A Lucrative Export Engineering Education: Down Under

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ABSTRACT

Education has become an Australian lucrative export. It is therefore necessary to write this paper to tell readers more about this export. A lot of literature has been found to describe education in primary and secondary education in Australia but only one about engineering education up to first degree level is available and it was published in 1990, i.e. pre-Dawkin era in higher education. This paper mentions the programs available for year 10 school leavers to professional engineers holding master's degrees; it starts with Technical and Further Education (TAFE) colleges, followed by the newly formed Australian Technical Colleges. Universities were lastly mentioned and the description was divided into three sections of first degree, master's degree and doctorate degree. It appears that Australian Technical Colleges would likely be absorbed into the TAFE system by the actions taken by the present government. The future education and training of professional engineers are likely to end up with the 3+2 year bachelor-master model. Professional engineering doctorate will likely become widely available to future professional engineers but Doctor of Philosophy (PhD) program will still be there.

Keywords: *Professional Engineers, Engineering Technologists, Engineering Officer, Bachelor of Engineering, Bachelor of Engineering Technology, Associate Degree, Advanced Diploma, Diploma, Certificate III, Certificate IV, Master's Degrees, Doctor of Philosophy, Professional Engineering Doctorate and Engineering Doctorate.*

INTRODUCTION

Australian third export, in monetary, is education, next only to coal and iron ore. Many Asian students come to Australian shore to pursue high schools and the number is increasing. However, the most lucrative export to this country is higher education. A lot of students from India and China come here to study engineering at TAFE, undergraduate as well as postgraduate levels. It is therefore worthwhile to write a paper in engineering education downunder and have it published in an Indian prestigious journal to inform the parents of potential students. In Australia, the secondary school system covers year 7 (8 in Queensland) to year 12 of a child's education. Secondary schools are divided into state and independent, including Catholic schools. Any children can leave the system after the age of 16 (17 in Queensland) (Young, 1990). After year 10, students can leave the system if he or she is ready to take on an apprenticeship. At the end of year 12, students will be required to take part in some form of public external examination to get a score for entry into universities or TAFE colleges to study in the areas they prefer. This paper will discuss engineering education only and it will cover programs suitable for year 10 school leavers to those holding master's degrees in engineering. The occupational categories for engineering profession vary from trades people, technician (engineering officer), technologist (engineering technologist) to professional engineers. The academic qualification requirements differentiate the occupational types; the trades people and technicians are mostly educated through TAFE and Australian Technical Colleges (DEST, 2008); the last two categories of the profession are trained in universities.

So far, nothing has been mentioned about Institutes of Technology (IT) and Colleges of Advanced Education (CAE) because all of them had gone through amalgamation initiated by the former Education Minister, John Hawkin to universities or universities of technology depending on whether they are Colleges of Advanced Education or Institutes of Technology respectively, e.g. Swinburne University of Technology (Blackall, 1992).

Down Under, the higher education (university) sector currently has sole responsibility for education to the first two levels of the profession, through 4-year (or equivalent) post-secondary school professional engineering awards such as the Bachelor of Engineering (B.Eng.), and 3-year engineering technology awards such as the Bachelor of Engineering Technology (B.Eng.Tech.) respectively; some universities termed the latter as Bachelor Technology (B.Tech). The university sector shares responsibility with the vocational education and training sector (VET) for providing award programs for engineering officers or technicians, through 2-year Associate Degrees and Advanced Diplomas in the university and VET sectors respectively (Carrick Institute, 2008).

AFE COLLEGES

Technical and Further Education colleges is a vital element of Australia's post school education and training system and is funded largely by the States and Territories. The Commonwealth money accounts for about 9% of the recurrent funding and about 65% for the capital funding. Courses vary from entry-level training, specialized instruction and vocational training prior to employment to adult education courses available for personal interest and leisure (Blackall, 1992).

TAFE colleges offer a range of courses: skills training in a trade; courses specially tailored to industry or government needs; vocational training; program to help people get back into studying or work; and enrichment programs. The awards given for a pass in a TAFE course mirror the educational level and duration of the course. There are numerous training and skills formation programs that can be taken up at TAFE. They fall into three categories: (Blackall, 1992).

- Trade training systems;
- The Australian traineeship systems; and
- Industry training support.

