Viewpoint:
Future Directions for Multimedia-Based Engineering Education

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This paper raises issues related to the use of multimedia in engineering education and comments on experiences gained in some of the Australian and overseas tertiary institutions and education centres. The paper, however, does not claim to provide final answers to these issues. It merely seeks to initiate discussion in this regard.

INTRODUCTION

IN RECENT years university education in Australia and elsewhere in the world has undergone massive restructuring. Relevance, quality, productivity, and accountability have become more than any time before, issues for vigorous debate and concern. Academics are now more than ever before expected to provide higher and measured quality of teaching, higher levels of administrative leadership, higher quality of research of international standing, attract financial support for their own research activities, make contributions to the profession, and raise the profile of their respective institutions by taking a positive and active role in scholarly and professional activities.

In response to the challenges posed above, academics have begun a search for more efficient ways of utilizing their limited precious time. It is therefore no wonder that engineers and in particular electrical and computer engineers, have identified multimedia as a prime target for providing a mechanism for quality, flexibility, and efficient teaching and learning. With the rapid advancement in microelectronics and optical fibre communications technology it is not difficult to envisage the expanding role multimedia will play in our daily lives and in steering our teaching and learning processes.

This paper raises the following issues, the answers to which may determine how successful multimedia applications to engineering education are likely to be.

- Feasibility and future direction of multimedia engineering education.
- How the education process will be affected by replacing existing teaching methodologies with multimedia.
- If the experience of open learning has been successful, then why have conventional universities not been affected by this success and changed their style of teaching?
- If multimedia education was to take hold and be adopted throughout, then what would the human resource implications be, and what role would existing lecturers be playing in the educational process?

WHAT IS MULTIMEDIA?

Although many universities and education institutions have, to varying degrees of complexity, used multimedia in education, there is still some discussion as what is actually meant by 'multimedia-based education'. Although the conventional mode of lecture delivery can be classified as multimedia, due to the use of voice, display unit (blackboard) and demonstration medium (chalk), modern interpretation of multimedia is quite different. A commonly acknowledged definition [1] refers to a teaching or learning process where a combination of electronic display units such as television or computer monitor or overhead screens, a computer system, voice, graphics, laser disc, CD-ROM, video, or computer software are used. A stand-alone or self-sustained multimedia education tool may incorporate all or a combination of the above elements.

There are two modes of interaction through multimedia. The first is a teacher-based one, where teachers use the available multimedia to present their course materials. The second is a digital learner-based mode, where the student accesses course materials through a computer terminal connected to a fileserver and perhaps through it to a network. Potentially, what stands to gain most from multimedia is the latter mode of learning, i.e. the digital learner-based system. This is due to many obvious reasons including the (i)

ability to provide more comprehensive treatment of the course materials through tutorials, simulation and self-evaluation, (ii) portability, (iii) time flexibility, (iv) pace of learning, (v) place of learning and others. More advanced digital leaner based systems provide the user with the opportunity of creating their own scenarios or problems and use the course material to solve them.

In order to develop a flexible and user-friendly multimedia-based learning system, the availability of experts in all of the areas relevant to the production of the system is essential. Four major areas of expertise are required: (i) course material, (ii) programming, (iii) graphics, and (iv) networking. An essential requirement for the successful production of any useful learning tool is the ability of those experts to be able to communicate and understand each other.

FEASIBILITY, TECHNICAL AND COST ISSUES

It is all very well talking and arguing about the use of multimedia in education and its potential, but before plunging ourselves right into it, we must examine the pros and cons of it and make an informed judgement about it. In doing so, we need to address, among others, the following important issues: Is multimedia inventible? Is it feasible, and if so, how feasible is it? How much does it cost? And does the benefit justify the cost?

This paper does not claim to provide final and concrete answers to all these issues, as there are no clear-cut answers to them. However, what this paper attempts to do is to shed some light on the factors that surround and influence these issues and hopefully, through vigorous discussion, some answers will emerge.

