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Support Initiative
for Multimedia Applications

Part of the JISC New Technologies Initiative

Multimedia Presentations

Workshop Report

Holly Royde Conference Centre
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THE UNIVERSITY
of MANCHESTER

Forward

This is the report of a workshop on the topic Multimedia Presentations. The workshop was held at Holly Royde Conference Centre, Manchester, UK in April 1996.

The report is structured as follows:

- Summary and recommendations.
- Presentations from invited speakers.
- Summary of the discussions from the 3 working groups and their recommendations.
- Case studies of multimedia presentations in use in higher education.

Acknowledgements

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Summary

Background

Recent years have seen a rapid increase in the numbers of computers used in education. Computers are now regularly used by staff and students, for a variety of tasks from computer aided learning to word processing and E-mail. However, presentations, and particularly lectures, are probably the last area to be affected by computer technology.

The fact that multimedia presentations are not in common use shows there must be a number of problems, and these are not only associated with production of multimedia materials, but also delivering them, particularly at remote sites. It is well known that producing any multimedia materials can be expensive and time consuming, and materials for presentations are no different. In addition once produced the materials must often be used at foreign sites, creating problems of portability. Finally, despite the increased investments in computers on many sites, lecture theatres often lack the facilities necessary to give electronic presentations.

Despite these problems, multimedia presentations offer sufficient benefits to make them worth pursuing. During the course of the workshop a number of benefits were identified including:

- Increased student motivation - lectures are perceived as more interesting and informative.
- Increased understanding and retention - often complex ideas can not be easily explained using only text and graphics.
- Electronic presentations can easily form the basis of ancillary support material, allowing students to explore lecture material in more depth.

As an example of some of the issues that have been raised, let us consider a recent international conference '3D and Multimedia on the Internet, WWW and networks', held at the National Museum of Film and Photography, Bradford in April 1996. This has been highlighted simply because it happened close to the workshop, and is typical of a high profile, well organised and well equipped conference.

Despite the nature of the conference, the vast majority of speakers used 35mm slides or OHP transparencies to give their presentations, supplemented by analogue video clips in some instances, including analogue videos of computer animations. Only a couple of presenters actually used electronic presentations, indeed they were recommended not to in the presenters notes (see Case Studies).

> *'Computers can give very effective presentations and for interactive demonstrations - but we have seen many examples of computers not working during the actual presentations even though they have been tested out beforehand'*

Resolution was also a problem, not necessarily of the projection equipment, but also screen resolution of portable computers (the venue did not provide computers). One presenter commented, that although he had intended to use a computer, when magnified on the large screen, 600x800 resolution seemed very poor quality.

Even so, the final advice to the presenters, highlights the need for multimedia presentations.

> *'The main thing which will survive in the long term memory of your audience will be your visual images and/or animation, so be sure to include visual results in your talk, and make them of high quality'*

Issues and Recommendations

Multimedia presentations are time consuming to produce
A good multimedia presentation will require considerably more time and resources to produce than a traditional one, making it impractical for individual presenters to develop suitable material alone.

Recommendations

- Set up a database of media clips (copyright cleared or easily obtainable). This might include video, audio and image clips as well as interactive simulations, perhaps written in a standard authoring package like Toolbook, or programming languages such as JAVA.
- Commercial resources should be investigated, including resource banks and commercially available configurable CD's.
- Institutions should give more academic recognition for production of such material.
- More publicity is required for national and institutional facilities which can help presenters, such as video and scanning services.
- Promote the use of standard formats for all types of media, so that clips may be easily exchanged.
- A cost benefit analysis of CBT/CAL is needed to show that it has value and will improve teaching

There are perceived problems moving from traditional methods of generating presentations to electronic ones.

Many people are reluctant to learn to user new applications, particularly if they are perceived to be very technical or require programming skills, and they will not wish to discard existing materials.

Recommendations

- Develop a list of criteria for choosing presentation software, including features such as wizards or templates to help novice users
- Survey of presentation tools based on the above criteria.
- Provided access to staff development to learn the skills required to develop multimedia presentations

Multimedia does not necessarily mean good quality
Any presentation can be good or bad, but while a fairly simple set of rules for producing good quality text only presentations has been established, no such guidelines really exist for multimedia presentations

Recommendations

- Develop a set of guidelines for developing multimedia presentations.
- Create a repository of good examples.
- A central unit should be set up to disseminate good practice

Lecture theatres are not 'multimedia ready'
Presenters are reluctant to use electronic presentations as presentation equipment in lecture theatres is often unavailable or unsuitable. Even if they bring their own computers, projection equipment is often low resolution and low brightness, and there may be problems with connections. Using computers provided by host sites may cause software compatibility problems.