Engineering programs provided by TAFE colleges consists of Certificate Level I, Certificate Level II, Certificate Level III, Certificate Level IV, Diploma, Advanced Diploma, Vocational Graduate Certificate and Vocational Graduate Diploma.

USTRALIAN TECHNICAL COLLEGES

The Australian Federal Government is funding Australian Technical Colleges across Australia in areas where there are skills needs, a high youth population and a strong industry base. They were first established in 2006 by the former Howard government. These Colleges cater for years 11 and 12 students who wish to study for their Year 12 certificate and start an apprenticeship whilst still at school (Australian School-based Apprenticeship). The Colleges support students through both academic and trade training; with mentoring, career advice and business and employability skills. These courses are all developed with industry input to ensure that the training offered will be relevant for local needs (Australian Technical Colleges, 2008a).

Students enter into an Australian School-based Apprenticeship in a trade at the Certificate III level, which leads to a nationally recognised qualification; study academic subjects, leading to a Year 12 certificate; and also gain IT, employability and business skills, enabling them to run their own business if they desire. They can also keep the option to go on to further study at university.

The Colleges provide an incentive for more students to stay on at school and encourage more students to pursue a trade qualification. They expand student choice by providing another pathway to a career involving trades. Facilities and educational services offered by the Colleges are high quality, establishing them as centers of excellence in trade training, thereby raising the profile of vocational and technical education in schools and strengthening the training system a whole. They are mainly concentrated in NSW and Victo Each College offers training in at least four of the followi priority industry areas (Australian Technical Colleges, 200 2008b):

- Metal and Engineering (including machinis fabricators, toolmakers, welders, sheet me workers)
- Automotive (including mechanics, au electricians, panel beaters, vehicle painters)
- Building and Construction (including bricklaye plumbers, carpenters)
- Electro technology (including refrigeration, a conditioning, electrician)
- Commercial Cookery

Local industry and community representatives have leadership role in the governance of each of the Colleges. T direct involvement of industry and community lead ensures that the skills taught to students match those sk required by local businesses. Students will be trained in the skills through an Australian School-based Apprenticesl which leads to a nationally recognised qualification. At t same time, students will also complete the academic subje required for their Year 12 certificate. Students will gradu from the Australian Technical Colleges with a Year certificate and substantial progress towards a nationa recognised vocational qualification under the Australi Qualifications Framework through a series of Statements Attainment (Australian Technical Colleges, 2008b).

As students will be undertaking apprenticeships in trac which normally take up to four years full-time equivale they will not complete these in two years on a part-time bas They will complete their training with an employer and public or private Registered Training Organisation after th graduate from the College. It is possible for the vocational a technical education undertaken as part of an Australi School-based Apprenticeship to be counted towards student's tertiary entrance ranking. However, there a significant differences in the structure, organisation a assessment processes that lead to tertiary entrances acr Australia (Australian Technical Colleges, 2008b).

The new Rudd Government will honor all existing contra for established Australian Technical Colleges until the end 2009. In the lead up to the period when contracts in pla between the Australian Government and individu Australian Technical Colleges expire, the Government will down and consult with the various interested parties a establish the best way of folding the management of t Colleges back into the State-based educational systems th will be done in a systematic, cooperative and orderly way make the best appropriate arrangements for individu Colleges and the relevant local community. This might be t State secondary school system. It might be the TAFE syste But equally, it might be the independent or the Catho secondary school system. It may also be the case th Australian Technical Colleges continue to operate with t management from private industry (Australian Techni Colleges, 2008b).

On the other hand, the new Government will address skills shortages through the founding of the Trade Training Centres in Schools Program which is an important element of the Commonwealth Government's Education Revolution. It will provide $2.5 billion over 10 years to enable all secondary schools to apply for funding of between $500,000 and $1.5 million for Trade Training Centres. The Australian Government will provide $84 million over four years to enable interested secondary school students participating in vocational education and training in years 9 to 12 to access one day a week of on-the-job training for 20 weeks a year (Australian Technical Colleges, 2008b).

NIVERSITIES

In Australia, universities are mainly funded by the Federal Government, fees charged to international and domestic students. The share of non-government contribution has increased significantly in the past 10 years to 2008 and it constitutes 60% of the universities' income now. In addition to educating and training professional engineers and engineering technologists, universities train advanced and research-orientated professional engineers by offering master's and doctorate degrees.

