

Crossing boundaries of disciplines: double degrees vs. combined degrees vs. specialisations

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Abstract

High complexity of technical systems requires multi-skilled teams of engineers to design and build them. Universities offer a large variety of courses that include double degree courses, combined courses, dual award courses and specialisations (minors and majors within existing courses). In mid-60s of the last century the common trend was to produce graduates with general engineering knowledge. Specialist knowledge was acquired in work environment. Nowadays universities offer elective units to support specialisation. The financial pressure forced many universities to start courses restructuring and trying to find a compromise between necessity to give students a choice, support the concept of multi-disciplinary study and make courses sustainable. This paper discusses different options of multi-disciplinary study within the Faculty of Built Environment & Engineering at Queensland University of Technology (QUT), as well as their advantages and limitations.

1. Introduction

Modern market environment with increasing complexity of engineering systems requires multi-skilled teams of engineers to design a product fabricate it and provide maintenance ^[1, 2]. Increased computerisation and the use of solid modelling, FEA (Finite Element Analysis) and other specialised software packages put additional pressure on both students and the academic institutions.

Universities responded to market demand by offering double degrees in engineering over five years. Despite formal attractiveness, these double degree courses appeared to be unpopular because of increased period of study, accumulated HECS debt and difficulty in deciding the area of the career.

In late 80s, many universities introduced combined engineering degrees such as mechatronics, which is a blend of mechanical and electronic system engineering. Queensland University of Technology (QUT) went further and introduced a combined degree in infomechatronics, which is a blend of information technologies, mechanical and electronic system engineering. The main challenge was how to squeeze relevant contents from three disciplines in a limited space of curriculum subjects of the degree program.

About 50 – 70 years ago the main trend in engineering education was to provide general engineering knowledge. Specialist knowledge was acquired by engineering graduates in their work environment or in postgraduate study. Nowadays increasing amount of knowledge and increasing complexity of technologies demand that the acquisition of some of the specialist knowledge be done during tertiary study. Most universities introduced elective units that students take in years 3 and 4. A free choice of electives not necessarily gives a coherent knowledge in particular area of engineering specialisation. In response to this, five years ago

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QUT introduced minors consisting of four coherent units and majors comprising of eight units including a final year project. However, necessity to meet prerequisite requirements limits the number of students that can take these minors and majors.

Another challenge facing the Institution is that the multitude of main courses, minors and majors puts additional financial pressure and makes it less sustainable. Currently the Faculty of Built Environment and Engineering at QUT is restructuring its courses aiming to have a limited number of main-stream courses and a variety of minors and majors.

In this paper, the authors discuss advantages and limitations of different pathways in cross-disciplinary engineering education as well as lessons learned in managing double degree courses, combined courses and courses with minors and majors.

2. Different pathways in tertiary education

Most engineering courses in Australia are four-year Bachelor of Engineering Degrees (BE) or three-year Bachelor of Technology Degrees (BTech). Some universities (e.g. USQ) attempted to streamline these courses and introduced a BE Degree with a possible exit point after three years with BTech Degree. On the contrary, some universities (e.g. Monash University) discontinued BTech degrees. For graduates from Institutes of TAFE that have Advanced Diploma (or equivalent Degree) QUT introduced an articulation program to BTech Mechanical Degree, and also an articulation program from BTech to BE Mechanical Degree. In 2003 QUT introduced a Dual Award Degree jointly with three Institutes of TAFE. Under this arrangement students study approximately 1.5 year at TAFE and another 1.5 year at QUT. Within three years students get an Advanced Diploma from participating Institute of TAFE and BTech Mechanical Degree from QUT.

In the late 80s and mid-90s many universities introduces double degrees when within five years graduates acquired two degrees. In some cases two engineering degrees were combined, in some cases engineering and the law. For students thinking of postgraduate study Master's Degree is available (by course work or by research). To streamline this process and attract good students in 2002 QUT introduced the Dean's Scholar program for students with OP level 1. In this program students in four years (10 semesters including two summer semesters) acquire BE Degree and Master's Degree in either Engineering Science or Engineering Management.

In the last 20 – 30 years most universities introduced a variety of elective units. In general, students could take any elective unit even outside engineering area with the approval of the course coordinator. Some universities (e.g. QUT) started grouping four units aiming at coherent delivery of certain specialisation (minor) or even eight units including a final year project to form a major within BE Degree. Multi-disciplinary education required team teaching to deliver specialist knowledge in different areas of engineering ^[3].

