model, these are not presented as a better option, but simply as an option. Four plus one programs may be perceived as a long-term solution, or even a transitional solution towards a three plus two. Regardless of the preferred pathway, Australian Universities must now prepare for the obviously imminent refocusing of our educational system towards Masters Programs.*

Introduction

University engineering education across most of Europe is radically and significantly changing. Traditional four-year Bachelor of Engineering (BEng) degrees are being replaced by three-year undergraduate programs. However, rather than an apparent dilution of the educational quantity and

quality, there is instead a growing expectation and encouragement of engineering students to complete an additional two years of study (3+2) towards a Master of Engineering degree (MEng). Some Australian Universities are now beginning to follow this trend, with Melbourne University trailblazing the way forward with their ‘Melbourne Model’. However, this has been perceived as a radical and risky solitary change and has attracted both praise and criticism alike. In 2010 the Faculty of Engineering Computing and Mathematical Sciences (ECMS) at the University of Adelaide, will launch an alternative 4+1 model. This “*show and tell*” paper is very much a work in progress, since there are only minimal indicators for the potential success of the program to date. Despite the irresistible title of the paper, it is NOT the authors’ intention to convince the reader which program is superior, but merely to show that there are alternatives, in an effort to encourage vibrant widespread debate in a subject that is almost certain to reshape the future focus of Australian professional engineering qualifications.

Three plus Two Programs

The widespread adoption of 3+2 (Bachelors and Masters) programs was a result of “The Bologna Declaration” which was signed in 1999 by twenty-nine European countries, all intent on establishing easily comparable; quality assured undergraduate and graduate programs that encourage the mobility of students, teachers, researchers and administrative staff between international higher education institutes (Saarinen, 2005). In 2008, after an intensive marketing campaign (Bachelard, 2008), the University of Melbourne adopted the Bologna model and officially introduced six new three-year undergraduate degrees as a collective of programs that was to become colloquially referred to as the “Melbourne Model”. This was amidst a mixture of responses from students, the public and university staff (Clark 2007). The new program structure includes:

1. Bachelor of Arts
2. Bachelor of Biomedicine
3. Bachelor of Commerce
4. Bachelor of Environments
5. Bachelor of Music
6. Bachelor of Science

While each three-year program offers variants of “depth” and “breadth” for major specialisations (Melbourne University, 2009a), the most significant observation (from an engineer’s perspective) is the apparent absence of an engineering undergraduate degree. However, students enrolling in the Biomedicine, Commerce, Environments or Science Degrees, who wish to major in engineering, must complete a significant number of engineering subjects towards obtaining a broad engineering foundation (Hadgraft, 2007). Students seeking further engineering specialisation are encouraged to complete a further two years of course work (five years of study in total) in the Master of Engineering programs (Melbourne University, 2009b). The structure of the model also clearly encourages scholarly interdisciplinary activity (Davis and Devlin, 2007).

A clear advantage of this program is that students are able to delay their choice of engineering specialisation until they have acquired a broad understanding of engineering (Hadgraft, 2007). It is likely to also encourage students to study for five years towards a deeper and broader understanding of engineering theory. By contrast, the more typical Australian four-year Bachelor of Engineering programs require less enlightened eighteen year old school-leavers to choose their engineering specialisation from the seemingly ever-increasing, confusing plethora of engineering degrees (Kestell, 2008). However, such a brave and significant change can be hugely expensive, disruptive and confusing to an environment more accustomed to four-year engineering degree programs (Bachelard, 2008). There is also the added problem that if students no longer wish to study after the completion of their Bachelor degree, they will have no real indication of attaining a professional engineering qualification, rather than a Biomedicine, Commerce, Environments or Science Degree that has engineering interests. While a closer observation of the transcript may show otherwise, the degree would not be perceived as comparable to the more traditional BEng degrees, especially due to the fact that it is one year shorter. Indeed, this makes it extremely clear that engineering students are expected to remain throughout the course of a five year program.

Professional Acceptance

The traditional status of Chartered Engineer (CEng) within the Institute of Mechanical Engineers (UK) now requires a Bachelor Degree and an appropriate Masters Degree (ECUK, 2008). Previously, graduation from a four-year Bachelor of Engineering Degree (without the need of a Masters) was the norm. However, students that now choose to complete their studies at a Bachelor Degree level can only now aspire to become “Incorporated Engineers” (IEng), clearly one step down in terms of the professional hierarchy. This plainly shows that the emphasis on professional qualifications has moved from a Bachelor Degree to Masters Degree in the UK. In Australia the benchmark qualification for Chartered Professional Engineer (CPEng) is still (to date) a four-year Bachelor of Engineering degree (Engineers Australia 2009). Students graduating with a three year degree may become Chartered Engineering Technologist (CEngT). However, it is possible that this all could change (as it did in the UK), depending upon the future popularity of Masters Degrees amongst engineers in Australia.

The Structure of the New Adelaide Four plus One

Advances in technology and increasing expectations from industry require a continual evolution of the engineering curricula. However, it is becoming increasingly difficult to offer specialisation within undergraduate streams, while retaining the quality and scope of the learning outcomes. Many universities offer multitudes of undergraduate degree programs (Kestell, 2008) but there is only so much breadth or depth that can be squeezed into a four-year program. Therefore, from 2010 and onwards, Australian and International students who have graduated from a relevant Bachelor of Engineering degree within the Faculty of Engineering Computing and Mathematical Sciences (ECMS) at the University of Adelaide will be eligible to enrol in a new one-year Master of Engineering program. Students will be able to specialise in:

- Aerospace;
- Chemical;
- Civil & Environmental;
- Civil & Structural;
- Electrical & Electronic;
- Mechanical and
- Mechatronics.