Over the past few years a number of major projects on computer-based education have been initiated in Australia and around the world. In Australia, the Department of Employment, Education and Training established in 1992 the Committee for the Advancement of University Teaching (CAUT). This committee has undertaken to promote quality teaching and learning through granting university researchers and educators financial support. So far over 60% of their grants have gone into supporting the development of computer-based teaching and learning systems. Recently, the committee established a software clearing house at the University of Wollongong to facilitate the usage and exchange of the developed software. Over AS$30 million has been spent by CAUT in this regard.

In the United Kingdom the Higher Education Funding Councils initiated in 1992 the Teaching and Learning Technology Program (TLTP) [2]. The aim was to find new ways of using information technology and multimedia in teaching a larger number of students with no extra staff. Around AS$100-120 million has been spent so far through the TLTP program [3].

Similar sister organizations exist in most west European countries, in the United States, and other countries with various degrees of sophistication and funding levels.

As a result of these and other initiatives, a large volume of educational methodologies and systems have been developed and reported [4–7]. Trials of these systems have also been reported and positive conclusions have been drawn with regard to their educational value. One can therefore conclude that not only is it technically possible to develop advanced and effective computers or multimedia-based education systems but also measurable positive outcomes can be achieved.

However, the point at issue here, which needs to be examined carefully, is not whether or not what multimedia education can enhance the educational process and provide positive outcomes, but at what cost and whether the gains justify the cost. For now, the only credible answer to this is that only time will tell whether multimedia will achieve the gains in productivity and efficiency that justify the expenditure.

So far no comprehensive cost–benefit study has been undertaken to compare the traditional and multimedia modes of teaching and learning. For this reason it might be too early to conclude with certainty that education would be better off by replacing the traditional mode of lecture delivery by a multimedia-based one. What is certain, though, is that a mode of delivery that is most suitable for a given environment might not be so for another. Hence caution needs to be taken and careful assessment of the environment must be undertaken before opting for either of the options, or for a combination of the two.

OPEN LEARNING EXPERIENCE

Open learning has been around for many decades in most European countries, the United States and recently in Australia. The Open University in the United Kingdom, and the recently established Opening Learning venture among Monash University, Wollongong University, and the ABC are two very well known examples.

The common practice has been to produce a set of lectures and other course materials on a variety of topics and make them available to students as hard copies or in the form of cassettes and video tapes. More recently CD-ROMS and interactive laser discs have been added to the inventory, though in a limited fashion. These may then be sold to students, or placed in the library for loan, or telecast through television channels.

One would have thought that open universities would be the first to jump on the multimedia band wagon and start developing their educational materials through its usage. All the signs are that the adoption of multimedia by open learning

institutions has not yet taken off in a substantial way. One might wonder why this has been the case. Although as yet there have been no published results on this topic, the following are contributing factors.

Student numbers

It is interesting to note that the number of students enrolled for a degree in open universities has increased, but the relative number of those students to those who have enrolled in conventional universities has not; if anything it has declined.

Cost

The adoption of new technology in education can be very expensive, from personnel and hardware viewpoint. To start off with, to be able to produce quality educational materials a high level of expertise in the subject matter, programming, and hardware understanding is required. In addition, the experts in these areas need to be able to understand and communicate with each other. This kind of expertise is not readily available and not inexpensive to acquire. If this is combined with the change in student numbers, investment of this magnitude is not easy to justify.

Compatibility and portability

Although attempts are being made to minimize the requirements for and cost of producing multi-media-based educational materials through the development of authoring systems such as Authorware, Toolbox, Hypercard, IconAuthor and others, compatibility and portability is still a very serious issue and sometimes is an impediment to its use. It is often the case that software developed for a particular platform does not run on another, different version of software require different hardware, and so on.

Special educational needs and requirements

A quick look through the electrical engineering curricula of universities in Australia and abroad would reveal quite clearly that the level, standard, and emphases of teaching a particular subject are quite different from one university to another. The same is also true for other disciplines. Obvious reasons for these are the differing social and economic needs, and the differing levels of industrial and technological advancements of each country.