First Degree

Australia's current pattern of professional engineering education, established around 1980, may be insufficient for the initial educational formation of future professional engineer; industry and the Engineers Australia College boards, asserted that moves towards a five-year award are either desirable or inevitable. With the current system, universities, particularly the regional ones, are faced with the apparent pressure of having to fit more into the curriculum, many contributors to the present study stated that the first degree must concentrate on foundation material, leaving more contextual or technically advanced material to postgraduate studies. In addition, several signatories of the Washington Accord have committed to extend the duration of their professional engineering programs within the next two decades. The Engineering Council UK requires a Master of Engineering (MEng) qualification, normally awarded after four years of study in England and Wales, and five years in Scotland to qualify as a graduate professional engineer (Carrick Institute, 2008). In continental Europe, engineering education is rapidly adopting the bachelor-masters-doctoral system. To expand the pool of available students and the globalization of economy, society, industry, and education, some programs are being taught in English. Traditional universities are introducing the bachelor-masters program to exist in parallel with their existing 5-year engineering programs. Fachhochschulen (University of Applied Science) are adding master's programs and expanding into research and development. A stated objective of these changes is to better compete worldwide for students, prestige and money (Yeargan and Hernaut, 2001). Engineers Ireland, has declared that an accredited engineering program will require five years post-secondary education for graduates from 2013. Australia is already moving towards this direction slowly. A good example of this model is the 5-year BEng/MBioMed Eng engineering program at the University of New South Wales. The 'new generation' 3+2 year University of Melbourne model is a variant on this pattern, with the first component being one of four three-year bachelor awards, none explicitly in engineering. Students wishing to progress to the two-year MEng take appropriate major studies within their bachelor program. In this latter model it is the 3+2 year program sequence that ultimately delivers the accredited, professional engineering outcome (Carrick Institute, 2008).

Another two cycle model operates at the University of Ballarat in which students first complete a 3-year Bachelor of Engineering Science (B.Eng.Sc.) (accredited at the engineering technologist level), with articulation possible to the 2-year Master of Engineering Technology. The combined five-year sequence of study has been accredited by Engineers Australia at the professional engineer level (Carrick Institute, 2008). This is also the model proposed by the Dean, Faculty of Engineering and Surveying, University of Southern Queensland (USQ). This aligns with the European adoption of the two cycle 3 year + 2 year Bologna program model in which qualification for entry to professional engineering is after the second cycle, normally a masters degree (Yeargan and Hernaut, 2001). The USA will not be left alone as the US National Academy of Engineering (NAE) has proposed that entry to professional engineering will require a masters degree qualification awarded six years after the completion of secondary schooling. The NAE report observes that engineering is the only American profession that does not require a master's level entry qualification (Carrick Institute, 2008). There is no alternative; the American also has to change to either 5-year Bachelor of Engineering program or 6-year bachelor-master program. Professional engineers are expected to be the leaders of engineering teams, and of the profession, and undertake a diverse range of responsibilities and roles. Therefore, requiring them to study more in engineering and generic skills is not too demanding.

Double degrees in engineering-science, engineering-arts, engineering-commerce and engineering-management have proven particularly attractive to school leaves, particularly women; they provide students and graduates with broader study and career options. Some of Australia's most brilliant students have chosen to take engineering in dual degree formats, and have progressed to high-level careers (Carrick Institute, 2008).

So far we have discussed programs leading to professional engineers, but it is understood that many jobs in this country are at technologist level. Some employers do not know the existence of BEngTech program and feel obliged to employ BEng graduates to perform the tasks of engineering technologists because they have to pay more. Another reason for employer emphasis on the professional engineering qualification is the perceived need for graduates to progress to the Stage 2 competencies and to acquire registration on the National Professional Engineers Register. Under state and federal legislation, registration is required for the conduct of defined engineering functions whose outcomes have inherent and potential risks to the public (Carrick Institute, 2008). Other than that, there is no reason to recruit BEng graduates to perform the duties that can be done by

technologists. This is particularly true when the supply of professional engineers in this country is far from enough. The society has to spend more time and money to train professional engineers.

