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## **Mechatronic Engineering By Distance Education**

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### ***Abstract***

*The number of students undertaking tertiary studies by distance mode in Australia has been steadily increasing over the last decade. The Faculty of Engineering and Surveying at the University of Southern Queensland (USQ) is a renowned leader in distance education and extended its offer of bachelor of engineering programs to external mode in 1988. A Mechatronic Engineering program became a part of this offering in 1995 and has grown steadily over time, especially with overseas students. The USQ distance education model is presented within the context of the Bachelor of Engineering degree programs. A typical external student profile is presented and an analysis of student demand for this mode. A brief assessment of the success of this study mode is made and its positive aspects highlighted especially with respect to Mechatronic Engineering. Finally how this mode of study complements face-to-face teaching is presented and indeed how this might be the case nation wide.*

### ***Keywords:***

*Distance education, mechatronics*

### **1. INTRODUCTION**

The University of Southern Queensland (USQ) is a major provider of tertiary courses by distance education, with 75% of its 22,000 students studying in external or "off-campus" mode [2]. The Faculty of Engineering and Surveying, a foundation faculty of USQ's predecessor DDIAE<sup>1</sup> in 1967, shows a similar distribution of on-campus (day) and external enrolments in its 2500 students.

The Faculty has a strong commitment to providing quality higher education opportunities to as broad a cross-section of the Australian community as possible. The Faculty offers accredited engineering and surveying programs that meet the needs of industry and the wider community for associate, paraprofessional and

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<sup>1</sup> Darling Downs Institute of Advanced Education

professional positions. In addition, a number of postgraduate programs are also available by coursework or by research.

The Faculty has successfully completed an Institution of Engineers, Australia reaccreditation of its Bachelor of Engineering programs in 2001 and now has full accreditation for the external as well as on campus mode. The Washington Accord Committee recently visited the Faculty to observe its model for engineering education in a distance mode and was impressed with its commitment to a quality educational process.

The Faculty of Engineering and Surveying has an organisational structure whereby overall financial and academic control is vested in the Dean and Associate Dean portfolios. There are no separate departmental structures; instead academic staff are grouped into related disciplines under the direction of an appointed Head of Discipline. The Discipline of Mechanical and Mechatronic Engineering is responsible for the academic delivery of a number of programs including those in the area of mechatronic engineering.

## **2. MECHATRONIC ENGINEERING**

### **2.1 Program Structure**

The mechatronic engineering program can be studied on-campus or by external study mode or a mixed mode combination of the two. Progression through the program is on a course-by-course basis. Each course or subject of study (nominally one credit point) represents approximately 155 hours of student effort, and a full time on-campus workload is four credit points per semester [3]. Students studying part-time (either on-campus or externally) are advised to undertake two units per semester.

### **2.2 Practice Courses**

In a recent major restructure of all of the Faculty courses, the bulk of the practical work was distilled from individual subjects (formerly 175 hours effort) and condensed into a number of “practice courses” [4]. Each of these practice courses (zero credit point) require approximately 50 hours of practical work from the student.

One generalist practice course is offered in the first year of all programs and two professional practice courses are designed specifically for final year Bachelor of Engineering students completing their undergraduate research project. In addition there are three practice courses that concentrate on specific skills required within the mechatronic engineering discipline. A further “mechatronic practice” course acts as a capstone that provides an opportunity to integrate the skills and knowledge developed earlier in the program [5].

On-campus students normally undertake their practice work throughout the year. External students normally attend an intensive one-week on-campus residential school during a mid-semester break.

Planning for this new approach to practical work commenced in 1994, based upon earlier USQ research into the objectives of practical work [1]. The practice courses were first offered in 1998 and have already proven to be very popular

amongst most staff and students. Prior to 1998, many individual courses included a residential school component and often a student might have attended a residential school each semester of their study. The cost of travel, accommodation and time off work was significant for a student who might only have been required to attend for one or two days of residential school each semester. The new practice courses have streamlined this process, and in the mechatronic engineering discipline provided opportunities to add more practical work into the course. This increase in practical work is rare amongst the Australian tertiary sector.

