

Flexible Learning in a Cross-Border Environment*

T. M. MCGINNITY, L. P. MAGUIRE and L. J. MCDAID

Intelligent Systems Engineering Laboratory, Faculty of Engineering, University of Ulster, Magee College, Northland Road, Derry, N. Ireland, BT48 7JL, UK. E-mail: tm.mcginny@ulst.ac.uk

The development of multimedia, video-conferencing and Internet technologies presents educationalists with new opportunities and challenges. Fortuitously, these opportunities coincide remarkably closely to an increasing demand for more flexible models of learning and course delivery. This requirement is particularly strong in the electronic engineering and computing fields, where engineers are continuously faced with the need to update their skills and maintain their portfolio of expertise. This paper describes the development of a cross-border, postgraduate course which has been designed to take maximum advantage of WWW, e-mail and CD-ROM multimedia technologies, while addressing requirements for flexibility and cost-effectiveness.

INTRODUCTION

THE ADVENT of the Internet is provoking dramatic change in many areas of human activity, including electronic commerce, tele-working, and indeed aspects of social interaction. It would be naive of educationalists to assume that this wave of change will leave their teaching and learning strategies untouched; and it would be arrogant in the extreme to assume that such changes have nothing to offer us.

There has been considerable discussion in the literature of how best to utilise the opportunities presented by such technologies. These range from proposals for 'virtual universities' [1], to detailed discussions regarding applications of multimedia technology for lecture recording [2, 3]. Heng [4] discusses three models of the learning process, and attempts to map such models to information technology provision. It is worth noting that the educational opportunities afforded by these technologies are not solely of interest to universities. Jonsson [5] discusses the use of an intranet approach in producing corporate distributed education in a commercial context, while Rodriguez [6] applies the idea of a 'virtual class' to small and medium-sized enterprises.

Academic institutions seeking to provide facilities for engineer re-training and lifelong learning via postgraduate diplomas and Masters courses have two additional concerns to consider. First, in a time of stringent budgetary control in higher education, lower limits of student enrolment on modules and courses is a critical parameter in terms of course viability. The second concern is related to the availability of specialist expertise; most institutions have staff with specialist expertise in particular areas of engineering, but would not be

able to claim the availability of staff with international reputation across the broad engineering spectrum.

This paper describes the development of a course which has been designed to take maximum advantage of modern technology, for delivery by academic staff with proven expertise in their topic, while addressing requirements for flexibility and cost-effectiveness.

The original concept behind the course is presented followed with an explanation of the aims of the course. Later sections discuss the course structure, delivery, management, and quality control mechanisms before reviewing the mechanisms which have been put in place to provide student support and guidance in a distance learning environment.

THE CONCEPT

The course in question is the PgDip/M.Sc. Electronics and Software Systems, and is a collaborative venture between the University of Ulster (Magee College), Athlone Institute of Technology and the National University of Ireland, Galway. The initial discussions arose following a visit between engineering staff from the Regional Technical College, Athlone (as it was then) to the University of Ulster's Magee College campus in Derry. At that time it was perceived that the combination of World-Wide-Web (WWW) technology, video-conferencing, e-mail and CD-ROM multimedia technologies presented a unique opportunity to develop a course which would:

- accommodate a perceived industrial need for graduates with an advanced understanding in newly emerging areas of electronic engineering,

* Accepted 15 January 1999.

namely neural networks, signal processing, software engineering, and hardware and software for embedded microcontrollers;

- enhance teaching and research links between institutions on the island of Ireland;
- provide a route for continuing professional development for engineering graduates employed in industry;
- enable delivery of the course to students remote from the partners' sites;
- be an example of 'asynchronous learning networks', moving away from the rigidity of traditional university teaching and learning methodologies, centred on formal time-tabled lectures, to a more flexible on-campus/off-campus approach (with respect to delivery/assessment, not content);
- enable students to access teaching material from their place of work or home, using the potential of the WWW;
- replace the traditional lecture with interactive WWW and CD-ROM teaching material which students access in their own time;
- utilise the specialist expertise of staff from a number of geographically displaced institutions;
- be offered both full and part-time, but blur this latter distinction in practice by simply requiring the student to complete the programme within the limits of a minimum-maximum period;
- promote communication between staff and students in an informal manner via e-mail, or desktop video;
- maintain the tradition of cohesiveness and collegiality within the student cohort;
- maximise the cost-effectiveness of the course by utilising the opportunities to recruit in a number of catchment areas.

Preliminary assessments of market need had indicated the requirement for an advanced course which enabled students to advance their knowledge of the integration of electronics and software, while developing a sound understanding of the importance of intellectual property law and the protection of innovation. Subsequent to these discussions, the National University of Ireland, Galway was approached, and requested to join the consortium.