Recommendations

- Adequate technical support must be available to presenters.
- Develop a set of guidelines for the creation of a multimedia delivery box.
- Develop a set of guidelines for a minimum standard for presentation equipment in lecture theatres
- Develop a set of guidelines for a ‘multimedia trolley’ that will provided mobile multimedia presentation facilities
- Institutions should provide an information sheet describing the hardware and software available in each theatre
- Encourage institutions to invest in and improve their facilities. They shold be prepared to be loss leader initially.

Presentations

Moving Towards Electronic Lectures

Philip Barker

What are Electronic Lectures ?

There are a range of different approaches to the use of computer technology in teaching and learning activities, e.g., conventional CAL, electronic books and libraries, electronic lectures, virtual classrooms, laboratories and universities. In an electronic lecture the lecturer is using a computer, with a projection system, ideally with a database of online lectures which can be accessed in the lecture theatre, or by students on their own machines.

Some basic approaches

A range of packages are available, such as PowerPoint and other tools like Excel, Harvard Graphics and Toolbook. Electronic lectures are easy to produce, update and share, can support distance and tele-learning, and can form the basis for ancillary support materials.

An evaluative study

To determine effectiveness of, and attitudes towards, electronic lectures, 10 lectures were converted into electronic form and made available to students and staff for evaluation. Students evaluated them when used by a lecturer and as a self study resource, and staff attitudes towards them were evaluated. In general student responses were very positive, finding them professional, well organised and highly legible. Students would welcome a change to electronic lectures provided notes were still made available, with paper as the preferred medium.

In the second phase of the evaluation, the lectures were made available over the network. The evaluation was more extensive, but again all the results were very supportive.

Future directions

Allow electronic lectures do seem to offer a number of benefits, more evaluation is required, with controlled evaluation to measure pedagogic benefits. More extensive use of WWW seems desirable, and the appropriate organisational infrastructures will be needed to support the use of electronic lectures.

Conclusions

Electronic (not necessarily multimedia) lectures are cost effective, provide an extensible resource and are positively supported by student feedback. Until CAL/CBT resources can be made and used as easily as OHPs there will problems with uptake, and electronic lectures may act as a 'half-way house' in moving towards multimedia electronic lectures.

Why I'm Sticking to 'Talk and Chalk'
Terry Hewitt

Terry Hewitt from the CGU, University of Manchester, acted as devil's advocate at the workshop and argued the case for continuing to use traditional lecturing methods.

'Chalk and Talk' in this case was extended to include OHPs, 35mm slides, as well as the blackboard/whiteboard. The talk largely concentrated on OHPs, since these are the most widely used support aid for lecturers. The main advantages of OHPs are:

- easy to modify
- bright - lighting levels can be high
- simple to make
- cheap - both transparencies and projector
- reliable
- high resolution

They can be created simply with a pen and blank transparency, or from familiar word processors and text editors. Presentation software such as PowerPoint and Persuasion can also be used to create transparencies. Their strengths lie in presenting summary information, with a list of bullet points, with or without extra graphics. Transparencies do tend to be single colour, but with the increasing availability of colour printers more effective transparencies can be produced.

Reliability and portability were themes that cropped up several times during the two days, and were felt to be major barriers to the uptake of electronic presentations. A presenter does not yet feel confident that, without taking all their own equipment, they can go to another site and run their presentation without problems.

OHPs do have a number of problems, particularly in the audience perception of them as old technology and possibly boring. This is increasingly true as younger students are more exposed to high quality graphics and multimedia, and their expectations of presentations increase.

In conclusion, OHPs provide a simple, reliable and effective delivery mechanism for most presentations. Currently multimedia presentations are being held back by the complexity of creation, and the poor quality of many LCD projectors, which are low resolution, require dim lighting and are very expensive.

Multimedia Skills
Sue Cunningham

Since people come from a range of backgrounds, with a range of skills, the first part of this presentation will look at a typical presentation package so that everyone is familiar with their basic features. The presentation package used will be Microsoft PowerPoint, which is perhaps the most widely used presentation package. It has a number of features which are available in some form in many packages. These include:

- Wizards - The 'AutoContent Wizard' creates a series of slides with suggested topics on each depending on the type of presentation (e.g., training) selected, using default colour schemes and layouts. The 'Pick-A-Look Wizard' allows the user to simply create their own default slide look.
- Views - The presentation can be viewed in several formats, one slide at a time, small snapshots of all slides, in outline form or notes pages associated with each slide
- Build/Fades - built in affects that allow text to be drawn in different ways, e.g., 'Fly from right'. Transitions affect how one slide is replaced by the next, build effects control each bullet point.

