Innovative Residential Schools for Engineering Degree Courses

A/Professor M.J. MORGAN, R.L. FULCHER and H.S. KU
Faculty of Engineering and Surveying, University of Southern Queensland, Toowoomba, 4350, Australia.

Introduction

The terms 'external studies', 'off-campus course', 'flexible delivery'[1], 'university without walls' and so on have been extensively used to describe courses offered by universities or colleges of advanced education through non-traditional mode of delivery. The media of delivery range from the use of traditional text books and study guides to the use of modern technologies like videos, CD-ROMs, computer mediated conferencing, the Internet, SMART 2000 video conferencing, computer managed learning, home experiment kits, computer simulation and experimental log books[2][3]. With some disciplines, particularly those not involving practical work, the above media of delivery are adequate but with science and technology based disciplines like mechanical engineering, attendance at residential schools for practical work becomes inevitable because by 'playing with' some hardware students can better understand the underlying principles of certain theories better, can reinforce their learning and enhance their design skills. In the Faculty of Engineering and Surveying (FOES), University of Southern Queensland (USQ), residential school sessions had traditionally been used as the major means of satisfying the practical requirement of engineering degree courses. Those residential school sessions were unit based and had brought with them inherited problems[3] and inconvenience to our students, particularly international students[4]. Course based residential schools, called *Practice* units, were therefore developed to cope with the problems and inconvenience. In this paper the term *course* is used to denote a systematic programme of study extending over a number of years that leads to the award of a degrees. The term *unit* denotes a component of a course that receives an official grade. A unit is sometimes referred to as a *module* or *subject* by other institutions.

Course Based Residential Schools

The Faculty of Engineering and Surveying offers programmes of study leading to the awards of Bachelor of Engineering, Bachelor of Technology and Associate Degree. For on campus students, these courses are of four, three and two years duration respectively. All courses are available by external study. Five course based residential school sessions, each of 50 hours duration, of which 40 hours are for practical work and 10 hours are for background reading, were developed for each discipline of the Bachelor of Engineering (BEng) course offered by USQ. One of the course based residential school sessions is the core unit, *Engineering Practice 1*, which develops basic engineering skills like instrumentation, measurement and analysis of data through a series of practical work exercises. This unit must be attended by all students of the Faculty, irrespective of type of degree courses[2][5] and of discipline area. In 1998, two modes of delivery of residential school sessions will be available. The on campus students will complete each unit by performing 4 hours of practical work per week over a period of 10 weeks; while the external

candidates will need to attend a continuous 40 hours of practical work over a period of one week for every residential school session.

In order to simplify our discussion, let us use the mechanical engineering discipline as an example. In addition to the core practical unit, *Engineering Practice 1*, there are four more practical units, *Mechanical Practice 1* through *Mechanical Practice 4.* Table 1 shows how the five practical units are taken by students from different types of award courses in mechanical engineering discipline. On campus BEng students, they will in *Engineering Practice 1* and *Mechanical Practice 1* in their first year of study, *Mechanical Practice 2* in the second year and *Mechanical Practice 3* and *Mechanical Practice 4* in the third. It should be emphasised that the *Practice* units do not solely foster the development of practical skills and expose students to engineering components and systems. These units will also be used to engender students in communication skills, teamwork skills such as negotiation, and time management skills. In the final year, all students in the BEng course will have another two project based residential school sessions, *Professional Practice 1* and *Professional Practice 2*[2]. In *Professional Practice 1*, students will be presented with research methodology for dealing with their dissertation; in *Professional Practice 2*, students will be required to present their project work to their peers and members of staff of the Faculty. Off campus BEng students will need eight years of part-time study to complete the course and their five non unit specific practical work and two project based residential school sessions will be so arranged that within 8 years of study they will need only to come to USQ a maximum of four times. For those who are able to have some of their course based practical work units done in their workplace or community, the number of their visits to the campus will be accordingly reduced and details of this arrangement will be discussed later.

Table 1. Course Based Residential School Sessions for Mechanical Engineering Degree Courses Students.

Courses / Practical Units	Bachelor of Engineering (BEng)	Bachelor of Technology (BTech)	Associate Degree (AD)
Engineering Practice 1	X	X	X
Mechanical Practice 1	X	X	X
Mechanical Practice 2	X	X	X
Mechanical Practice 3	X	X	X
Mechanical Practice 4	X		

Bachelor of Technology (BTech) on campus students will undertake *Engineering Practice 1* and *Mechanical Practice 1* in the first year of their study, *Mechanical Practice 2* in the second year and *Mechanical Practice 3* in the final year. As for the external students, they will need to come to USQ for their practical work at a maximum of 3 times in their six years of part-time study. Finally, the Associate Degree on campus students will do their four course based practical units over two years of their study; their off campus counterparts will need to come to USQ twice only, over a period of four years of their external study. The arrangement of the course based residential school sessions for the three types of degree course for on campus students may be changed in the future to suit the best interests of our students.

They may be rescheduled to coincide with those for external students and be carried out on a continuous 40-hour session over the period of one week during the semester break. This will give day students the chance to interact with their off campus counterparts and will give them the opportunity to learn more about workplace environment.