The University of Adelaide’s undergraduate courses are all 3 unit multiples, with students required to complete 24 units of study per year. In a four year degree (such as in engineering) this amounts to 96 units in total. The Master of Engineering program continues this pattern with students required to complete an extra 24 units in one additional year of study (120 units in total). Each specialised program requires that students complete a number of core (compulsory) courses as well as elective (choice) courses from a nominated pool relevant to the area of specialisation. These additional courses have been carefully selected from existing final-year honours courses that are already offered within ECMS, but identified as having a particularly high academic standing. Student graduates from appropriate degrees within ECMS will have the required knowledge to complete the program in just one additional year of study, providing that all of the relevant courses of the Masters program are successfully completed within that year.

Students without the required prior knowledge

Some students from external institutions that have very obvious differences in their engineering curricula (some international universities for example) may not meet the prerequisite criteria for either the program or the individual course components. To accommodate these students ECMS will also offer an intermediate year of study towards achieving the required knowledge and prerequisite skills, especially in statistics, numerical analysis and project management. During this preliminary (preparation) year, students will also enrol in discipline specific courses that provide additional technical material at a level beyond that of a first engineering degree. While students that pass these courses would be encouraged to continue onto the Master of Engineering year, they may instead conclude their studies at this point, graduating with a Post Graduate Diploma. This “escape strategy”

might be an attractive option to those concerned about the prospect of two years of study, especially those who are far away from home.

Fee Support

Commonwealth Supported Places (CSP) will be offered to eligible students who are offered and accept a place in any of the seven Master programs. This means that the Government will contribute towards the cost of the programs and that the students are able to defer payment until they have secured a suitable income (in the same manner that they repay the cost of their undergraduate degree). Students that are not eligible may still enrol in the program, but must pay full fees.

Additional Benefits of the Adelaide Four plus One

The most obvious benefit of the *Adelaide Four plus One* is the elegant simplicity by which graduating students, with a full four-year Bachelor of Engineering degree (BEng) can choose to complete a Master of Engineering (MEng) in just one additional year. If they choose not to, they still have a full four year (honours) degree and remain readily employable as a professional engineer by today's Australian standards. Scotland has already adopted this model, choosing not to follow the Bologna process. The '*Scottish Credit and Qualifications Framework*' advocates a four plus one (4-year BEng (Hons) plus 1-year MEng) which is recognised as an acceptable and alternative route towards Chartered Engineer (CEng) status within the UK's Institute of Mechanical Engineers (ECUK, 2008).

Another benefit is that the program has not required a significant amount of additional resources. Over the last few years, a large number of undergraduate degree programs have built up within ECMS resulting in an extensive range of final-year honours courses. Many of these have been designed to be at an advanced level (to prepare students for future research) and are therefore ideally suited to a Masters by coursework program. In the long-term, this may lead to the consolidation of some undergraduate degrees, thus promoting specialising at a postgraduate level, rather than at undergraduate level.

There are also many five-year double degree programs within the faculty. While these broaden the knowledge of the students, one significant aspect is that students believe that they are more attractive to employers if they have two Bachelor degrees rather than just one. In some cases this may be so, but the timetabling of these dual programs, to avoid classes clashing, is becoming more and more difficult each year. Late night and early morning lectures are becoming more common as a direct result. Graduating with a MEng and a BEng – *perhaps a BEng (Mech) and a BEng (Aero)* – may be perceived as a far more effective use of a five year study period and perhaps might therefore lead to the reduced popularity and hence possible consolidation of some of the *less* beneficial double-degree programs.

Initial Indication of Student Interest

While there are still some minor program issues to be resolved for a faculty wide implementation of a unified 4+1 model (preventing any rigorous marketing to date) within ECMS, four schools will be introducing this model for 2010. The School of Mechanical Engineering (offering Aerospace, Mechanical and Mechatronics at Masters level), The School of Electrical and Electronic Engineering, The School of Chemical Engineering and the School of Civil, Environmental and Mining Engineering all firmly support the initiative.

Despite the lack of widespread advertising and marketing, student interest has been high. While news of the degree has spread amongst the student body via the grapevine, over ninety emails have been received requesting further information in Mechanical engineering alone. ECMS remains optimistic that it will be a popular program.

Conclusion

Regardless of the mathematics of 3+2 or 4+1, the answer remains the same: 5. The bar has clearly been raised for European Professional engineers, who are now obviously expected to have a Master of Engineering Degree. The writing on the wall, which is plain to see, is that the same will happen in

Australia. However, both pathways have their own benefits. The Melbourne 3+2 model closely adheres to the Bologna method and so students may more easily be able to commence their education in Melbourne and complete it in Europe (or visa versa). It also delays the need for the student to decide on a specialised area of engineering until they are better informed to do so. However, it is expensive for universities to implement and carries a large risk with respect to its popularity (amongst both Australian and International students). On the other hand the 4+1 model is far easier for universities to introduce with far less risk. The existing four year programs remain, and only the additional year requires careful design to ensure that it meets the educational expectations of a Masters program. This may either provide a long term permanent solution or even a transitional solution, if the three plus two model ends up becoming the favoured widespread model across Australia. Both programs will be equally attractive to international students. Both offer a two year opportunity to study in Australia towards a world class qualification, although the Adelaide variant also offers a Post Graduate Diploma as a “one-year escape strategy”. The authors are obvious stake-holders in the Adelaide four plus one model, but were not intent on implying it is better than the Melbourne Model, merely that it is a workable option. Evidence strongly suggests that the focus for professional engineering qualifications is about to change from Bachelor Degrees to Master Degrees and every engineering university should therefore be making plans towards this, one way or another. Exactly how this occurs needs to be wisely debated and researched so that Australian engineering education ultimately emerges as a world leader.

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