Carrick Institute (2008) claimed that most of the industry participants and professional groups recognised a need for workers at levels between VET trained and professional graduate. However, academic groups were much less enthusiastic, and even strongly opposed to their schools responding to the 3-year qualification concept, unless they had built such a program successfully to satisfy local needs, such as at the University of Ballarat, University of Southern Queensland, and Central Queensland University. A common view was to leave technologists and technicians to the VET sector. This view exhibits a lack of understanding of the graduate level required of technologists, and the opportunities that exist to offer programs at Associate Degree level. USQ needs the two programs because these graduates will usually enrol in USQ BEng program later in their life.

Master's Degrees

Most Australian universities award master's degrees after four semesters of full-time study for graduates of 3-year bachelor's degrees but these degrees are not necessarily recognised by Engineers Australia for Stage 1 competencies for professional engineer because Engineers Australia does not accredit stand -alone master's degree. Such awards are regarded to provide a professional development pathway for existing graduates, rather than upgrading their professionalism.

There are 117 engineering master's coursework programs, varying in duration from 2 to 4 academic semesters equivalent full-time coursework. Many programs are nested with graduate certificates and graduate diploma awards. The programs are provided by a range of delivery methods, including by distance-education, and some are operated in collaboration with internationally-based universities. Most of the programs incorporate project work, in some case up to 50% of the total program time. Many programs also allow for students to take undergraduate courses, as part of their master's program. Most of these are conversion programs, either for engineering graduates to change to another branch of engineering or for graduates without an accredited professional engineering degree to gain a qualification that would be recognised by Engineers Australia at professional engineering entry level. The graduate attribute outcomes may be closer to a first degree. However, some are discipline specialisation, focussing on in-depth technical material, and possibly oriented towards postgraduate research studies, with normal entry qualification being a four-year engineering degree (Carrick Institute, 2008).

International students dominate many of Australia's postgraduate programs, having a sixfold increase in numbers of 1996 to 2006. Many of these students have the expectation that their programs will assist their immigration into Australia, ultimate employment in the engineering profession. Many international students are surprised, however, by the absence of program accreditation at the professional engineering level for some of the master's programs described earlier (Carrick Institute, 2008). Th recognition is by individual circumstances. Fortunately, mo Master of Engineering Technology (M.Eng.Tech.) graduat with project option of the University of Southern Queenslar had their qualification recognised by Engineers Australi It is good to hear that Engineers Australia has declared i commitment to examining program accreditation of maste awards. However, the typical stand-alone three-semest masters program tends to focus on technical content, rath than these broader attributes as required by the four-ye BEng program for professional engineers. Their recognition in doubt unless the first degree of the international student included as part of the evaluation; this becomes recogniti by individual case as in the case of M.Eng.Tech. of US graduates.

Having strong specialist postgraduate coursework program a measure of higher education quality in some countri Australia's engineering education enterprise is generally we in this regard. Under the Skilling Australia's Defence Indust (SADI) initiative the Commonwealth government supporting defence industry companies to have speci postgraduate award programs delivered to employees usua on-site. A notable feature of one such program is the ME (Military Systems Integration) at the University of Sou Australia. A second approach that exploits the expertise several universities is the Defence Science & Technolo Organisation's (DSTO) postgraduate Continuing Educati Initiative (CEI). This is an example of quite complex industr university and private sector cooperation, involvi coordination of programs and courseware from seve Australian universities. Several academic groups expresse the concern that the general lack of specialist advanc programs in engineering signals a fundamental weakness Australian engineering industry (Carrick Institute, 2008). Th is true but it can be argued that it is not easy for Australi universities to develop such taught master's cours individually because of the small population dispersed in large area of this country.

Regarding research student numbers, it was found th Australia has fewer BEng graduates progressing to resear degrees than is desirable or comparable with internation institutions. Domestic graduate progression rate is 5 - 7% recent years. This figure is highly tentative, and assumes th initial research candidature is at master's level, which may n be the case across the system (Carrick Institute, 2008). O reason for the lack of attractiveness to research engineeri degrees by domestic candidates is the tremendous drop in t stipend of the scholarship; it had dropped from 75% to or 40% of a first year engineering graduate salary in the last tw decades (Ku and Ross, 2008). Looking at total research degr enrolments, the figure of 5,413 in 2006 is small for a potent supervision complement of 2,831 teaching and resear academics. Having more research degree students adequate quality would undoubtedly strengthen Australi engineering research (Carrick Institute, 2008).