Most people use packages such as these to produce electronic overheads, rather than multimedia presentations, and there are simple rules they can follow to make their presentations clear and legible. For example keeping font size above 18pt, using good colour combinations such as dark blue background and yellow text etc.. Designing good multimedia is much harder, and, perhaps because of the diversity of possible presentations, there are no standard guidelines available to help them. Much of the multimedia that is available today is basically simple text and graphics with additional media added in, rather than multimedia designed from scratch. This can lead to multimedia being used inappropriately, just 'bells and whistles', rather than being used where it provides real learning benefits.

Multimedia presentations can offer real benefits over standard presentations, electronic or otherwise, increasing motivation, aiding retention and allowing students to see theoretical work in practice. In order for these benefits to be realised issues of staff training and portability of presentations need to be addressed, as well as the financial issues involved in suitably equipping lecture theatres.

~~Multimedia Electronic~~ Presentations

Stuart Hirst

The core of my material is multimedia based and live and so the paper equivalent is a “little thin” in comparison.

I seem to remember reading that there are a number of things which presenters and speakers should bear in mind when delivering material to any audience:

1. Start with a beginning
2. Finish with an end

and in the middle:

3. Leave enough signposts for the audience to allow them to get out of the session what they want.

Therefore

- Tell the audience what you’re going to say
- Say it,
- Tell the audience what you’ve just said

If these are broad guidelines to be followed then a good presentation has the potential to be enhanced by making it electronic and by further addition of multimedia elements and a bad presentation ....

This presentation will, therefore, have a definite beginning, an in-between bit and an end!!

The presentation will have two parts.

1. A little bit of history describing the facilities available to Leeds Metropolitan University staff for electronic and multimedia presentations and
2. A multimedia presentation using PowerPoint

I have to lay my cards on the table and say I believe that, for an electronic presentation to have suitable multimedia elements, either a lot of time has been spent getting appropriate multimedia materials or that its inclusion has been contrived. My own presentation is a strange mixture in that, ostensibly, it’s a multimedia presentation about Multimedia. I’ve used it in the past as a first lecture to introduce multimedia computing to students and it’s undergone evolutionary change over a period of about 18 months. In this presentation, however, I expect that it will be viewed in a quite different way and welcome its dissection in light of discussion during the 2 day workshop.

You’ll notice that the title of this presentation has bits “struck out” ~~Multimedia Electronic~~ Presentations and this in part is a measure of some of the conflict which I feel occurs as soon as we try to do too much with an electronic presentation. A presentation of any type can involve an audience in many ways and (research seems to show) those requiring audience participation or feedback have a stronger chance of being remembered. However multimedia presentations do not lend themselves easily to this interactivity and therefore **interactive** multimedia (using current technology) has little to do with presentations (unless the presenter is a strong media component!).

The presentation uses the following PowerPoint facilities:

1. Launching a second presentation from another presentation (embedded presentation)
2. Hiding a slide or sequence of slides
3. Transitions
4. Bullet point builds and dimming of earlier points
5. Templates and Wizards
6. Use of Master slides
7. Inclusion of clip-art, sound (Wave and Midi), animation and video
8. “Hidden” hot-spots for launching multimedia “applets”
9. Objects embedded using Object Packager
10. OLE embedding of executable files
11. Media Clip objects embedded and subsequent use of media player and play settings for object playback control.

Having just typed the above list, I wonder how this presentation will hang together or whether it will actually seem very contrived with lots of multimedia “bolted on” for effect. I already have my own thoughts on the matter!

Group Reports

The workshop split into three groups for discussions:

- Software Tools
- Basic Environments
- Strategy

Although the groups covered different areas, much of the discussion inevitably overlapped. A common theme was the difference between OHPs and electronic methods of presentation, and the need to support the move from OHPs to computers. The table below shows some of the differences between OHPs, 35mm slides and electronic presentations that were highlighted during these discussions.

Feature	OHP	35mm Slides	Electronic Presentation
Production method	Pen Word Processor Presentation Package	Word Processor Presentation Package	Presentation Package
Ease of use and set up	Very Easy	Easy	Easy if you are familiar with the software
Resolution	High	Very high	Limited by computer used to deliver presentation and data projector. 640x480 is relatively poor but most common. 1280x1024 very good quality, but rare and expensive
Brightness	Very bright	Fairly dim	Generally dim, depends on data projector used
Note production	Depends on method of production. Most presentation packages allow handout and speakers notes to be generated		
Appearance and legibility	Look less professional. Hand written transparencies often illegible	Professional. Easy to read provided font size is large enough	Can look very professional. Easy to read provided font size is large enough
Interactivity and adaptability	Interactivity limited to jumping to another transparencies. Can be written on at the last minute, but this can look messy	Limited to back and forth. Slides cannot be altered	Degree of interactivity depends on the package used. Most have forward and back buttons, with the ability to include 'hidden' slides. May support hyperlinking (e.g., WWW browsers), and be able to run other applications from the presentation
Ease of update and distribution	Difficult to update the actual slides well. Do not want to produce multiple copies to distribute		
	Electronic copies can be easily updated and distributed. Presentation packages may allow slide show to be distributed as executable file or with a runtime viewer		
Portability	Very high	High	Low. Presenters may need to bring their own hardware. Portability problems using onsite hardware. Multimedia presentations can be very large - require network or CD-ROM
Cost consumables	£0.50 + per colour printed transparency	£1.00+ per slide	no consumables
hardware	£150+ for OHP	£500+ for slide projector	multimedia PC £1500 data projector +OHP £3000+ or combined projection equipment £6000+