These factors are evolutionary and dynamic and, combined with others, make it difficult to mass produce—a necessity of cost effectiveness—educational tools which can be of direct use and benefit to a wide range of users of differing backgrounds. One might liken this situation with the existing practice of using textbooks. Experience has shown that different universities, even in the same country and province, use different textbooks for the same subject. And even when the same textbook is used, different emphases are placed on different topics. This is natural as departments and universities, in general, should and do provide alternatives and varieties that satisfy and serve the special needs of their communities.

Another example that demonstrates the diversity of needs is the fact that, apart from open learning institutions, very few have resorted to teaching solely by video and audio means, such as tapes, discs, etc. This is despite the fact that many top quality materials of this kind, which have been produced by the IEEE, IEE, etc. and leading international universities using the best experts in the field, are available.

Equipment and maintenance

In order to be able to use multimedia- or computer-based teaching in the classroom, computer hardware and networking equipment need to be installed. Allowing for the different platforms that software can run on, there might be a need for installing, for example, a Macintosh, an IBM-compatible, and Sun or other workstations in the same classroom. These will have to be supported by an acoustic system, a display system, and a networking system. On top of that is the requirement for providing continuous maintenance and upgrading services.

This is an example of the kind of expenditure that is likely to be encountered. Therefore before a university chooses to embark on a venture of this kind, it should weigh the level of investment and the ongoing expenditure needed against benefits that might be derived from it. As this is not yet a clear-cut situation, universities have been reluctant to go down this path. This is so especially when the level of government support, in real terms, to education is declining world wide.

HUMAN FACTORS AND FUTURE DIRECTIONS

Let us contemplate the following scenario. Suppose that the best international panel of expertise in a particular subject that can ever be assembled got together and produced the best possible multi-media-based educational tool in the subject. Now, would all lecturers, departments, and universities in the world be using the developed tool for teaching the subject? The fact that we, lecturers, still lecture and are likely to do so in the future suggests that this has not happened and is not likely to happen. Therefore, one might conclude that the answer to the question posed above is *no*, at least for the time being. One might also argue that the main factor that has stood and will stand between such concepts and their adoption is the social factor. Humans like to communicate with each other, and only through personal communications does efficient transfer of information and knowledge take place.

However, this does not mean to say that changes

in the traditional role of lecturers have not taken and will not take place in the future, as multimedia-based education is more and more experimented with. Perhaps the main roles lecturers will be playing are the following:

- As teaching, as we know it, will gradually be replaced by learning, lecturers will assume the role of facilitating the transfer of knowledge from its source, e.g. journals, databases, software, textbooks, tapes, discs, etc., to students.

- Lecturers will rely more and more on multimedia for the presentation of their course materials, design of tutorials, and other complementary materials. This will serve the dual purpose of freeing lecturers' time and at the same time provide students with flexibility in learning their subject.

- As universities are likely to place more importance on the quality of teaching and reward teaching as they do research now, lecturers will be using their time evaluating their and other teaching practices, software packages, adopting new concepts, and modifying existing ones.

- As personal interaction between lecturers and student is fundamental to the learning process, lecturers will spend more time with students, advising and directing them. This will be one of the prominent roles of lecturers in the future.

CONCLUSIONS

Multimedia-based education is still in its infancy. It can be a very useful tool for both teaching and learning. As technology develops, its usage can grow and it can gain wider acceptance. It can in the future be the norm rather than the exception, as it is now. However, for it to fulfil this role, major problems have to be resolved. The main ones are (i) cost; (ii) compatibility; and (iii) maintenance.

The traditional role of lecturers will change from one that is primarily a classroom-based teaching to that of providing advice and facilitating the transfer of knowledge. More personalized discussions and consultations will take place between lecturers and students. Lecturers will be able to identify weak students and pay special attention to them, perhaps by devising alternative tutoring systems.

When the difficulties mentioned above are resolved, and multimedia becomes a fact of university life: (i) marked improvement in the learning process will be achieved; (ii) students will be able to achieve higher level of competency and therefore will be more equipped for their future employment; and (iii) universities will be more efficient in the ways they use their academic resources, and therefore provide better services to the community.

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