Global J. of Engng. Educ., Vol. 3, No. 3
Printed in Australia

The Integration of Engineering and Artistic Competencies in a Novel Engineering Programme

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The multimedia and screen-based graphics industries have expanded rapidly over the past few years. This paper describes the development of a novel programme at Glasgow Caledonian University which attempts to create a degree that integrates engineering and graphical skills to meet the demands of the expanding marketplace. The paper describes the approach that was taken to the development of this programme and the problems that had to be dealt with. In particular it addresses the issue of integrating students who have studied graphical design courses for two years on an outcome driven Higher National Diploma (HND) into an engineering department which is syllabus driven. While the paper describes the issues in the context of a particular programme, this is used as an exemplar to illustrate issues that are of relevance to any programme that intends to involve students from arts backgrounds in an engineering environment.

INTRODUCTION

The emergence of the multimedia and digital graphics industries over the past few years has led to a proliferation of new programmes which attempt to address the need for formal education in this rapidly expanding area. At Glasgow Caledonian University the Department of Engineering has been at the forefront of this process and has developed several programmes which attempt to provide a valid educational experience for the student. These programmes take a variety of forms and it is the intention of this paper to describe the development of a particular programme called Applied Graphics Technology with Multimedia. The development of this programme raised several important issues as it integrates graphical design with technical understanding of multimedia systems to produce graduates that have a mix of skills that meet marketplace demand. The key issue that was raised was how to provide a valid learning experience for students who may have had no contact with technical issues and are purely used to working in an arts-based environment. In addressing this, the Department made a significant shift in its teaching strategy.

It is only in recent years that Applied Graphics Technology and Multimedia Technology programmes have become available in Further Education (FE) and Higher Education (HE) centres in the United Kingdom. This late development is largely symptomatic of the recent development of the industry.

It is now being recognised that with the rate of change and complexity of the technology which underpins multimedia, an academic background is advantageous to ensure that developers can understand and thus use new and emerging technologies to their full potential.

BACKGROUND TO THE INSTITUTIONS

The programme is a collaborative effort between the Department of Engineering as Glasgow Caledonian University (GCU) and the Faculty of Visual Communication at Glasgow College of Building and Printing (GCBP). Both centres have a long established tradition of delivery and design of programmes with a strong vocational emphasis. GCBP has been delivering various applied graphics, media and technology programmes since its inception, and has been focusing on emerging and integrated media with applied graphics for some ten years both at Higher National Certificate and Higher National Diploma level.

The Department of Engineering has been developing and running programmes in this area for several years. The third year BSc programme in Multimedia

Technology has been provided since September 1996. In June 1998 the Department received approval to run an honours year and the programme is now a full *2+2* (ie the first two years are completed at a local FE college and the University provides the further two years for the unclassified and honours degree). The programme has also recently received full and unconditional accreditation from the Institution of Incorporated Engineers (IIE). The Department has a strong commitment to active research, publications and consultancy in this area, which was deemed satisfactory to fully support the new honours year. The first 4th year intake started in September 1998. Similarly, the BSc in Applied Graphic Technology with Multimedia has run since September 1997 and the BA Honours programme in Integrated Product Design started in September 1998.

BACKGROUND TO THE INDUSTRY

The development of the multimedia and digital visualisation industry within Britain has changed dramatically over the past few years from the initial growth of start-up companies dealing in the production of CD-ROM and kiosk installations to the development and establishment of network multimedia content. The Internet adoption and growth, coupled with technological improvements, have influenced the delivery patterns of interactive media and the application of the same. Although home PC ownership within the UK and Europe is still low by comparison with the United States, the latter half of 1998 saw the recognition by advertising and marketing bodies that there was sufficient Internet access levels to justify offering clients this type of medium as a sales strategy. The *edutainment* CD-ROM market has always been limited to the nature of PC home ownership and remains at present a relatively moderate growth area. However the demand for interactive content creation has been fuelled by both the growth in web production houses, and the arrival of digital broadcasting and interactive television. It is predicted that interactive advertising within the new medium of digital television will see a rise in the European market from $50 million to $4.25 billion by 2002 [1].