The three partners to the course development were thus the University of Ulster, Magee College, Athlone Institute of Technology and the National University of Ireland, Galway (hereafter known as 'the consortium').

The fact that the parties to the consortium were located on both sides of the border was also an important consideration; all three partners believed that not only was such a combination appropriate, at this particular point in the developing relations between the two parts of the country, but also that such a development was consistent with the increasing international ethos of educational provision, especially within the European Union. The coming together of higher

education institutions on both sides of the border to offer specialised modules at Masters level, using modern communication technologies, was seen as representing an effective and progressive approach to broadening technological educational opportunity at that level. It was accepted that a consortium involving members from other EU states at some future date was most desirable, but that the initial provision should proceed on the basis of partners from the island of Ireland.

COURSE AIMS AND OBJECTIVES

The aims of the PgDip/MSc in Electronics and Software Systems course are to provide students with an education that will enable them to realise their ambitions to practice as enterprising and successful professional electronic/software engineers; to produce graduates who have a high level of proficiency and sound understanding of the integration of software and hardware systems design, who are familiar with good design procedure in both disciplines, and who have the expertise and capability to apply advanced knowledge in their chosen area of specialism. The course also aims to engender in the young engineer the confidence and competence to apply their acquired skill and knowledge to real problems with economic purpose, and provides an appropriate balance between the vocational skills necessary for immediate employment and the more fundamental and enduring principles of the engineering disciplines involved. To this end the course instils in the intending electronic and software engineer a thorough knowledge of scientific principles and engineering practice together with an appreciation of the industrial and business environment in which they will work.

The course also aims to provide a reservoir of students with the talent and ability to pursue advanced research and development. It provides a platform for postgraduate DPhil programmes of research for those students with career ambitions directed towards industrially relevant Doctorates. All three collaborating institutions have strong traditions of collaboration with industry, particularly technology-based industry, and also with educational institutions in Europe and beyond.

At the end of their course graduates of the PgDip/MSc degree will have developed a rigorous understanding of advanced theory and principles embodied in electronic and software system design and synthesis, acquired an extended capability in the application of analytical procedures to the development and design of digital systems and demonstrated potential for leadership in industry or commerce through independence, self-motivation and initiative in project work.

COURSE STRUCTURE AND DURATION

The PgDip in Electronics and Software Systems is of nine months duration if taken as a full-time course (i.e. the conventional academic year); alternatively the course may be pursued part-time, with a maximum elapsed time between start and completion of three years. The course consists of four taught modules (selected from eight) offered between October and June in a two-semester system.

The M.Sc. in Electronics and Software Systems is of twelve months duration; it consists of four taught modules (selected from eight) offered between October and June in a two-semester system. In addition however students on the M.Sc. course must complete a major project dissertation.

The modules for the PgDip course and the M.Sc. degree are drawn from the following list with the respective ownership as specified:

1. Embedded Systems Design* (University of Ulster, Magee College)
2. Intelligent Engineering Techniques (UU)
3. VLSI Design (UU)
4. Software Engineering Design* (National University of Ireland, Galway)
5. Industrial and Intellectual Property Law (NUI)
6. Systems Project Management (NUI)
7. Signal Processing Theory and Applications* (Athlone Institute of Technology)
8. Communications Networks (AIT)

Those modules with an asterisk (*) are core modules to be taken by all students. Each student is therefore required to take a core module from each of the partner institutions. The vast majority of subjects have associated computer-simulated practical assignments and project work which integrate theory with application and provide a continuous thread of intellectual activity.

COURSE DELIVERY

The provision of a course by a distributed network of higher education institutions offers both advantages and disadvantages. On the positive side the advantages are:

- it enables the diverse expertise of the collaborating institutions to be combined for the benefit of the students;
- it allows for fluctuations in admissions at an individual site to be accommodated while maintaining an overall acceptable input cohort;
- it enables enhanced integration among students from differing educational backgrounds, and the development of networking and communication skills;
- it enables the student to harness to potential of modern communications technology to achieve a focused objective.

Conversely the distributed nature of the course provision means that:

- there are increased demands for sound management of the course;
- there is less face-to-face contact between lecturers and student;
- practical laboratory sessions pose specific problems.