Doctorate Degrees

Doctoral degree provides training and education in resear under appropriate supervision, with the objective

producing researchers capable of conducting research independently, at a high level of originality and quality. A doctoral student should uncover or create new knowledge by the discovery of new information, formulation of theories, development of new approaches, or the innovative re-interpretation of existing ideas, theories or approaches. The University expectation regarding the length of time taken to complete a PhD is three years EFT (36 months). Candidates can apply for an additional two or more, six month EFT extensions. Maximum duration for the Victoria University is four years EFT (48 months), (Victoria University Handbook, 2008a).

Professional Doctorate is a research degree that focuses on the issues and problems of a particular profession. It includes up to one third of assessed work as coursework, which supports the development of the thesis. This degree has the objective of developing a student as a professional able to research into their professional field at a high level of originality and quality. The professional doctorate provides education, training and development to assist candidates to uncover new information or insight within their professional area (Victoria University Handbook, 2008a).

Doctoral education in engineering Down Under is still predominantly 'PhD-driven' model now because of the high amount of resources in government funding. This model is relatively unconnected to industry or the professions in any formal or substantive way. The result is a dominant model of doctoral training that is university-focused and university-driven. The traditional PhD is a university award, administered by a university's Research Office (Kemp, 2004). In addition, PhD is not a single 'program', but rather caters for a wide range of variation (Pearson and Ford, 1997). The majority of current academics in Australia have undertaken their doctoral training in PhD programs. In addition, the PhD is familiar to industry and industry associations. Most of these PhD graduates will end up working in Universities, Commonwealth Scientific and Industry Research Organisation (CSIRO), Australian Research Council (ARC) and other research organizations as lecturers or research fellows respectively (Ku and Ross, 2008).

Universities Down Under offer engineering research degrees for which a thesis or other work is the major component of assessment and these include the Doctor of Philosophy Degree (Ph.D) and Professional Doctorates, e.g. Engineering Doctorate offered by the University of Southern Queensland, and Doctor of Petroleum Engineering offered by the Curtin University of Technology (VU, 2008b; USQ Handbook, 2008a; Curtin Postgraduate Courses Online Handbook, 2008). The entry requirements for both types of doctoral degrees are usually master's degree or an honours degree (normally first or upper second class) in a relevant engineering or science discipline.

As Doctor of Engineering (Eng.D), Doctor of Technology (D.Tech), Doctor of Business Administration (DBA) and Doctor of Education (Ed.D) are all professional doctorate for engineers. It is therefore worth mentioning some of their general characteristics. Professional doctorates have been defined as a program of research and advanced study, which enables the candidate to make a significant contribution to knowledge and practice in their professional context, in which the candidate may also contribute more generally to scholarship within a discipline or field of study. The nature of many professions means that they very often draw upon a number of disciplines to create a basis of knowledge, rather than professional knowledge being contained within a single discipline. Professional doctorates need to be trans disciplinary in order to be of substantive value to the profession that it is attempting to serve. Professional doctorates must seek to extend or even transcend a number of fields (Green et al., 2001; Kemp, 2004). As indicated by Green et al. (2001) and Kemp (2004), professional doctorates are a significant addition to the tertiary sector's research training curriculum, but they are not the alternative PhD.

Therefore, there are an increasing number of calls to provide more for doctoral education in universities and they need to be more industry focused. Professional doctorates are reasonably new in Australia, having only first emerged in 1991. Whilst there has been a willingness on the part of universities to expand the number of professional doctorates offered to around 131 in 2001 (McWilliam and Taylor, 2001; Kemp, 2004). There is less evidence available to support claims that there has been an improvement in doctoral education through the pursuit of effective industry and university partnerships.

Engineering Doctorate seems to be the most appropriate name given to a professional engineering doctorate program for engineers. After some literature survey, it appears that the Group of Eight (Go8) research intense universities except University of Western Australia do not offer such or similar programs to engineers. She offers Doctor of Engineering in Information and Communication Technology. It is a 3- year full-time or its part-time equivalent program. This professional doctorate draws together a mix of advanced postgraduate coursework and research across the broad range of Information and Communications Technology (ICT). Research preparation for the doctoral thesis is provided by the coursework units and the substantial individual project in Stage 1 (equivalent to the Master of Engineering in Information and Communication Technology) of the program. Stage 2 is for thesis preparation (UWA Handbook, 2008).