On-line shopping, training, education and games sales will earn $5.3 billion in 2002, the largest sector being on-line shopping which earned revenue of $108 million in 1997, predicted to rise to $5.1 billion by 2002. The European Internet market generated $2.2 billion in 1998. One in three European households is anticipated to have Internet access by 2003 [1]. The links between multimedia interactivity and digital product visualisation will be strengthened within the areas of on-line sales and marketing. This includes, at present, interactive video manipulation and three-dimensional representations via technologies such as QuickTime VR from Apple computing.

THE DEVELOPMENT PROCESS

The degree evolved from discussions between staff at GCU and GCBP. From the earliest stages of the development process it was important to ensure that a coherent philosophy for the programme was in place so that as the structure and content of the programme evolved the work was directed to a common end.

Given that the students have normally gained an HND in Graphic Design, Illustration or Visual Information Design and Illustration at GCBP with the relevant practical and design skills, the fundamental philosophy of the BSc was stated as follows:

- To extend and further develop students' existing knowledge base and skills.
- To change the emphasis in student skills from use of multimedia tools to understanding of the fundamental principles that underpin these tools and to enhance design and development skills.
- To equip students with the academic and transferrable skills to support the continual learning required in the rapidly changing applied graphics and multimedia environment.

Based on these core philosophical elements the development team then identified a set of aims and objectives that would support the integrated design and engineering nature of the programme.

Aims

- To provide an appropriate learning environment which will equip students with the necessary skills to function effectively in a development team within the applied graphics and multimedia development industry.
- To provide students with the technical skills to specify, design, develop and implement applied graphical multimedia systems.
- To develop a sound understanding of the theoretical concepts supporting applied graphics technology and multimedia systems in the areas of software development, underlying technologies, communication networks and user interfaces

Objectives

- To introduce the basic principles of software development within the Software Engineering paradigm and develop the ability of students to apply

these principles in the design, implementation, testing and documentation of software.

- To provide students with experience of programming using a visual programming environment, the ability to use the structural features of a visual programming language and to work as part of a project team to develop an application from initial concept to final product.
- To equip students with the necessary skills to understand the operation of modern communication networks, and to critically assess the suitability of such networks for the transport of multimedia information.
- To provide students with a detailed understanding and the ability to apply knowledge of graphical design and sequential imagery development with respect to the construction of interactive multimedia presentation software.
- To provide students with an understanding of the operation of multimedia subsystems, and the manner in which the performance of these subsystems affects the operation of the system as a whole.
- To provide students with the opportunity to practise the skills developed in support of the theoretical aspects of the programme to a professional standard.
- To provide opportunities for integration of skills through project work.
- To develop a range of transferable skills.
- To provide opportunities to develop social and communication skills through teamwork.

In designing the programme curriculum, the Programme Development Team recognised two factors:

- the need to extend students' capabilities in the area of multimedia technology; and
- the importance of maintaining a link with previous studies at HND level.

Entry to the programme is normally restricted to those from the named HND awards at GCBP. This has enabled the Programme Development Team to focus its attention on the requirements of students from the following specific programmes:

- HND Graphic Design
- HND Illustration
- HND Visual Information: Design and Illustration

The third year of the BSc is designed to extend the knowledge and expand the range of skills that the students have gained through the recommended selection of units from the HNDs.

With this background the Programme Development Team identified and designed five taught modules and a group project. The taught modules are:

- Visual Software Development 1 (Department of Engineering, GCU)
- Graphic Design 1 (Faculty of Visual Communication, GCBP)
- Sequential Imagery Development (Faculty of Visual Communication, GCBP)
- Multimedia Technology (Department of Engineering, GCU)
- Communication Networks (Department of Engineering, GCU)

The fundamental aim of each of these modules is to provide students with a body of knowledge and the ability to apply this knowledge to a specific subject area. The assessment for each of the taught modules is split into two parts. The final examination provides a vehicle for testing students' ability to analyse a problem, recall appropriate information, and apply the necessary theorems and techniques to produce a solution. The coursework focuses on their ability to extract relevant information from practical work, lecture material and published sources, and relate this to a given application area. Overall assessment weighting varies between individual modules depending on the aims of the module and the teaching strategy adopted.