The consortium reviewed these advantages and disadvantages and assessed the teaching and learning strategies which are appropriate. The following guiding criteria were agreed:

- relatively few formal lectures presented on the course;
- lecture notes, student-centred learning packages and associated material to be made available on the WWW—cognisance will be taken of developments arising from research in networked tutoring (e.g. the FP4 ESPRIT TALENT project [7]);
- attendance for formal lectures, tutorials and seminars is not compulsory;
- those formal lectures which are presented, together with tutorials and seminars are delivered using video-conferencing facilities over an ISDN link and all students are encouraged to acquire a networked PC either in their home or place of employment;
- a strong emphasis on student-centred and independent learning;
- a module-specific tutor available for consultation either by phone or video-conferencing on the basis of three timetabled hours per week;
- course-related material to be available on CD-ROM for students without access to the Internet;
- e-mail consultation and inter-student conferencing (e.g. using the Class system) encouraged;
- in general, laboratory work to be replaced by the use of specific software simulation packages such as Matlab, LEDIT, Viewlogic and equivalent.

In accordance with these principles, WWW-based and CD-ROM teaching resources are currently being developed to support the course.

MANAGEMENT OF THE COURSE

Management of a distributed course requires considerably more attention than would otherwise be the case. Operational management of both courses (the PgDip and M.Sc.) has been assigned to a Primary Course Director with two Assistant Course Directors; each of these are located on one of the three participating sites. The development and supervision of the course is delegated by the Faculty Board of the Faculty of Engineering (UU), the School of Engineering (Athlone) and the Faculty of Science, NUIG to a course committee whose members include those persons who make a

significant contribution to the teaching or administration of the course. The course committee establishes policy, seek resources for the development of the course and promotes the course to client industries, meeting at least once per semester, more frequently if required.

Each applicant for the PgDip/MSc course applies through any of the partner institutions, but can only register at one. Dual or triple registration is not permitted; in view of the blurring of the boundary between full-time and part-time modes of attendance, fees are based on modules, i.e. four modules for the PgDip and five for the M.Sc. Each institution charges the same fee per module.

QUALITY OF COURSE DESIGN, DELIVERY AND ASSESSMENT

The PgDip/M.Sc. course is subjected to a stringent validation. One of the problems which arose during the development of the course was that the three institutions had significantly different administrative procedures for the inception of new courses, particularly in terms of validation. The normal External Examiner system is used to verify the achievement of the specified academic standards; one external examiner is appointed for a four year period, and visits each institution on at least one occasion per year.

The consortium adopted the definition of quality as 'the quality (of a product) is the extent to which it meets customer expectations'. Therefore, the consortium is very careful, through all documented and verbal presentations, to ensure that students know exactly what the course offers, and what is expected of them. The consortium is also careful to ensure that all staff involved in the course are aware of and governed by documented syllabuses and codes of practice. Finally, the course will rigorously canvass feedback from students, graduates, employers and potential employers on the content, experience, and final opinions.

All existing UU courses are subject to the University's system of both an Annual Course Review and a more detailed Periodic Course Evaluation. The consortium agreed that course delivery would be monitored by this system, in addition to the procedures in place on the other two institutions.

The University of Ulster Annual Course Review is carried out in November of each year. The Course Director completes an Annual Course Report which provides an evaluation of various aspects of course delivery in the previous year. It covers such matters as students enrolment and performance, destination of successful graduates, reports from external examiners, reports from industrial placement supervisors and minutes of meetings of both the Course Committee and the Staff-Student Consultative Committee. Each

module coordinator completes a Module Evaluation form, which highlights any problems in the delivery of the specific module. These reports are considered by a Faculty Course Review Panel consisting of the Dean and Assistant Dean of the Faculty, Heads of School in the Faculty, and two representatives of the Policy and Development Committee (usually Pro-Vice-Chancellors or Deans of other Faculties). The review panel interviews each Course Director to investigate the extent to which issues raised in the reports are being addressed by the Course Committee. A global report on all the courses offered by the Faculty is then submitted to the University Sub-Committee on Taught Courses which requires that the Faculty provide follow-up monitoring to ensure that all outstanding issues are subsequently addressed.

Courses are initially approved for a period of not more than five years. Each course is then subject to a rigorous evaluation at the end of this period of approval. This is a process not dissimilar to the initial course validation except that it also includes a detailed review of the operation of the course since its previous evaluation and will involve the interviewing of current students and recent graduates by a periodic review panel. It provides the Course Committee with an opportunity to redesign the course in the light of experience and of contemporary developments in the subject. The course may then be re-validated for another five-year period.

The review system is particularly appropriate for an innovative course such as that being described. In addition, it is extremely important in the fields of electronics and computing, which are subject to almost continuous change and development and could thus lead, if not monitored, to courses quickly becoming outdated within a very short time. In practice almost all of the courses and modules offered are subject to minor adjustments every year, with a more thorough revision and redesign at five yearly intervals.

