

Fast Tracking New Courses in Mechatronic Engineering

Robert L Fulcher and Christopher P Snook,
Faculty of Engineering and Surveying,
University of Southern Queensland

Abstract

In Australia, the discipline of mechatronic engineering continues to develop as educators and industry leaders attempt to define its scope and function. Flexibility in course design is essential if undergraduate courses in mechatronic engineering are to keep pace with these rapid changes. An effective approach is a modular course design based on subjects taken from the traditional disciplines of mechanical and electrical engineering. This requires a faculty organisational structure that is able to transcend the financial and political disincentives for co-operation that normal occur between the traditional disciplines.

Keywords:

Mechatronics, modular, course design, distance education.

1 Introduction

The term Mechatronics is derived from the words *mechanics* and *electronics* and has come to mean the combination of mechanical, electrical and electronic engineering through the design process. To develop the concept of Mechatronics further, it is useful to state two definitions espoused by the IEE/IMEchE Mechatronics Forum, namely:

- 1) Mechatronics is the synergistic integration of mechanical engineering with electronics and intelligent computer control in the design and manufacture of products and processes.
- 2) Mechatronics is the design and manufacture of products and systems possessing both a mechanical functionality and an integrated algorithmic control.

Whilst these definitions provide a useful focus for discussion, there are many more definitions in common use, and the precise nature of mechatronics continues to be debated. However, the common theme through all definitions is that mechatronics is a design philosophy built over a solid foundation of knowledge, spanning many

of the traditional engineering disciplines. In this way it could be argued that mechatronics is all things mechanical engineering and all things electrical engineering; indeed, that mechatronics is good engineering design and that the traditional mechanical and electrical engineering courses are mere specialisations of mechatronics.

2 Mechatronic engineering education in Australia

The Institution of Engineers, Australia (IEAust), is the major body responsible for the registration of engineers in Australia. A cornerstone of this process is that the IEAust accredits acceptable four-year bachelor of engineering courses that lead to "graduate" membership of the Institution. A "graduate" member with appropriate post-graduate experience can apply for full or "chartered" membership of IEAust. Whilst the IEAust allows for alternate pathways to membership, the four-year bachelor of engineering degree remains the most common.

2.1 Undergraduate courses

At the undergraduate level engineering education in Australia is provided by the following three course types:

- 1) Two year associate degrees to train paraprofessional "engineering officers";
- 2) Three year bachelor of technology courses to train "engineering associates"; and
- 3) Four-year bachelor of engineering courses.

Over the past decade, Australian Universities have created a number of bachelor of engineering courses with a major in Mechatronics. These courses have quickly come to be accepted by new students (especially school leavers). Of the 24 engineering schools at Australian universities, thirteen offer some form of Mechatronics major in their Bachelor of Engineering courses. These courses are listed in table 1.

- All of these mechatronic courses are built on the traditional engineering disciplines of mechanical and electrical engineering. None was an entirely new course designed from the bottom up.
- Seven of the courses (Curtin, Deakin, JCU, UNSW, USQ, USyd, Monash) are presently accredited by the IEAust [1].
- The USQ course is fully accredited by IEAust for on-campus, mixed and distance education modes of delivery.
- There is a roughly equal balance of mechanical and electrical engineering subjects in the core engineering material in eight of the courses.
- Four of the courses appear to be predominantly mechanical engineering.
- The course at the USA is predominantly electronics, indicated by the course name of electrical and mechatronics engineering.

- Most courses are owned by the mechanical engineering department.
- Approximately 80% of the courses include new subjects (introduced when or since the course started) specifically in the mechatronics area.
- Most of the mechatronic engineering majors were developed from a department that had existing research strengths in the mechatronics/robotics area. This provided a ready resource of their capstone project and provided teaching staff and infrastructure for the undergraduate subjects.

In addition, many of the Universities offer a five year combined degree in bachelor of engineering (mechatronics) and bachelor of commerce, business, or computer science.