Advantages and limitations of each pathway will be discussed in the following section

3. Experience with Different Pathways in Engineering Education.

3.1 Double Degrees

Many universities in Australia introduced double degree programs in the late 80s and late 90s. The reasons for introducing double degrees were:

- There was a decline in students entering engineering programs.

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- To attract students who wish to have multi-disciplinary skills.
- To provide training in complementary disciplines to fast track the students to be work ready with multiple skills.

QUT introduced the BE(Manufacturing Systems)/B.Bus(Marketing) in 1988 ^[4,5,6]. It was recognised that majority of Australian manufacturing industry, especially in Queensland, can be categorised as Small to Medium Enterprises (SME) employing no more than 25 employees. Manufacturing and Management functions are often performed by the same person(s) of the enterprise. Thus, these SME require person(s) with manufacturing systems understanding as well as conversant with marketing, management and business skills. To satisfy this requirement of the SMEs, QUT introduced the double degree program. At that time this was an innovative approach to engineering education. Further, it was recognised that to obtain both skills one has to obtain a degree in engineering and acquire the business and marketing related skills through self study or a post graduate program. This often takes too long and expensive. The curriculum of this double degree program comprise of 20% basic sciences, 30% engineering sciences, 20% engineering applications and 30% business, marketing related units over 5 years. The curriculum satisfies the accreditation requirements of Engineers Australia and the BE(Manufacturing Systems) component of the program was fully accredited after 5 years of introduction in 1993. Since then four more double degree programs with engineering were introduced at QUT

Even though these double degrees were popular initially, over the years students find it difficult to focus their studies for five years continuously. This led to a decline in student enrolments. The BE/B.Bus program was eventually discontinued in 2002. Another reason for the decline of BE/B.Bus is that the high school students did not have the correct information about the program despite considerable effort by the Faculty to promote the course. The double degree students due to their involvement in industry based projects in their final year acquired better graduate capabilities and had no difficulty in finding jobs at graduation. Despite the positive outcome, the program had to be discontinued due financial pressures on the School. The student numbers in other double degree programs are also small. However, these programs uses existing units from the main single degrees and do not have specific units. Thus, there is no additional financial burden on the School. It is apparent that the double degree programs are being phased out at many universities.

3.2 Combined Degrees

As a result of not being able to sustain the double degrees programs and pressure from industry, universities start to design courses that combine disciplines in a single degree program. The Faculty of Built Environment & Engineering at QUT, over the past few years, introduced Infomechatronics, Medical Engineering, Computer Systems Engineering, Telecommunications Engineering and Software Engineering. The different disciplines in these programs are: Mechanical Engineering, Electronics Engineering, Information technology, Human movement studies (within Health), Computing Science.

Infomechatronics

Since the late 1980s many universities have introduced courses in Mechatronics in recognition of the growing demand for engineers who have the skills to design, develop, build and service machinery/ devices that combine electrical phenomena and mechanical structures. In the last decade microprocessors and information technology have profoundly changed the

nature of machines, creating the need for an engineer knowledgeable in the areas of, electrical and electronic engineering and mechanical design and fabrication and increasingly information technology. In order to acquire the combined knowledge, graduates in mechanical engineering will have to either get the required knowledge on the job or another undergraduate qualification or a post graduate diploma in either Electronics and/or information technology. To address this deficiency, QUT introduced a 4 year bachelor's degree in Infomechatronics in 2000 ^[7]. The program had its first graduates in early 2004 and again in early 2005. The students seem to enjoy the course due to its variety. It is again evident, through student focus groups, that the industry at large is finding it difficult to comprehend the nature of these combined courses. This is despite many industries, which specifically require the combined skills in their workforce. Informal meeting with the students in these combined degrees also revealed that due to the wide area of study, the expectations are quite individual. Some see it as specialisation in robotics and automation, some see it as specialisation in computing & related science, and some see it as mechanical with some basic knowledge in other disciplines. This leads to the difficulty in maintaining a stable curriculum. The student quota for these combined degrees is limited. Therefore, every student does not have the option to pursue the specialities if they want to do so.