Working Group 1 - Software Tools

Chair: Stuart Hirst

Introduction

This group will look at what is required in a good presentation tool, at what tools people are currently using, and their strengths and weaknesses. Issues such as portability of the final presentation, ability to incorporate a variety of media, etc., should be addressed. This group should look to produce recommendations, perhaps not for a particular tool, but criteria that could be used to select a tool.

Discussions

The group first looked at some of the reason why people did not feel comfortable developing electronic presentations, and at what features would be required by a package suitable for novice users. They felt it was necessary to differentiate between development and delivery tools, as much of a presentation could be developed in a word processing package, provided the presentation package had the facility to import (and export) to and from other packages.

One barrier to encouraging the use of presentation tools was users being frightened of technical/programming packages. Therefore the structured templates (e.g., PowerPoint's Wizards) can be very useful, but they obviously do impose a structure and 'look' on all presentations.

It was felt there was the need to distinguish between presentation packages and authoring tools. While authoring tools could be used to deliver presentations, the development overhead may be too large. The main advantages of authoring tools over current presentation packages were thought to be:

- support for non-linear narratives
- flexibility
- icon based application generation

The support for non-linear narratives is particularly important, as it allows for some degree of interactivity with the audience. This need for interactivity, which is not really present in current presentation packages, was felt to be at least as important as the ability to include multimedia. The easiest system to use which provides this non-linear support is the World Wide Web, and this should be considered when selecting a presentation tool.

The group then when on to create a schematic of an integrated software tool environment. (Fig 1)