Table 1 Mechatronic engineering courses in Australia

University	Course Name and Parent Department	Core units emphasis (Mech/Elec)
Curtin University of Technology (Curtin)	Mechatronic Engineering, School of Mechanical Engineering	70/30
Deakin University (Deakin)	Mechatronics, School of Engineering and Technology	50/50
James Cook University (JCU)	Mechatronic Engineering, Discipline of Mechanical Engineering	70/30
Monash University (Monash)	Mechatronic Engineering, Gippsland School of Engineering	50/50
Queensland University of Technology (QUT)	Infomechatronics, School of Mechanical, Manufacturing and Medical Engineering	60/40
University of Adelaide (UofA)	Mechatronic Engineering, Department of Mechanical Engineering	50/50
University of New South Wales (UNSW)	Mechatronic Engineering, School of Mechanical and Manufacturing Engineering	80/20
University of South Australia (USA)	Electrical and Mechatronics Engineering, School of Electrical and Information Engineering	30/70
University of Southern Queensland (USQ)	Mechatronic Engineering, Discipline of Mechanical and Mechatronic Engineering	50/50
University of Sydney (USyd)	Mechatronic Engineering, Department of Mechanical and Mechatronic Engineering	50/50
University of Western Australia (UWA)	Mechatronics Engineering, Department of Mechanical and Materials Engineering	50/50
University of Western Sydney, Nepean (UWS)	Mechatronics, School of Mechatronic, Computer and Electrical Engineering	50/50
University of Wollongong (UOW)	Mechatronic Engineering, Department of Mechanical Engineering	50/50

(Source: Search of the WWW site of each University)

2.2 Postgraduate courses

Postgraduate coursework degrees are rare for Australian students because government funding via the HEC scheme is not available. Nonetheless, there are some courses (eg a Master of Engineering Technology) that are designed to allow an existing degree-qualified student to sit for a second major in mechatronic engineering. This mainly consists of advanced undergraduate subjects appropriate to the mechatronics discipline that the student would not have done as part of their first degree. These coursework masters are only available to full-fee paying students and are almost exclusively the domain of overseas students.

Postgraduate research degrees are more common, provided the student achieves sufficient grades to earn a postgraduate scholarship or similar funding sources. Most Australian universities award HECS exemption scholarships. The precise training then depends on the academic supervisor, the scope of the project and the support facilities that are available. This mode of "mechatronic" training appears to have been successful over the course of time (otherwise today's practitioners might not exist).

3 Industry response

For the most part, industry appears to be uncertain of the value of, or capability of, bachelor of engineering (mechatronic) graduates. There are very few positions that are advertised as a "mechatronic engineer". It appears that industry more readily recognises graduates of the traditional courses (eg mechanical, electrical, electronic engineering) where the courses around Australia have very similar content. In other words, industry believes that it knows what it is getting. The mechatronic engineering courses around Australia offer more diverse content and so comparing graduates from different institutions is more difficult.

It is clear that industry wants "those kind of skills" because many job advertisements demand a base degree in mechanical engineering with three years electrical experience or a base degree in electrical engineering with three years experience in mechanical engineering systems. There appears to be a shortage of such skilled practitioners and in many cases, the employer takes a new or recent graduate and provides "on the job training". Mechatronics courses are yet to fill this void en masse.

4 Case study - The Faculty of Engineering and Surveying at USQ

In April 1992 Professor John Billingsley joined the staff of the Faculty of Engineering and Surveying at the University of Southern Queensland (USQ). He, as a Professor of Robotics, introduced the Faculty to the term, "mechatronics" which had rarely been heard beforehand [2]. The mechatronic engineering major

was introduced at USQ in 1995 [3]. A bachelor of technology course was considered briefly but not developed.

At USQ a very pragmatic approach was taken with respect to designing a bachelor of engineering (mechatronics) course by a simple amalgamation of appropriate subjects from the existing and mature mechanical engineering and electrical engineering courses; and using practical work and the major project unit to integrate them.

4.1 Background

The Faculty of Engineering and Surveying at USQ is a zero department University organisation. This is quite different from the tradition departmental structure. Here the disciplines of agricultural, civil, electrical, mechanical engineering and surveying coexist in an integrated structure under a single Dean who has full control of courses, staff and resources. Each discipline is led by a Head who, amongst other duties, is charged with the educational delivery of discipline-specific courses. These courses are made up of subjects (called units at USQ) offered by the Faculty and cover all the forementioned discipline areas. Thus disciplines have nominal boundaries but are easily transcended when selecting subjects for a particular course and major. Moreover this structure allows new engineering majors to be simply created when a perceived need to do so occurs. Thus with this ability, two new Bachelor of Engineering majors were offered in 1995; environmental engineering and mechatronic engineering.