3.3 Dean's scholars

The Faculty of Built Environment and Engineering at QUT had its first intake into the Dean's scholars program in 2002. This program was introduced mainly to attract high calibre students with the following aims:

- To raise the profile of engineering and to raise the overall capability of the entire cohort of engineering students.
- To attract students, who on completion would turn to research; thereby raise the research profile of the institution.

School leavers who obtained an OP (Overall Performance) score of 1 (1 -25 scale with 1 being the top of the cohort) with a rank cut off at 99 (0 – 99 scale) are eligible to apply for the Dean's scholar program. The successful students will receive a HECS free education for 4 – 4.5 years and receive a Bachelors Degree in Engineering and a Master's Degree in either Engineering Science or Engineering Management provided that they maintain an overall GPA (Great Point Average) greater than 5.5 throughout their study program. There is a high demand for this program from the school leavers. The quota and the number of first preferences in the application for admission to the university in the past three years are 40/34, 40/117, 19/55 respectively. So far the students are coping well with the studies and the extra work load in some semesters with good performance.

3.4 Dual Award Degrees

A Dual Award arrangement Advanced Diploma / Bachelor of Technology, Mechanical was introduced in 2003 jointly by QUT and three Institutes of TAFE: Moreton, Yeronga and Brisbane North Institutes of TAFE. A Dual Award arrangement in civil engineering was introduced at QUT in 2002. The main idea behind of this arrangement was to combine benefits of the tertiary and TAFE systems and reduce the cost of study. In particular, these benefits are as follows:

- The Dual Award course combines the advantages of both the TAFE system with its focus on hands-on, practical experience and the university system with its balance of theory and practice.

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- Students enrolling in the Dual Award course have a gradual introduction to University study.
- Multiple possible exit points.
- Students can complete both TAFE and QUT awards in three years at much lower cost than with direct entry to university.
- The proposed Dual Award program enables high school students to take TAFE units as electives while still at school and obtain credit where appropriate.
- Students will receive enhanced training in Computer-Aided Design (CAD) at TAFE, as well as developing strong practical skills in the use of modern production equipment.
- The early exposure to CAD, CNC machining equipment and the applied focus of the first two years of the program should assist students in gaining part-time employment before completion of the Dual Award program.

Three Institutes of TAFE were given individual quota for students' enrolment. The direct entry to QUT BTEch course had been discontinued. Advanced Diploma courses at Institutes of TAFE were retained. Thus, students have a choice to enrol in a Dual Award program or to do AD course first and then the Articulation program at QUT. In the latter case students have to study 3.5 years compared to three years in a Dual Award course.

Main difficulties and problems encountered during introduction of the course were as follows:

- On the second year of study students have to do both QUT and TAFE units in the same semester, which caused some timetabling problems.
- The current Australian legislation does not allow students from overseas to enrol simultaneously at two institutions, which prevents overseas student from taking the Dual Award course.
- Some students doing the TAFE part of the Dual Award course thought that they could fail as many units as they want and still be eligible to continue their study at QUT. A memorandum of understanding was prepared where clear conditions were specified how many, and what TAFE units students can fail and be eligible to continue study at QUT.

To address the current issues and manage the Dual Award course a management committee was established including Course Directors from participating Institutes of TAFE and QUT representatives (Head of School, Course Coordinator, officers from student services).

3.5 Specialisations (minors and majors)

In the last 20 – 30 years most universities introduced a variety of elective units. In general, students could take any elective unit even outside engineering area with the approval of the course coordinator. In most cases course coordinators encourage students to take elective units offered by their School or Department. In some cases engineering students are forced to take electives outside engineering. The availability of electives gives students an opportunity to take units of their choice. Main limitations of this system are as follows:

- Provision in the curriculum for electives in particular semester does not guarantee that an elective unit of interest is offered in the same semester.
- In some cases electives require to take prerequisite units first.
- Free choice of electives does not guarantee a coherent delivery of material required for specialisation in particular area.
- Under financial pressure large number of electives becomes unsustainable.

To address these issues in 2002 QUT introduced minors. Each minor includes four relevant units that form a specialisation in particular area. For example, the Design minor includes the following units:

- MMB281 Fundamental of mechanical design.
- MMB381 Design of mechanical components.
- MMB472 Design for manufacturing 2
- MMB232 Material technology

Another example is a minor in maintenance engineering, which includes the following units:

- MMB382 Design and maintenance of machinery.
- MMB353 Tribology.
- MMB413 Industrial noise and vibrations.
- MMB470 Engineering asset management and maintenance.