Graphic Design 1

This module introduces the theory and the practical application of screen-based design principles associated with image choice and manipulation, typographic selection and colour choice. At the end of this module students should be able to understand the technical constraints associated with the application of images, type and colour to the screen and to create solutions for short screen-based presentations.

Assessment weighting is 70% coursework, 30% examination.

Visual Software Development

This module provides students with experience of programming using a visual programming environment. At the end of this module they should be able to use the structural features of a visual programming language and work as part of a project team to develop an application from initial concept to final product.

Assessment weighting is 70% coursework, 30% examination.

Communications and the Internet

The aim of this module is to equip students with the necessary skills to understand the operation of modern communications networks, and to critically assess the suitability of such networks for the transport of multimedia information. Emphasis is given to the acquisition of specialist skills in the evaluation of hardware and software issues raised by the increased use and expectations created by the Internet.

Assessment weighting is 30% coursework, 70% final examination.

Sequential Imagery Development

This module introduces the basic principles involved in conceptualising and creating 2D/3D animated sequences and applying the methods used for creating navigation and interactivity within multimedia productions.

Assessment weighting is 70% coursework, 30% examination.

Multimedia Technology

The aim of this module is to provide students with an understanding of the operation of multimedia subsystems, and the manner in which the performance of these subsystems affects the operation of the system as a whole.

Assessment weighting is 30% coursework, 70% final examination.

Project

This module develops and integrates the technical and managerial skills gained from other units. The project consists of elements of planning, resource management, design, analysis, specification, implementation, validation (testing), group working and communication.

Lectures will be used at the start of the module in order to inform students of their role in the project, to outline good project management practice and to describe the format of the final report and oral presentation. The main point of contact with the staff from that point onward is the regular series of project meetings which students conduct with their supervisor. As the project is concerned with the ability of students to design and develop a product as part of a group, while exhibiting management and interpersonal skills, the project will use continuous assessment exclusively.

The supervision workload was split 50/50 between GCBP and GCU staff to ensure that both the project management and graphical skills are supported and assessed properly. Assessment is 100% coursework.

THE EDUCATIONAL MODELS AT THE TWO INSTITUTIONS

The key area where the two institutions differ is in the educational paradigms that they each follow. GCBP follows the outcome driven model, whereas GCU follows a syllabus driven model with a significant proportion of the assessment based on end of module examinations. It is not the function of this paper to compare the relative virtues of these two methods critically, but to illustrate the approach taken to reconcile the differences and to easing the transition between the models. Clearly one of the first problems that any cross institutional degree has to deal with is that of the assessment model to be followed. In the case of this particular example, the decision was imposed due to the fact that the degree is awarded by GCU and thus all regulations and standards would be those that applied to a normal in-house degree developed at GCU [2].

The culture clash: engineering and the arts

The challenge for this programme was to take students who have significant existing graphical skills and continue to support and develop these skills while introducing the engineering concepts that support multimedia development. The issues raised were:

- The lack of mathematical skills in the students.
- The perception of engineering as a dry, boring topic.
- Convincing students of the necessity of having engineering content in the programme.
- The change in working styles between the further education institution that the students had come from and the higher education institution they were now attending.
- The need for specialist graphical design skills to support certain modules.
- The perception by some members of staff that this subject was not proper engineering.
- The need to integrate the students into the Department.
- The difference in working practices between traditional engineering classes and graphics students (the lab vs studio approach).

The solutions that were developed are described in the following sections.

The lack of mathematical skills

Many of the students who joined the programme had not done maths since leaving school. As such they

were understandably concerned about their ability to deal with the more technical modules in the programme. Similarly the staff were concerned about how to convey technical issues to non-technical students. A variety of techniques were tried, with varying levels of success. The first thing that had to be realised was that the students worked with technology on a daily basis and were in no way technophobic. As a result of this the challenge was to catch their interest and to make technical issues relevant to their core concerns of becoming better graphical artists. This was facilitated by the structure of the programme as the development team had created a set of modules which dealt with technical issues of relevance to modern graphical designers. It would still have been possible to bury the students under a sea of often unnecessary mathematics, so an attempt was made to ensure that when mathematical concepts were introduced they were always placed in a context. For example, file size and data transfer rate calculations were put in the context of designing Web pages for rapid download.

Students were also provided with a considerable number of worked examples and tutorial work as well as introductory lectures which explained the importance and relevance of the mathematical concepts that were going to be used.