As far as the five technological universities are concerned, Curtin University of Technology offers Doctor of Petroleum Engineering (Curtin Handbook, 2008); the Faculty of Built Environment and Engineering, Queensland University and Technology (QUT) and Royal Melbourne Institute of Technology University (RMITU) jointly offer Doctor of Project Management. Candidates in the program will have access to the expertise and resources in both institutions. The Doctor of Project Management is a three year professional doctorate degree, designed for candidates to consolidate and better understand their existing skills and knowledge on how to manage projects, while drawing from their professional experiences and real life scenarios for research initiatives. Students will are expected to be holders of masters degree from a recognised university in an appropriate discipline area such as an MBA, project management, logistics, IT or engineering where the fundamental elements of business and

project management have been studied (QUT Handbook, 2008a). Swinburne University offers Doctor of Design program which recognises the practice of design as a legitimate form of research i.e. it consists of creative work undertaken in a systematic manner leading to the generation of new design 'knowledge'-ideas, images, processes and products. All candidates are expected to demonstrate satisfactory progress on an annual basis. To be assessed for a Doctor of Design, candidates must present a designed outcome and project document carried out under Swinburne staff supervision. This program can, of course, be enrolled by professional engineers working in design environment, e.g. product design. The program consists of two parts: stage 1 is for one semester and students must undertake Advanced Design Research Methods and pass all assessment tasks before applying for the Major Design Research Project in semesters 2 to 6 (Swinburne Handbook, 2008).

As far as the eight publicly funded universities in Queensland, Australia, University of Southern Queensland (USQ) is the only university that offers EngD (USQ Handbook, 2008a). Of the Group of Eight research intensive universities in Australia, none of them provide Engineering Doctorate programs. However, most of them offer higher doctorate in engineering.

The linkage between doctoral programs and professional and industry bodies for professional doctorate programs can be understood in terms of two broad typologies: 'surface' and 'deep' (Ramsden, 1992; Biggs, 1999). The majority of Australian professional doctorate programs exhibit a surface level linkage with the professional bodies and/or industries with which they claim to engage (Neumann, 2002; Kemp, 2004). McWilliam and Taylor (2001), and Kemp (2004) pointed out that 'surface' engagement allows for continued alignment of the 'alternative' model with PhD-driven models, a position that is much easier to defend within internal university accreditation processes. Therefore, an emerging criticism is that most Australian 'alternative' doctorates do not exhibit 'deep' links with industry partners. There is no evidence that programs evolve in ways that move them from 'surface' to 'deep' engagement. Kemp (2004) also claimed that there is no evidence of attempts by universities to move from the current 'surface' approach to a 'deep' approach within the near future; the lack of inter-institutional partnerships and inter-disciplinary partnerships within and across institutions is also perceived by the professions and industry as a serious inhibitor to realising 'deep' engagement and 'legitimacy' of professional doctorates. This is disappointing but recent study has shown that this is changing slightly. The Doctor of Project Management offered by QUT and RMITU is an example of the move towards 'deep' linkage between institutional partnerships. An inter-disciplinary example is the Doctor of Engineering in Information Communication and Technology offered by the University of Western Australia, in which the disciplines of engineering, computing and mathematics are involved. Moreover, these examples are drawn from professional engineering doctorate only. Other professional doctorates may have more 'deep' linkage. However, the trend for change is still too slow because the European Union has founded virtual institutes to do make 'deep' linkage between member countries and geographically dispersed industrial sectors (Howes, et al., 2004).