### **3. USQ DISTANCE EDUCATION MODEL**

USQ has a team approach to designing and developing external study materials. This team is normally comprised of a team leader and other content experts from within a Faculty; and an instructional designer (ID) and a materials development officer (MDO) from a separate department called the Distance Education Centre (DEC). Faculty members deliver the course content, normally based on their on campus teaching materials, while the ID assists in the design of the educational process, and the MDO looks after the formatting of materials to a USQ standard.

The USQ policy of 'flexible delivery' means the design team aims to provide educational materials independent of place and time and in a medium best suited to the students. The range of media incorporated in a USQ "study package" include:

- Print (eg a study book)
- Audio tape
- Video tape
- Teleconferencing (audio, audio graphic, video)
- Computer Managed Learning/Computer-based exercises
- CD-ROM multimedia presentation
- Computer mediated conferencing
- Internet material

#### **3.1 External Study Package**

External study packages consist of a number of different materials which maybe divided into four sections; introductory booklet, study book, ancillary material and general administration correspondence.

The introductory booklet contains the course specification (including specifying text book requirement), course overview, lecturer communication policy, assessment and general information, a copy of all assignments and at least one past examination paper.

Study books either present the total content material for the course; or are companion material to a textbook (a guide on the side); or are a book of selected readings. A solutions manual may also be included for review questions in the study book. The study book is normally the main body of the external study package.

Ancillary materials may include videos, audiotapes, diskettes containing computer managed assessment or software, or a CD containing all of the aforementioned materials which complement the study book material.

General administration correspondence such a residential school timetable is also included.

### 3.2 Distance Education Centre (DEC)

DEC is a centralised, University agency that acts as a resource for content experts to use in designing and developing materials, production of external packages, mailing of materials to students, processing student enquires (Outreach) and organising residential schools as shown in Table 1.

Instructional Design	Assistance by professional instructional designers
Production	Word processing of text
	Production of graphics
	Production of AV materials
	Printing of manuscripts
Mailing	Mailing of Study Materials
	Management of receipt and return of assignments
Student Enquiries	Outreach Services
Residential School Organisation	Outreach Services

**Table 1. DEC Functions**

DEC maintains the master copy of all external materials; schedules their maintenance; and facilitates the development of any new materials. Normally a 12 months of lead-time is required for these processes.

### 3.3 International Office (IO)

A special office has been set up for overseas students called International Office. In recent times, with the rapid increase of overseas, external students, IO has been instrumental in facilitating the enrolment and liaison with these students and hence has supplemented the role of DEC in this regard.

### 3.3 Model Deviations

These days' academic staff within Faculties who have developed several external packages, now have the expertise to do their own instructional design and with readily available publishing software can even format materials in a print ready format. This tends to reduce the need for the ID and MDO input. Similarly, email correspondence with students negates the need for Outreach involvement other than receipt and dispatch of assignments.

## 4. TYPICAL EXTERNAL STUDENT

Firstly let us use a typical, commencing, on campus student as a reference (Internal) and compare characteristics with those of a typical commencing, distance student (External) as show in Table 2.

The typical on-campus student is generally a grade 12 leaver, is under 20 years of age, single, unemployed and their motivation is to gain a degree to get a job. Generally distance mode students are mature age, married with children, fulltime employed (often in an engineering company) and are strongly motivated to gain a degree for job advancement or retraining reasons.

<b>Characteristic</b>	<b>Internal</b>	<b>External</b>
<b>Age</b>	<20	>25
<b>Qualification</b>	Grade 12	Trade, Diploma
<b>Av. Retention Rate (1994 - 1999)</b>	87%	69%
<b>Overseas commencing (1996)</b>	14%	5%
<b>Overseas commencing (2001)</b>	29%	56%
<b>Motivation</b>	Get a job	Improve career
<b>Employment</b>	Mostly none	Mostly fulltime
<b>Funding (2001)</b>	HECS 70% Full fee 30%	HECS 44% Full fee 56%
<b>Gender</b>	Mostly male	Mostly male

(HECS denotes High Education Contribution Scheme)

**Table 2. Student Characteristics**

#### **4.1 Mechanical and Mechatronic Students**

A few typical examples of external student profiles within Mechanical and Mechatronic engineering can further refine this comparison. Firstly, a large proportion are Australian students (Queensland based) working in industries such as the sugar industry, power industry and public utilities. This group has completed all their education in Australia and in many cases are sponsored by their employer.