Lab work was used to reinforce lecture content and often tied directly to the taught material so that, for example, sampling and quantisation was taught in parallel with a series of audio and video capture labs which allowed students to relate their real world experiences to the theory being presented in the lectures.

The perception of engineering as a dry and boring subject

To be honest this is not a problem unique to this programme or indeed this institution. Too often, engineering is presented as a dull topic which has no space for imagination or creativity. In reality this is not the case. The challenge was how to get this across to the students. The techniques applied varied from modifying the presentation style of the notes so as to make them more visually stimulating and in some ways closer to magazine articles than the standard lecture notes, to use of multimedia within the lectures and labs to bring home concepts in an interesting and informative manner.

Convincing the students of the need to have engineering content in the programme

To the surprise of the staff involved this was not the major stumbling block that they had expected. While individual students would question why they were getting topic X instead of topic Y, the vast majority understood the reasoning behind the structure of the programme and the relevance of the individual modules. The reason for this is that the students were all informed of the content of the programme before joining and as such accepted and indeed actively chose to attend a programme with technical content. The continual emphasis on the relevance of the technical content also assisted as it meant that the students could see why they were studying the topics. Their own practical experience of technical issues affecting their ability to create their graphical work meant that they had a vested interest in understanding the technical issues that affected the tools that they were working with. The fact that the pass rates for the technical subjects did not differ significantly from the arts biased ones indicates that the students were able to grasp the material presented.

The change in working styles between the further education institution that the students had come from and the higher education institution they were now attending

The Department has developed several programmes that take students from further education and integrate them with great success into higher education. The general issues were covered in a previous paper where it was shown that by careful planning the transition for the students could be made relatively seamless [1]. The development of the Applied Graphics programme however brought some new problems as the students did not have a technical background and were not used to working in an engineering environment.

In the case of this programme however, there were additional problems in the relative lack of numeracy and technical awareness of the students. The problem was addressed by the use of bridging classes which helped the students to make the transition to numerical work and reinforced the context in which the numerical work was done. In addition the staff on the programme made themselves informal points of contact and thus identified problems early on. The staff involved were a major factor as well. An interest and enthusiasm for subjects outside of engineering (particularly in the visual arts) and a relaxed way of working with students meant that it was easier for the students to communicate with the staff.

The need for specialist graphical design skills within the Department

The Department recognised that there would be ele-

ments of the programme where the use of engineering staff would not be appropriate. These elements were the two graphics modules and the final project. Unlike the model followed in the music technology programme, where an external institution was used for specialist teaching, it was decided to equip a new laboratory with graphics workstations and to subcontract staff from GCBP [2]. These staff were used to teach the two graphics modules and to act as joint supervisors with engineering staff on the project module. This brought two main advantages. The staff from GCBP were able to teach the graphical subjects to a high level while keeping the students within the GCU campus. This reinforced the concept of this being an integrated programme in that the students were not leaving the campus to study the arts subjects and returning only to do the engineering subjects.

The fact that most of the students on the programme had previously known the lecturers at GCBP from their first two years of study meant that the feeling of dislocation was reduced when they made their move to GCU.

The perception by some members of staff that this subject was not proper engineering

The core of this problem is in the definition of engineering. Certainly, if the perception of engineering is the application of mathematical techniques to the solution of real word problems, then the programme is not engineering. Alternatively, if the view is taken that engineering is the application of design skills to the solution of a real world problem, then this programme can be seen to fit into that definition. This is an argument that exists across the engineering discipline and can be exemplified by the argument as to whether software engineering is an engineering discipline or not. The view of the author is that this programme is not traditional engineering but that the overall content and structure of the programme instils a range of skills in the student that match those that would be expected from a more traditional engineering programme.

The need to integrate the students into the Department

To some extent we are still working on this problem. It is the nature of almost any programme of study that the students on that programme tend to remain within their own peer group, to the extent that there can sometimes be very little interaction even between students in different years of the same programme. The techniques we have used to address it have included the usual cheese and wine type of gatherings as well as open invitations to events. These have not really achieved their aim and so we are now attempting to *force* some interaction by looking at methods which will involve the students in elements of other programmes as graphic designers who are given a brief as part of another programme's project activity. This idea is still being developed and has many potential flaws but could bring useful experience to the students on both programmes.