Another problem facing the Ph.D full-time degree programs is recruitment of suitable and good domestic candidates. The first factor affecting to the recruitment problem is the amount of stipend given to a full-time Ph.D candidate; in 1990 the scholarship is approximately 75 % of a first year engineering graduate salary (Young, 1990). Now, the stipend is only 40% of the salary of a fresh engineering graduate. This is why many bright domestic engineering graduates are not willing to team up for the programs. The second factor is about the career prospect of PhD degree holders most of whom will end up working as post-doctoral fellows or lecturers in universities in Australia and working for the starved sector (universities) as research and teaching fellows is not a rewarding career as implied by the current Education Minister Julia Gillard (The Australian, 2008a). Most of the scholarships are therefore taken by migrant engineers who do not hold degrees from English speaking countries and would like to upgrade themselves with an Australian Ph.D to improve their employability. It can be argued that this is not too bad as the future Ph.D holders will come from a broader base of the population and a large proportion of future lecturers of this countries will be migrants, this is particularly true for regional universities.

Doctor of Engineering or Doctor of Science or Doctor of Applied Science is the degree conferred to outstanding candidates by different universities in this country and most of the members of the Group of Eight research intensive universities confer Doctor of Engineering (UNSW Research, 2008; QUT Handbook, 2008b; UWA Handbook, 2008; Monash Handbook, 2008; U of Adelaide Handbook, 2008, U of Melbourne Handbook, 2008). University of Queensland awards Doctor of Engineering (DEng) to a candidate in recognition of his/her substantial original and distinguished contributions to engineering knowledge. It is a research program and requires part-time attendance of 0.5 year. It appears that the University would like the candidate to use the 0.5 year to prepare a pile of documents and submit it for the examination of DEng. DEng is the highest academic award in engineering; it gives formal public recognition to professional engineers and thereby enhances their authoritative standing (UQ Handbook, 2008).

ISCUSSIONS

As far as TAFE colleges are concerned, it appears that the current Rudd Government will let them perform their original duties with main funding coming from the State and Territories. It is also possible that the new technical colleges will be absorbed into the system to avoid chaos in the sector.

It can be argued that the intention of the previous government to set up Australian Technical Colleges was to introduce competition to the state-controlled vocational education and training system so that better efficiency can be attained but with the final aim of taking over the vocational education and training sector to the Federal Government and integrate it with higher education sector, e.g. Swinburne University of Technology with her TAFE sector. This will eventually make

the articulation of programs from the vocational education and training sector to higher education smoother and cheaper.

The current 4-year professional engineering program is praised by many employers because of its strong focus on design and project work (Carrick Institute, 2008). This is indeed higher than most overseas engineering programs, e.g. four-year program in the USA (Yeargan and Hernaut, 2001). These graduates also have generic qualities such as problem solving, project management, communication and teamwork skills expected by the business community. Most engineering schools have intensified their industry advisory systems in relation to program and course development. This is a key issue in the revised engineering accreditation process.

The review discussed the merits of having fewer large schools, and expressed doubts about the viability of some of the smallest regional schools unless they address niche markets. This is true and USQ tried to offer BEng and BEngTech in small number of disciplines using its expertise in e-learning and distance education. The number of external students has been increasing in double digits in the past three years with the number of day students remained unchanged. The BEng had been offered totally external by employing innovative residential schools (Morgan et al., 1999). This will be further developed to include remote access laboratories to cut costs for students, hence increasing the competitiveness of USQ engineering programs (Goh, et al., 2008).

The four-year full-time course equivalent must remain the minimum requirement, but diversity must be encouraged. Many universities have, as proposed, facilitated entry of students from non-traditional backgrounds through relaxation of prerequisite subjects, with bridging programs and flexible entry paths, and do provide articulation and credit transfer arrangements with industry, the VET sector, and other engineering program providers (Carrick Institute, 2008). It appears that the Ballarat's 3+2 year bachelor-master model to be more acceptable than the Melbourne's one because students who do not want or do not have the ability to pursue the master's program can exit with an engineering technologist qualification which is very marketable in Australian industry. Another reason is that the Ballarat model mirrors the Bologna's one. This will enable Australia's higher education sector to go on to complete with a single European Higher Education Area consisting of 46 countries, particularly in the lucrative area of wooing international students (The Australian, 2008b)

Undergraduate teaching dominates the effort of engineering schools, being 78% of all student enrolments in 2006. Since 1996, undergraduate enrolment growth of 25.5% was overshadowed by postgraduate coursework growth of 128%, most of which is from international enrolments. In fact the number of domestic postgraduate coursework students has changed very little, from 4,029 to 4,430 over that period. Almost all of the growth in undergraduate commencements since 1996 has been in international students: from 1,650 to 4,156, compared with domestic undergraduate commencements increasing from 10,944 to 11,140 (Carrick Institute, 2008).