4.2 History of enrolments and graduates

The new course, Bachelor of Engineering (Mechatronic Engineering) was launched in 1995. There were eleven new student enrolments and nine students transferred from other undergraduate majors, mainly mechanical and electrical. The course is offered on-campus and via distance education.

High school students and specific industries were been targeted for enrolment promotion. A special promotional tour of secondary high schools was undertaken to demonstrate the specific mechatronic developments of the Faculty with a view to, firstly, show people what mechatronic engineers can do and secondly to attract new students. It should also be noted that this course exists with a background of postgraduate research in the mechatronics area. This gives ample opportunity for undergraduate projects and quite useful access to software and test facilities. A specialised laboratory has been created for mechatronic engineering that services most of the practical work in the mechatronic engineering course, provides infrastructure for the honours project work and also supplements the existing research laboratories.

4.3 Analysis of course performance

Initially it was hoped to have an annual new enrolment of about twenty students in total. In actual fact this has reached about 25 after two low start up years. A mid year intake of overseas students from FRIS in Malaysia has meant half our day mode students are full-fee paying while the remainder are grade twelve leavers. The external intake consists of overseas students and industry-based mature age students.

4.4 Evolution of USQ mechatronic engineering course

The first year of the course was subsequently rearranged to align the first year of the course with the electrical major rather than totally mechanical major, thus giving better balance for new students; allowing students to “belong” to a larger student cohort in their first year; and making class timetabling simpler. This change was simple to implement since the subjects were all under the control of the faculty.

Practice units were introduced in 1998 from electrical and mechanical majors in the first and second years and a specialist mechatronic practice unit in the third year was created to integrate the hands on experience in the course.

New electives were introduced without affecting core subjects. Engineering management studies was split into two subjects to strengthen this area of study and the honours project was given two credit points to increase its importance and acknowledge the student effort therein.

4.5 Case study summary

The Faculty of Engineering and Surveying at USQ has a unique structure, which allows easy cross-teaching between disciplines. This structure, as well as the assistance of Professor John Billingsley, has been utilised to fast track the formulation of a mechatronic engineering course.

Several positive changes have improved the course over the past five years and led to increase enrolments both in day and external modes. Moreover, the unique external mode is serving a market not served by other Universities. The course has found some popularity with students in Malaysia especially from FRIS. Through the Institution of Engineers, Australia accreditation process the course compares well with similar courses in Australia and has proven to compare well in the international market.

On a negative note, evidence suggests that the total number of students enrolling in engineering at USQ has not changed and that there is some bleed off from the traditional majors into this “new” mechatronics major.

5 Conclusions

Many Universities in Australia have embraced mechatronic engineering throughout the advent of bachelor of engineering courses. In all cases this has been parented by a traditional mechanical or electrical engineering department. At USQ this has been similarly done but for both day mode and for external students via distance education. Moreover, the faculty zero department structure has allowed very low cost fast-tracking of course development and subsequent modification. The IEAust accreditation process has “quality assured” these courses, and ensured an appropriate standard.

This fast tracking, however, has hindered the development of mechatronics as a discipline in its own right. To many, mechatronics is seen as an “add-on” to the traditional disciplines. Industry, therefore, has not seen it as a distinctive specialisation and has not generated a significant demand for this type of graduate (yet).

If mechatronic engineering wants to come of age in Australia, a significant change needs to take place, firstly within the tertiary education sector and then extrapolated into industry. Otherwise it is doomed to be forever an extension of the traditional mechanical and/or electrical engineering disciplines.

References

1. “Index of current accredited courses in professional engineering”, Institution of Engineers, Australia, 2000. <http://www.ieaust.org.au>.
2. Billingsley J, “Mechatronics - An Integrated Discipline”, University of Southern Queensland, June 1993.
3. “Submission to the Institution of Engineers, Australia for the Accreditation of Major Studies in Environmental Engineering and Mechatronic Engineering in the Bachelor of Engineering Programme - Provisional Recognition”, University of Southern Queensland, Faculty of Engineering and Surveying, Document No ES012/94, September 1994.