The difference in working practices between traditional engineering classes and graphics students (the lab vs studio approach)

The approach to practical time on engineering programmes tends to be based around limited access to lab space for the performance of practical exercises. While this model worked successfully for the engineering modules, it was clear while the programme was being developed that this would not be appropriate for the graphics modules or the project. The approach that was taken was to some extent a compromise between the ideal of full open access to the studio space (which would have meant chaos given the number of students on the programme) and scheduled times only (which denied the students time to develop their work). The compromise was to allocate large blocks of time to specific groups, which ensured that each student had time when they were guaranteed access to a computer. Over this, open access during the day (when possible) and in the evening was also provided. This solution worked reasonably well but the students would have liked even more access. Steps have been taken to allow the students to access their software resources from other departmental labs and hence have easier access.

THE SUCCESS OF THE PROGRAMME

In order to review the degree of success that this integrated programme has achieved it is necessary to look at it from different points of view.

The staff perspective

The staff at GCU have been delighted with the motivation of the diplomats from GCBP. Amongst the staff who were not part of the development process, there was some worry about the level and ability of the students who had come from an educational environment with different assessment methods, teaching styles and low mathematical content.

As the progression rates for the modules showed this was not the problem that was anticipated and any

limitations in the mathematical manipulative skills have been overcome by motivation and a very mature attitude to work.

The student perspective

There has been a strong demand from the diplomats for the opportunity to continue their higher education up to honours degree level. At present this is under consideration but the issues it raises for proper honours level teaching are major. As for the programme content, the topics are generally perceived by the students to be related and relevant to the graphics technology area they are interested in.

The students appreciated the wider access to resources that study at GCU gave them and the relative freedom that they had to take control of their own studies. They appreciated the freedom that the lack of continuous small outcome assessments gave them but missed the reassurance of having regular feedback on their progress. Most students stated that they were glad they had made the move.

The management perspective

The mission statement of GCU incorporates the aim of increasing the accessibility of higher education to a wider body of students from backgrounds that may not represent the traditional entry qualifications.

As a consequence of this, the University has developed a series of linked programmes with its affiliate colleges of which GCBP is one. The Applied Graphics Technology with Multimedia degree has provided both GCU and GCBP with significant additional income, but of greater importance, it has provided a distinct and compatible pathway to higher education for the diplomats.

From the University point of view, GCU has now attracted highly motivated and qualified students to the third year of the integrated programme with very positive results in terms of the standard of the output and retention rates.

SUMMARY

The development of a degree that incorporates engineering and graphical design between further and higher education institutions can be extremely successful. It does depend on several key features:

- Both types of institution must be committed to making it work and give proper support to the development process.
- The development team should be small and committed to the programme under development.
- Informal links are as important as formal links.
- The programme chosen for such a tightly integrated degree needs to be picked with care. Ideally it should have a clear identity, have a keen staff already in place and be attracting a student body that would be interested and able to make the transition from further to higher education.
- The development process needs careful management in order to ensure that the focus is maintained and that the continuing development and integration of the programme remains on target.

CONCLUSIONS

There are significant challenges to developing a degree in such a novel area. The use of a small development team that is closely involved with the development and teaching of the programme and that works together effectively can result in a qualification that is relevant and focused on the needs of the student and that brings considerable benefits to the contributing institutions.

REFERENCES

1. Datamonitor 1999 Report, Profiting from Interactive Services.
2. Stewart, I. Westwood, T. and Craig, I., Development of an integrated honours degree between further and higher education institutions. *Professional Standards and Quality in Engineering Education,* Sheffield Hallam University (1997).

BIOGRAPHY

Iain Stewart is currently a lecturer at Glasgow Caledonian University where he teaches on a range of electronics, multimedia and computing programmes. He received his MEng from Heriot Watt University in Scotland in 1984. Prior to entering lecturing he worked for Vickers Marine Controls where he designed microprocessor-based control systems. He has recently been involved with the development of several novel programmes that have linked engineering education with emerging subject disciplines in music technology and multimedia technology.

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edited by Peter LeP. Darvall and Zenon J. Pudlowski

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