In addition to the review mechanisms outlined above, the consortium agreed that a Staff-Student Consultative Committee would be established, consisting of all the staff teaching on the course and a representative group of students. These meetings, which will be held via video-conferencing, provide a useful forum for dealing with the day-to-day issues which arise in the delivery of a course; students take full advantage of the opportunity to comment on staff performance and to resolve issues arising from course organisation and administration. Furthermore students are invited to complete questionnaires on the quality of teaching provided by each lecturer. The feedback provides a student evaluation, in the form of a score in the range 1...5, of a lecturer's teaching performance over a range of issues such as punctuality, clarity of delivery, quality of teaching material, openness to student questions, promptness in marking assignments, etc. Lecturers are then provided,

through their Heads of School, with a list of average scores obtained in each aspect of their teaching while schools and faculties are provided with tables of average scores. This procedure, suitably modified to reflect quality of CD-ROM and WWW material, is being adopted for the PgDip/M.Sc.

STUDENT SUPPORT, GUIDANCE AND INTEGRATION

The Institutions participating in this initiative are keenly aware of the role of the social support which students derive from one another whilst attending college in the normal manner. As the PgDip/MSc course is delivered using remote technology, it is considered essential to bring staff and students together for intensive tuition and integration on a regular basis.

Thus, on a rotating site basis, PgDip/M.Sc. workshops are held at each Institution on the

basis of one workshop per semester. The duration of each workshop, which may be held at weekends, is a minimum of three days. Routine additional student support is provided via e-mail, with local tutor support available at each site.

CONCLUSION

This paper discusses an innovative distance learning initiative between the University of Ulster, the National University of Ireland, Galway and the Athlone Institute of Technology. The course seeks to utilise the potential of modern communications technology, WWW resources and CD-ROM multimedia facilities in a flexible, student-centred learning environment. As the course is in its early stages, it remains to be seen how successful it becomes, as compared to the traditional techniques. However the authors are convinced that it has the potential to become a model for future collaborative course development.

REFERENCES

1. G. Hart and J. Mason, The Virtual University, *Symposium Proceedings*, The University of Melbourne, ISBN 0 73251 428 2, (1996).
2. C. Jesshop, A. Sharfarenko and H. Slusanschi, Low-bandwidth multimedia tools for Web-based lecture publishing, *Computing and Control Engineering Journal*, August, 1998, pp.156–162.
3. C. Jesshop and A. Sharfarenko, Web-based teaching: a minimalist approach, *Proc. 2nd Australian Conf. Computer Science Education*, ISBN 0 9791 958 0, (1996) pp.16–23.
4. L. Heng, Using information technology to enhance engineering education, *Int. J. Engineering Education*, **13** (5) 1997, pp.319–324.
5. A. Jonssen, Producing Distributed Education for the Corporate Intranet, in *Technologies for the Information Society: Developments and Opportunities*, Ed. J-Y Roger, ISBN 90 5199 450 8 (1998) pp.294–300.
6. B. Rodriguez, *et al.*, Virtual class: a long-life learning telematics tool for SMEs, in *Technologies for the Information Society: Developments and Opportunities*, Ed. J-Y Roger, ISBN 90 5199 450 8 (1998) pp.691–697.
7. TALENT, Training and Learning Environment with Networked Tutoring, *EU ESPRIT Project 22151*, European Commission, DG III, Brussels.

T. M. McGinnity is a senior lecturer in the School of Electrical and Mechanical Engineering of the University of Ulster. He holds a first class honours degree in physics and a doctorate from the University of Durham, and is a Chartered Engineer. Dr McGinnity leads the research activities of the Intelligent Systems Engineering Laboratory at Magee College where his current research interests relate to the design and implementation of neural networks, fuzzy systems, genetic algorithms and embedded systems.

Liam Maguire graduated from the Queen's University of Belfast with a M.Eng. and Ph.D. in Electrical and Electronic Engineering in 1988 and 1991 respectively. He worked in industry for three years before joining the University of Ulster in 1994. Dr Maguire is currently a member of the Intelligent Systems Engineering Laboratory at the Magee Campus. His research interests include fuzzy logic, neural networks and genetic algorithms with particular application to novel hardware/software implementations, control engineering and decision support systems. He has authored 30+ publications.

Liam McDaid is a lecturer in Electronic Engineering at the University of Ulster (Magee College) and a member of the research group ISEL, based at Magee. He obtained both a first class honours degree in Electronic Engineering, and a doctorate in solid-state electronics from the University of Liverpool. Dr McDaid's current research interests relate to the hardware implementations of neural, fuzzy and neuro-fuzzy systems.