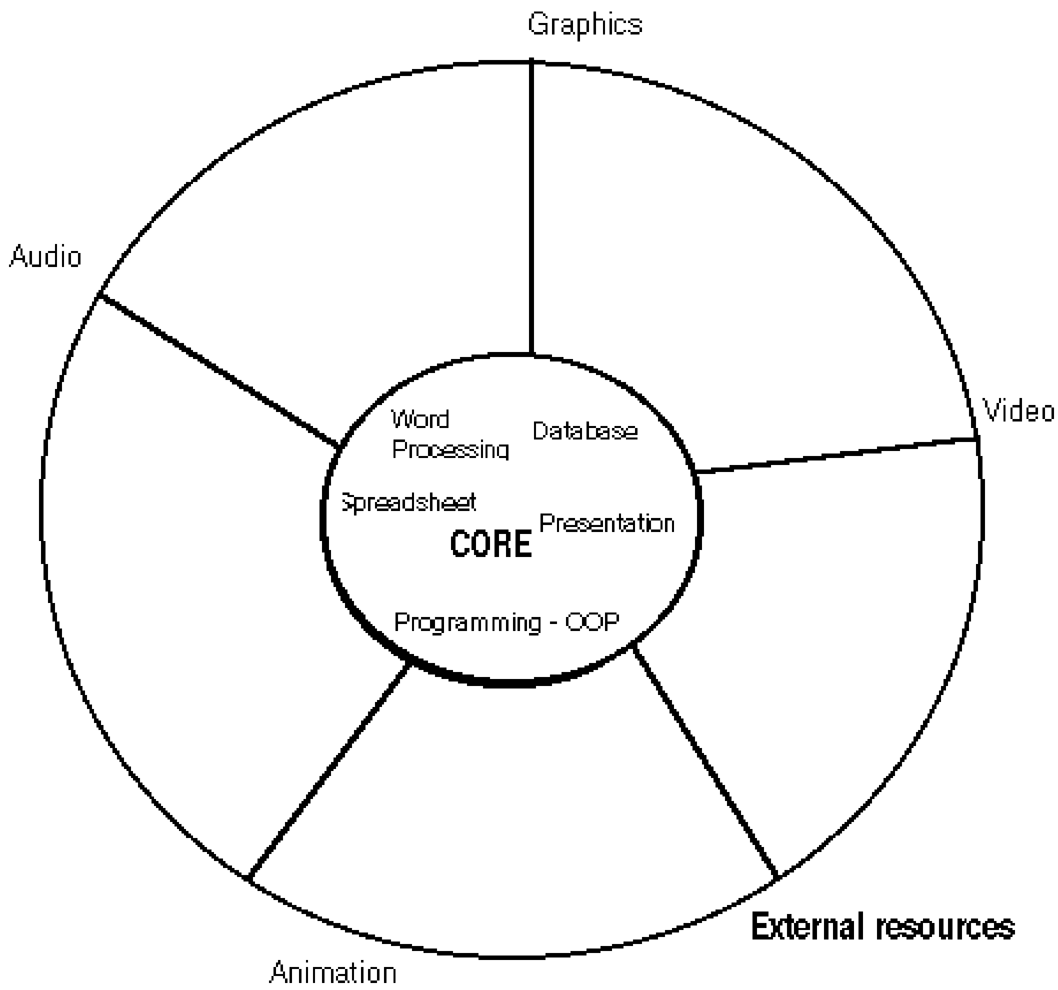


Figure 1 Schematic of an integrated software tool environment

This was envisaged as a cartwheel, with an inner core of basic software tools and the support tools around the rim. A presenter could therefore start generating their presentation in any of the core tools with which they were already familiar. The outer rim represents an external resource, either local or networked, of not only software tools but also media clips held in a data bank. Issues such as synchronisation of audio and video would be dealt with by tools in the rim.

One of the main problems with multimedia is the time and resources necessary to create it, and the data bank(s) would be necessary to encourage presenters to use multimedia. These were seen to be collections of clips produced by other institutions and perhaps commercial clips for which copyright was either waived or less constrained due to academic or educational usage.

In order to make use of this kind of environment the core presentation tool must meet a number of requirements:

- the ability to import from other packages - this should include the ability to import platform independent standard formats such as JPEG for images, so that data can more easily be exchanged between lecturers, departments and institutions

- export ability - to allow the production of paper based notes, and information to other packages runtime viewers and executable file production - a single executable file is easier to transport and distribute, but for cross platform compatibility runtime viewers, which should be free, will be required.

Recommendations

An ideal multimedia presentation tool should meet the following requirements:

- Instructor - templates/wizards/tutorials to encourage novice users
- Navigation - hyperlinking to allow non-linear narratives
- User Interface - should be simple and easy to use, both in developing and presentation
- Import - import a variety of media, including formatted text, from other packages, including support for ISO standard formats
- Notes - support for the production of paper based notes
- Network - support for networked or stand alone running
- Support - the tool must have good support, such as a help desk, technical support, good online help etc..

There is the need for a data base of copyright cleared media clips which can be used by lecturers to illustrate presentations

Working Group 2 - Basic Environments

Chair: Philip Barker

Introduction

This group looked at the basic requirements for both developing and delivering multimedia presentations. Two main perspectives were considered:

development - gathering material, creating video/audio clips e.t.c; and
presentation - how difficult it is to take a presentation and use it elsewhere (e.g., compatibility problems with both software and hardware).

The group explored the idea of producing guidelines at two levels:
(1) advice for a presenter; and
(2) advice for departments buying and setting up multimedia presentation equipment

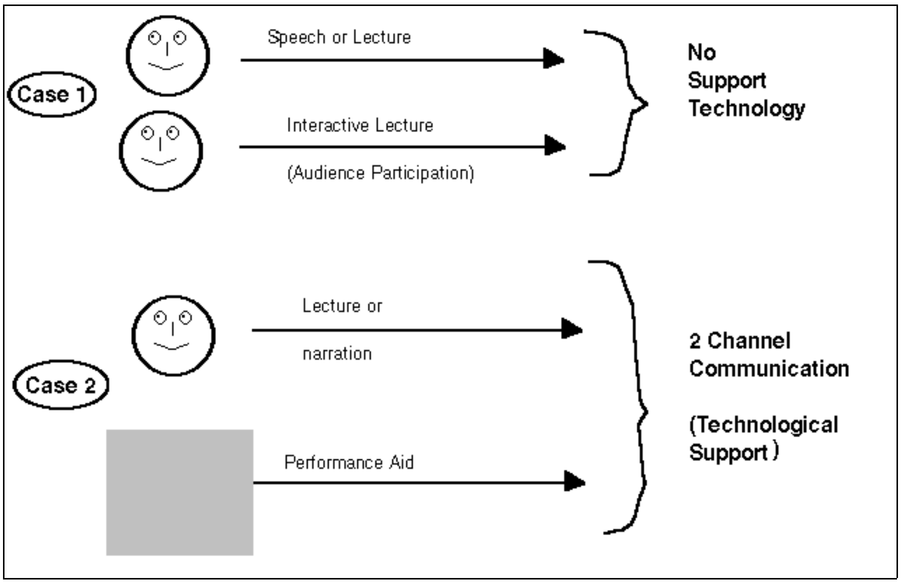
Discussions

Three separate strands for discussion were identified:
1) Development - gathering, capturing, converting and developing multimedia resources and integrating them into a multimedia presentation
2) Presentation - Problems associated with making a multimedia presentation at local and remote venues
3) The characteristics of the delivery environment to enhance the use of multimedia presentations

Strand 1 - Development Issues
Many people are already using tool such as PowerPoint to generate text-based presentations, often to produce OHP transparencies, which are easy to use, portable and reliable, but often perceived as bland by students

Factors that influence the transitions from talk through talk and chalk to multimedia presentation.