#### **4.2 Overseas External Student**

A second group are full fee paying overseas students normally from Asia. Overseas students are typically characterised as follows -

- Full fee paying
- Privately funded
- Completed a Diploma or Polytechnic program (thus up to 16 credit points advanced standing may be granted)
- Mature age
- English as second language eg from Singapore, Malaysia, Hong Kong
- Highly motivated

## **5 NOTED ASPECTS AND TRENDS**

### **5.1 Student Enrolments**

The majority of USQ enrolments in Engineering and Surveying are in the external mode of study (75%). Many of the Australian based students are from regional

Queensland. A significant number of enrolments in the BEng program are from overseas. Tables 3 shows the number of commencing students in the Bachelor of Engineering (Mechatronic) from 1997 to 2001.

	1997	1998	1999	2000	2001
ONC	17	15	7	20	15
EXT	6	7	14	12	18
Total	23	22	21	32	33

**Table 3. BEng Mechatronic Commencing Students**

Over the past few years the steady influx of overseas students has contributed to a dramatic increase in the number of students enrolled in the external offer of the mechanical engineering program. There has also been a gradual shift in enrolments from on-campus to external to the point where 80% of enrolments are external. This increase is lagging slightly in the mechatronic program with 62% of enrolments being via the external offer. The total number of enrolments in each mode is shown in table 4.

	Day	Ext	Total
<b>BEng (Mech)</b>	42	168	210
<b>BEng (M'nic)</b>	25	42	67
<b>BEng Tech</b>	33	109	142
<b>AD</b>	7	74	81
<b>Total</b>	107	393	500
<b>%</b>	21	79	100

**Table 4. Mechanical and Mechatronic Discipline Enrolments 2001**

### 5.2 Preferred Entry Points

It has been seen that most on-campus mode students prefer direct enrolment into the premier Bachelor of Engineering program. This is expected as most school leavers view the four years additional study as a logical extension of their earlier schooling. The majority of on-campus Mechatronic students follow this pattern. It is pleasing to note that a high proportion of these students have attained Honours in the BEng.

Most external student enrolments tend to come for full fee paying overseas students particularly from Singapore and Malaysia. There are also a number of external enrolments who have articulated into the mechatronic program from the mainstream mechanical majors of the associate degree and bachelor of engineering technology programs.

### 5.3 Student Migration Between programs

BEng mechatronic students sometimes move to the BEngTech (Mechanical) program if their academic progress is poor, either by their own choice or because they are instructed to do so [7]. Sometimes these students improve their performance and may be reinstated in the BEng program at a later date. Program changes such as these require careful consideration; otherwise a student may complete a course that cannot be credited to the BEng program.

#### **5.4 External Student Focus**

The focus of all program review and development activity since 1995 has been on designing programs for external students [8]. Currently external students make up about 75% of enrolments in the Faculty.

An example of this approach was the adoption of the Practice course concept previously mentioned in section 2.2 from 1998.

#### **5.4 Special Agreements**

In 1996, a twinning arrangement was put in place with FRIS in Malaysia to fast track mechatronic students to on campus mode at USQ. This model has since been extended to Singapore Polytechnic Diploma graduates for both on campus and external modes. Currently the external mode is the most popular with students entering into year three.

#### **5.5 Recognition of Prior Learning**

Like all other Universities, USQ recognises prior studies at similar institutions in Australia and for that matter worldwide. But because external students invariably have prior qualifications and are increasingly from all over the world, our recognition system for prior learning has been tuned for expediency as well as academic rigor. In many instances advanced standing protocols have been developed to basically automate this process at least for significant batches of students from known areas like Singapore.