The most notable change in staffing for the decade to 2006 is the high growth of research-only staff numbers, with this category being 40% of the total academic staffing complement in engineering in 2006; many of the originally teaching and research positions have been changed to contract position rather than continuing after a probationary period. The decline in the number of support staff has been mostly from workshop and laboratory technical support functions; this jeopardises the teaching in the practical side of the program. The decreasing proportion of engineering graduates seeking to progress to higher degree research and towards academic careers, thereby weakening prospective staffing in engineering schools (Carrick Institute, 2008). This problem can be relieved by attracting migrant engineers, provided Australia remains a prosperous country and can attract engineers from all over the world, e.g. India.

It was reported that many universities offering the 3-year programs at the engineering technologist level have experienced very low demand from school leavers because there is a clear perception that the 3-year engineering program is in some way an inferior outcome, in some cases a fallback exit point for students not coping with the Bachelor of Engineering. However, the program is an opportunity for some trades people and technicians; they want to progress in the ladder of career in engineering profession but do not have the mathematics skills and science knowledge to challenge the BEng program and BEngTech program will be their initial and only choice. USQ have enrolled a large number of such candidates and those holding Advanced Diplomas from TAFE colleges to her BEng program and they will be given advanced standing. Depending on the courses studied in the previous programs, they will get at around 12 courses of exemption and will need only to study 12 courses for the award of BEngTech. Those with Associate Degrees from universities will usually need to study 8 courses for the award of BEngTech. This is not to discriminate TAFE graduates because exemption is granted on a course-to-course basis and Associate Degrees are usually the subset of BEngTech. If the courses studied by TAFE Advanced Diploma holders can match the 16 course of BEngTech offered, there is no reason why they cannot study 8 courses and be qualified for the award of BEngTech. In general, it was not agreed to design BEngTech program as the first three years of a four year BEng program because they are for different occupation category in engineering workforce (Carrick Institute, 2008).

Another point worth mentioning is the contribution by students towards their engineering degree education has increased from $ 2000+ per eight courses to $ 8000+ in the period of 1996 to 2008, a fourfold increase. This is unfair to students as they and their parents have paid heavy income tax and goods and services tax (GST) to the Federal Government. It is hoped that the current government should do something reduce the burden of the students and their parents.

With the implementation of University of Ballarat or University of Melbourne model, it can be argued that Australia needs to develop more professional engineering doctorate programs with exit point at Master of 'Advanced Engineering' for those who have completed the coursework component of the program. Herrera (1997) suggested that master level is a

requisite for the doctoral program because the courses taken during the master's level provide the theoretical basis for the doctorate students, and also their master thesis provides important basis for their doctoral research. This is in line with the modified doctoral program suggested above (Ku and Ross, 2008).

Wiggins (1984) indicated that a doctorate is necessary to teach undergraduate engineering courses because students and staff surveyed by him felt that a PhD was of some importance in teaching undergraduate engineering courses. Therefore, PhD in engineering programs should be continued and supported strongly to supply new blood to Australian engineering or technological faculties but increasing stipend to 75% or more of the salary of a graduate, and increasing funding to universities is a must to attract best brains from domestic and international engineering graduates. Therefore, it can be argued that PhD program in engineering will exist side by side with professional engineering doctorate as PhD program will still supply most of academics of the Faculty of Engineering because of its research-focus characteristics.

Since engineering education or Australian education as a whole is a lucrative export for Australia, it is necessary for the sector to maintain its world-class standard to ensure that th 11 billion dollars export is not jeopardized. It can be argue that the government must also maintain its policy permitting good graduates with professions in great deman to stay here.

ONCLUSION

It appears that Australian Technical College may disappear from Australian vocational and training education sector because it mat create chaos in the system. This is good in the sense that State Governments will still be responsible for the administration and funding of the vocational and training sector; this is to avoid the Federal Government to obtain too much power. As for the professional engineering education and training, it appears that the Ballarat model and the Melbourne model will exist in parallel with smaller and regional universities joining the Ballarat model and the bigger universities, including the Group of Eight research intense universities joining the Melbourne model. Both will have their pros and cons and markets. Students will also have more choice.

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