Types of presentation



Performance aids, such as OHP, slides and computer presentations, help with the delivery of a message by improving the communication bandwidth between the sender and recipient. A 3-channel system (2 aids) is just a variation of the basic model

The OHP is currently one of the most popular and widely available support aids, but anything that can be presented on celluloid can be emulated using electronic transparencies, and the group accepted that electronic presentation have the potential to be much superior to celluloid transparencies.

What is a multimedia presentations?
A multimedia presentation will contain some or all of the following resources:

> *text, sound, images of all sorts (including video/animation) and possibly some degree of interactivity.*

These could be put together in various ways, for example on a CD-ROM , and delivered by computer, or may be published on multiple different and discrete media, such as video tape, audio tape, 35mm slides e.t.c.. The group felt they should really be consider the former as multimedia, and the latter they termed 'Polymedia', which it was felt lay outside the current discussions.

In other words, a multimedia presentation is:
human presenter + CD-ROM + Internet resources + digital resources

Gathering materials

There are a number of places multimedia materials can be found:

- Paper based resources - text/image
- Internet
- 3rd party resources
- self produced material

While some of these resources may be 'multimedia ready', i.e., they can be just imported into presentation tools, others will require some form of conversion e.g., conversion of analogue video or audio to a digital format. The resources required to do this will probably be centrally held, and use should be made of centres, such as the National Video Centre at Manchester, where there is equipment and experience available.

Issues Raised

1 - copyright problems
2 - quality audit
3 - finding resources and indexing of resources

Storage issues

1 - portability of basic resources (CD/tape streamer/portable hard disk/network)
2 - portability of presentation (CD/network)
3 - large amount of storage required during development of a presentation

Editing Issues
1 - a range of tools should be provided and supported
2 - tools vary in sophistication
3 - institutional services
4 - need for support units
5 - institutional training
6 - affect of the enthusiasm factor

Strand 2 - Presentation

The main issues raised under this heading related to delivery environment issues such as:
resident software/hardware compatibility
hardware suitability
projection facilities
local technical support
lecterns for portables
no trailing cables

Strand 3 - Lecture Room Issues

This strand looked at the physical requirements of lecture rooms. It is important that any audio-visual equipment does not block the view of the audience. For example a large dat projector located at the front of a small seminar room can block the view of many of the audience in the central part of the room. Consequently back projectors or ceiling projectors would be the preferred method.

The presenter should have full remote control facilities. This should include a remote control mouse, so that he/she is not tied to the computer. Lights should also be controlled remotely, either by lecturer or technician. Ideally all equipment would be effectively hidden from the audience, but where equipment is present there should be no trailing wires, which are not only distracting, but also present a health and safety risk.

Group Recommendations

Strand 1 - Developing

1) Readily available equipment for converting analogue resources to digital
2) Provide appropriate mechanisms for converting digital resources between different formats
3) Adequate digital storage media such as high capacity portable hard drives and recordable CD
4) Appropriate network infrastructure to facilitate exchange of digital resources and delivery within the organisation
5) Appropriate guidelines for copyright observation with respect to utilising other peoples' resources
6) Encouraged to share resources both with respect to equipment and intellectual material
7) Support services for multimedia development
8) Provide appropriate standardised development tools for use by staff
9) Provision of training and support for staff to create their own material
10) Institutional recognition of using multimedia teaching techniques and producing multimedia
11) Guidelines about how individuals should go about developing (incrementally) multimedia presentations

Strand 2 - Presenting

1) Host institution should ensure the operability and serviceability of equipment
2) Technical support available to presenter
3) Guidelines for the creation of a multimedia delivery box for presenters to use
4) Minimum standard for presentation equipment:
screen/resident PC/audio support/ projection equipment/ remote mouse

Strand 3 - Lecture Theatre Provision

1) Layout of equipment should not block viewers
2) Automatic light dimming (remote)
3) Cables hidden (health and safety)
4) Network connection
5) Telephone socket
6) Information sheet describing hardware and software available including details of available players
7) VCR+monitor, so ordinary videos can be played

Working Group 3 - Strategy

Chair: W T Hewitt

Introduction

This group looked at general reasons why people do not use multimedia presentations (MMP) , and how to help make the most of MMP.