### **6 HOW DO ON CAMPUS AND EXTERNAL MODES COMPARE?**

#### **6.1 Improved Teaching**

The changed focus on external student learning has arguably improved our teaching processes and systems to the extent that a specific student centred Faculty structure has evolved. Pastoral care of on campus students, which has always been strong, has now translated to external students.

#### **6.2 Student Flexibility**

Students now have such a range of choice of modes and programs that most foreseeable student circumstances (time, place, method) maybe accommodated by the student's own initiation.

#### **6.3 Market Funding**



The recent influxes of overseas students who are full fee paying have been a financial plus for USQ especially since Government funds have been reducing. Happily for engineering, there has been a market for our programs in Asia attracting full fee paying students and this certainly has made up some of the lost government funding. Nevertheless there are significant overheads in these markets so a careful financial system is needed to make sure a positive cash flow eventuates.

## **7 FURTHER COMMENTS**

### **7.1 Accreditation**

The current courses have accreditation with the Institution of Engineers, Australia as Associates, Engineering Technologists and Members respectively [9]. Students have an achievable, valuable qualification at their exit point.

### **7.2 Value Adding**

With the multiple mode model students can enter tertiary study at a level appropriate to their background and financial position. As they succeed in their studies they can progress to levels originally unattainable. Thus, value adding their knowledge well beyond the single on campus entry path.

### **7.3 Student Managed Learning**

Day mode students have a structured learning path over a relatively short time frame. Students enrolled in external mode have twice the time frame to complete their program and are free to develop an individualised study path. With this in mind, external students prefer to break their studies into manageable "chunks" or stages that nicely correspond to our value added model.

Day mode students can do this too, but it often occurs in the reverse direction. If their current course becomes too much for them then they can still transfer to a program of lower difficulty and achieve a university degree.

### **7.4 Minimising the Effects of Attrition**

Most engineering courses report high attrition rates at first year and in many cases throughout the course (eg [6]). With the multiple modes at USQ, a student who struggles in the BEng program due to financial or environmental reasons may transfer to a more appropriate mode. Thus, the student (and associated EFTSU) might not be lost. The flow of students into and out of the modes is usually balanced. The increase in retention rate for on campus mode over external mode is mostly attributed to a certain percentage of external students enrolling in courses but not participating. Mostly, this appears to be due to lack of time or priority setting and possibly over ambitious expectations. This occurs in first year courses but once over this hurdle they progress similarly to on campus students.

The introduction of problem based learning courses, especially at first level, is aimed at improving relevance of studies to students and thus improving student motivation and retention rates.

### 7.5 Life-long Learning

The flexibility of multi mode offerings reinforces the life-long learning paradigm. Students can see the relevance of their present course and can see where this material can be and will be extended in the more advanced courses. A number of "repeat customers" are presently enrolled who have previously completed other USQ programs. They see their present program as the logical next step in their overall professional development and can use the external mode to maintain this development through their working life.

### 7.6 Technology Push

The new communications technology (eg Internet) available to all is now pushing us to on line delivery of courses to students in any mode but obviously most applicable to the external mode. Email is already the preferred communication for external students. A few courses have already been developed for on line offering but enrolments so far for engineering have been small. Nevertheless this will be the future and skills and knowledge gained now with this new mode will be invaluable in times to come.

## 8. CONCLUSIONS

Over time, the distance education model has allowed mechatronic engineering students to access tertiary studies when they may otherwise never had the opportunity. The application of this mode has allowed students to achieve higher qualifications as well as expedited the general improvement of our teaching processes. The external student market has developed during the 1990's to include a significant proportion of overseas full fee paying enrolments. This has given us a market-funded incentive at a time when Government funding was decreasing. Recent full accreditation of Bachelor of Mechatronic Engineering in external mode by the Institution of Engineers, Australia using generic graduate attributes has endorsed the USQ model for this mode of study.

In the final analysis, the distance education model has arguably achieved successful outcomes for our particular student market.

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