Both minors in Design and Maintenance engineering have become popular among the students. Large cohort of mechanical engineering students takes the Maintenance minor. The Design minor is taken by Electrical engineering and Industrial design students.

In 2003 A major in Engineering Management has been introduced within BE Mechanical Degree, which includes eight units. The final year project is among these eight units.

Despite the minors and majors give students a choice, under financial pressure relatively large number of minors and majors become unsustainable. In 2005 the Faculty of Built Environment and Engineering at QUT started restructuring of all courses aiming to streamline and minimise the number of main stream courses and offer a choice of minors.

4. Closing remarks

As discussed above, the Faculty of Built Environment & Engineering of QUT offers a large variety of cross-disciplinary courses. Double-Degree courses are still offered, however they are not that popular as initially expected and are being phased out. Large number of elective units, minors and majors becomes unsustainable. Combined degrees are a way to cater for the multi-disciplinary engineering and related skills required in many industries. However, small quota for combined degrees is preventing students in the single degrees to have the flexibility to specialise. Under financial pressure that many universities experience, a reasonable solution seems to be to limit the number of main stream courses with minors in various allied disciplines. A recent review of the Faculty of Built Environment and Engineering at QUT has recommended a re-organisation and rationalisation of the courses. Accordingly, a unified curriculum structure is being proposed with two or three main stream courses with major areas of study with the requirement that all students will take a minor consisting four inter-related units in a discipline of choice. The minor will give students a choice and provide coherent delivery of specialist knowledge. This unified curriculum structure allows diversification and still keeps it sustainable.

5. Conclusions

In this paper different kinds of cross-disciplinary courses have been discussed, such as Double-Degree courses, Combined Degrees, Dual Award courses, specialisations, minors and majors, based on QUT experience and experience of other universities. Advantages and limitations of each option are analysed. Faculty of Built Environment and Engineering at QUT is implementing a unified curriculum for all the courses within the Faculty consisting of

three degree programs with different major study areas such as Mechanical Engineering, Electrical Engineering or Civil Engineering. The curriculum also gives the student the freedom to choose a minor (four units) and experience another discipline or possible specialisation in an allied discipline,

Reference:

[1] Kosse, V., Ma, L., and Mathew, J. “The teaching of asset management and maintenance”, Proceedings of the 9th Asia-Pacific Conference of Engineering Management Educators, October 2002, Brisbane, Australia.

[2] Kosse, V. and Mathew, J. “Undergraduate education in condition monitoring – current trends”, Proceedings of the 2nd Asia-Pacific Conference on System Integrity and Maintenance (ACSIM 2000) and Exhibition, 23-25 August, 2000, Nanjing, China.

[3] Kosse, V., and Hargreaves, D. “Roll modelling team work through teaching of mechanical design”, Proceedings of 14th Annual Conference of Australasian Association for Engineering Education, 29 September – 1 October 2003, Melbourne, Australia.

[4] Wong, W.C.K., (1987) “ Development of an Innovative Programme: Double Degree (B.Eng/B.Bus) in Manufacturing Systems and Management”, Conference on Engineering Management, September 23 – 25, Brisbane, Australia.

[5] Mahalinga Iyer, R. and Wong, W.C.K., (1992), “ A review of the BE/B.Bus Degree in manufacturing Systems and Marketing Programme at QUT”, First Australian Conference for Engineering Management Educators, April 22 – 23, Session 4, Sydney, Australia.

[6] Mahalinga Iyer, R. and Wong, W.C.K., (1994), “Seven Years experience with the Innovative BE/B.Bus Double Degree Program at the Queensland University of Technology”, Proceedings of the Fourth Triennial Conference of AEESEAP, November 13 – 16, Papua New Guinea.

[7] Yarlagadda, P. K. D. V., Sitte, J., Ternel, I., and Wong, W.C.K., (2000), “INFOMECHATRONICS: Design and Development of First Undergraduate Inter-Disciplinary Engineering Course in Pacific Region”, Proceedings of the 2000 Pacific Conference on Manufacturing, September 6 – 8, Detroit, Michigan, USA.