Discussion

The discussion revealed a number of reasons why the take up of MMP was small:

- It is complex and time consuming to create an MMP. It has a "techie image".
- Lecture theatres are generally inadequately equipped.
- Using my software on the lecture theatre PC takes a long time to get going.
- The effort is not recognized in the individuals promotion prospects.
- The cost effectiveness of CBT/CAL had yet to be proven satisfactorily.
- For students to follow up such MMP a lot of "expensive computers" were needed.

The group however identified a number of reasons for investing in MMP:

- There is evidence that it improves the learning process, and therefore improves the pass rate.
- It would improve an institutions results in the Teaching Quality Assessments (TQA).
- It attracts students, and as more an more school children get exposed to computers, they will expect it when they come to University.
- With the move towards more distance learning MMP would augment the traditional talk and chalk style presentation.
- There is some good competition available, e.g., the Microsoft CDs, which could be used as an effective teaching resource.
- It would attract fee paying conferences.

It was recognized that upgrading a typical lecture theatre could cost of the order of £30K-40K, and combined with the large cost of preparation of material it was important that these costs were recognized at an institutional level, and included in the institution’s Teaching & Learning Strategy.
In essence the group believed that Institutions need to treat MMP as a loss leader, and lead the community down this path.

Discussion about existing CBT/CAL materials revealed a number of problems:

- There was a concentration on closed modules, and what was required was "clips" or extracts that could be more easily incorporated into the individuals existing materials.
- The preparation to delivery ratios of MMP vs a traditional lecture are enormous (100-500:1 for MMP, against 8:1 for chalk and talk).
- Thus the cost benefits of CBT/CAL, i.e., the MMP were not proven.

This led us to the Golden Rules of MMP Development:

- Don't re-invent the wheel
- Use low cost CAL, e.g., MS Excel
- Produce bespoke material only as a last resort
- Share your work with others

The last rule suggesting that a repository of clips would be very useful. In this clips includes images, sounds, video clips, program fragments, working programs, scripts and data files.

With the move towards distance learning, CBT/CAL, and the increasing availability of material on the Internet, we concluded that there was still a role of the one to many lecture, though it will change to focus on charting a path for students through the plethora of material available from a wide variety of sources, including books, CDs, Internet, …

We questioned the value of just putting "OHPs" on the network. For there to have any value to the student they must be augmented in some way.

Recommendations

- There is still a role for the 1-n lecture

- The role of academic will change, but will still be to chart a path through the available resources

- Institutions should recognise the cost and value of MMP
  - Particularly in career development

- A cost benefit analysis of CBT/CAL is needed:
  - Need to show that it will improve teaching

- Each institution should have a number of MM equipped lecture theatres. These will:
    - Cost £30-40k, (PC/MAC, 1K x768 resolution)
    - Improve quality of presentation
    - Do things which you can't do with OHPs
    - Have a high PR value
    - Improve results in the TQA

  but
    - Lecture room allocation must include use not only size i.e., small teaching groups may have equally valid requirements for multimedia presentation facilities, therefore such facilities should not be limited to theatres holding several hundred people.

- MM Trolley's should be provided so that multimedia presentations can be held in rooms not permanently equipped for such presentations. They may also act as a first step towards fully equipped lecture theatres.

- MMP will require institutions initially to be loss leaders.

- Institution wide strategy required

- A Central Unit should be set up to disseminate good practice

- Provide several Case Studies

- Encourage re-use of material, via a repository

- Employ people to find good examples and material. Good examples need to cover good multimedia design and presentation, including guides to how much material can be well presented in a lecture. MMP allows you to convey a greater amount of data, hence presenters may end up cramming in too much so students don't take anything in.

- MMP needs to lose its Techie' image

- Make it simple to start (small number of tools). Presenters should be able to start to create MMPs using skills they already posses, such as Word Processing etc..

- Access to staff development for the MMP process. As staff develop more advanced multimedia there will inevitable be a requirement for new skills and to learn how to use more tools.

- Lecturers to understand the T.L. process for MMP

- Survey of existing tools and say what tools are required.

- MMP support material such as printed notes and files on a public server. Although there appears to be strong support for MMPs among students, there is still a very strong preference for printed notes. If notes and files are networked, students would be able to follow up material presented in the lectures in their own study time. There is therefore a requirement for suitable public MM machines, both for learning and development.

- Research needs to be carried out to determine what sort of follow up material should be available for students after a MMP.

KNOWLEDGE SHARING THROUGH ELECTRONIC COURSE DELIVERY

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ABSTRACT

The changing nature of computing and communications technologies has critical implications for the future delivery of education. There are three crucial issues. First, the delivery of distance education, student remediation, performance assessment and accreditation through mechanisms such as the World-Wide Web (WWW). Second, the development of guidelines which will allow designers to embed sound pedagogic principles into computer-based education provision. Third, the development of suitable electronic performance support systems to support student and staff activities within such environments. This paper addresses these problems through a discussion of the underlying processes. A case study is then presented which illustrates how these ideas have been practically applied and the impact that such work has on the wider problems of knowledge sharing through electronic course delivery within a university setting. This work provides a powerful framework for future knowledge sharing on a global scale.