BEng Courses Entirely by External Study

Up to 1997, the BEng students at USQ could not complete their degree study by external study mode only. They studied the first six years of their part-time course externally and were required to come to campus six or more times intermittenly to perform their unit based residential school sessions. After that they were required to come to study for one year full-time on campus like the BEng courses offered by Deakin University[6] and Monash University[7]. With the implementation of our innovative residential school sessions in 1998, we are able to offer BEng courses totally by external study but at the same time satisfy the requirements of the Institution of Engineers, Australia for professional engineering courses [8][9].

Contents of Practice Units/Course Based Residential Schools

Now it is time for us to discuss the contents of the course based residential schools in detail. Students will be given a log book for each residential school session. Taking *Mechanical Practice 3* log book as our example, the topics in the log book include :

CNC/CAM:
- Task A NC Programming
- Task B Basic CNC Machine Operation
- Task C CAM for NC Programming

Metrology
- Task D Alignment Testing
- Task E Angle and Parallel Testing
- Task F _ _ _ _ _ .
- and so on.

To start with, students are informed about the topics and activities they are scheduled to undertake and what are their purposes. In one of the topics, Task E, students are required to demonstrate their competence in using an angle dekkor and some accessories to measure the included angles of different types of engineering components. It will be found that there are four tasks associated with that topic and they are listed as follows :

i) measuring the apex angle of a solid triangular block using an angle dekkor and with the aid of a set of slip gauges and angle gauges;
ii) measuring the included angle of a steel cylinder using an angle dekkor and a set of gauge blocks;
iii) measuring the included angle of a taper plug gauge using an angle dekkor with the aid of a protractor and a set of angle gauges;
iv) measuring the angle of a brass wedge with the aid of an angle dekkor and a set of

angle gauges.

Students will then be informed that they can claim exemption from the tasks if they have had the opportunity to measure the included angles of engineering components using an angle dekkor and its accessories in their workplace or community; they can also opt to do the measurements in their community or workplace rather than coming to the campus to have the tasks done. In both cases they will be required to fill in the information and diagrams or photos in the spaces following the description of the tasks. The student must fill in the name and the address of the company in which the tasks are carried out and have the claim certified by a responsible person of the organisation; the person certifying the claim will preferable be a Corporate Member of the Institution of Engineers, Australia or of equivalent standing in the country in which the student is enrolled. He/she then has to describe the procedures for carrying out the tasks as well as taking photos or drawing diagrams of the equipment and tabulating the results, as appropriate, in the space provided. A student may only be able to satisfy the requirements of the tasks of certain topics by prior experience; he/she will then be required to fulfil the remaining requirements by attending some of the course based residential school sessions. The detailed task requirement for Task C, CAM for NC Programming as stipulated in *Mechanical Practice 3* is attached below for reference:

Task C CAM for NC Programming

Introductory Comment

CAM is an acronym for Computer Aided Manufacture or Computer Aided Machining. The use of computers is ideally suited for NC program generation. This is particularly so where complex geometric interpretation is involved. Such a task is demanding, time consuming and subject to erroneous calculations when done manually.

There are numerous CAM software packages available. These typically facilitate two and/or three dimensional shapes requiring multi axial operation. Other features include graphical representation showing the cutter or tool path through the work piece.

This activity requires you to demonstrate competence in programming a Computer numerical-controlled (CNC) machine using computer-aided software to manufacture or machine a variety of components.

As an example the activity can be completed by designing a mechanical component e.g. puller base, which gives the scope to use a CAM package e.g. Auscadcam, for generating the numerical-controlled (NC) codes, for manufacturing the component using a range of CNC machine tools or a machining centre.

Task Specification

To prepare an NC program using computer software. This may be achieved by using a CAM package such as or similar to:-

- *AusCAD-CAM*
- *Smart CAM*
- *Master CAM*

or by conversational programming as found on many CNC machines.

Typical activities for this task include:-

- *the preparation of a component drawing on computer*
- *identifying and selecting the drawing elements representative of surfaces or areas to be machined*
- *formulating a machining plan by determining appropriate cutting tools and establishing a logical cutting sequence.*
- *verifying tool path by graphical simulation*
- *generating NC program for a specific machine*
- *producing plot of simulated toolpath*

COMPANY DETAILS

Company Name _____

Address _____

_____

Telephone : _____ *Facsimile :*_____

Responsible Officer (please print) _____

Position and qualifications of above person

_____

_____

Signature: _____ *Date:* _____

Dimensioned Drawing of Component

Name of Software OR Name and Model of Conversational Control Unit

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General Features of Software

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Photograph, Printout, or Plot of Tool Path Simulation

Basic Steps / Outline of Procedures for Program Preparation

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Program Printout (NC codes)

Comments on Results

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Conclusions

With the implementation of the course based residential school sessions, the University of Southern Queensland, one of the largest providers of distance education in Australia, will be the first university in this country[8][9] to provide professional engineering degree courses totally by external study; USQ may even be the leader in providing such education in the Asia Pacific region[10]. The innovative residential schools will be implemented for the first time in 1998 and we believe there will be room for improvement, and therefore suggestions and advice from the engineering education and engineering profession sectors are highly welcomed.

References

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