1. INTRODUCTION

As human beings, knowledge is just one of a number of different commodities that arise and develop as a result of our perceptions of the events and processes that occur both within ourselves and within our environments - the worlds that exist beyond each one of us as individuals. Of course, this statement must not be construed to imply that knowledge is a uniquely human property. Indeed, other animals and some machines (such as computers) are said to be able to acquire and process this vital resource. However, having said this, this paper is primarily concerned with human knowledge and how this might be shared and distributed using computer-based technology.

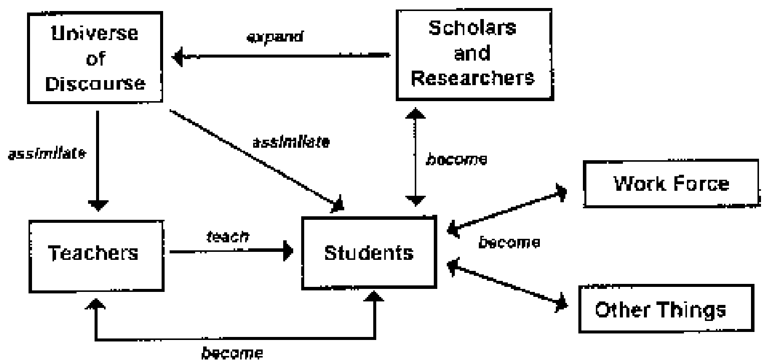
Some of the other important commodities which relate intimately to the ways in which we acquire and structure knowledge as a result of our perceptual and cognitive processes include signals, data, information, meta-knowledge and wisdom. Each of these items plays an important role in the intricate tasks involved in observing, recording and monitoring events and happenings and of disseminating and communicating to others the knowledge that is derived from these processes. Obviously, the basic activities referred to above form the fundamental foundations of a generic class of systems that are commonly referred to as 'knowledge transfer systems' (Barker, 1994).

Within the context of education and training, the basic model that we propose for knowledge transfer is illustrated schematically in figure 1. This shows how scholars and researchers within a particular subject domain create new knowledge and, in so doing, cause an expansion in the Universe of Discourse relating to that subject. In order to ensure that this new knowledge gets passed across to new generations we have created various sorts of educational system. Within these systems 'teachers' usually have to assimilate a subset of this knowledge and then 'teach' it to students. Through the acquisition of this knowledge, students become new scholars and researchers (thereby propagating the cycle), an informed society and a skilful and competitive workforce. Unfortunately, formal education in most countries ceases after the onset of adult life. As a consequence of this, there is a vast industry developing in the area of post-compulsory education - be this for the support of leisure activities, entertainment purposes or for career development and enhancement.

Within the context of both conventional and post-compulsory education we propose that 'electronic coarse delivery' has much to offer in terms of the efficiency and effectiveness of knowledge transfer - as depicted in figure 1. Furthermore, it is our contention that this approach can form a sound basis for the realisation of an ongoing 'learning society' that is supported by a flexible and dynamic approach to knowledge dissemination through the creation of a new type of organisation which we refer to as the
'virtual university'. We envisage such an organisation providing an infrastructure to support both
conventional approaches to education and ongoing 'on-the-job' learning and training activities within industrial and commercial settings.

Figure 1 Basic model for a knowledge transfer system

Bearing in mind what has been said above, the remainder of this paper outlines the basic



requirements of a system to support electronic course delivery through the development of appropriate course materials that are delivered by various electronic means - such as electronic books, online lectures and computer conversations of various sorts. We also outline how the creation of appropriately designed electronic performance support systems can be used to facilitate ongoing learning and training activities within both academic and non-academic settings. Finally, in the concluding part of the paper we discuss how these resources can be integrated in various ways to meet the requirements of a versatile and comprehensive future learning society based upon global knowledge sharing.

2. KNOWLEDGE SHARING

In order to facilitate the transfer and sharing of knowledge, human beings have for centuries used a variety of communication aids (such as maps, books, journals, papers, art, the spoken-word, and

music). As time has passed these communication aids have had to evolve and adapt in order to support the ever growing and diverse types of knowledge that are continually being created. Historically, there have been four significant advances in communication technology to facilitate
knowledge transfer. These have involved the development of: (l) various aids to facilitate reading and writing activities; (2) printing/photocopying for the mass distribution of information; (3) radio and TV broadcasting for the global dissemination of non-interactive, non-print material; and (4) the use of computers for the realisation of interactive information systems. Presently there is a move towards the global sharing of electronic resources through the use of an 'Information SuperHighway'. Obviously, this represents a further important development with respect to the creation of technologies that support knowledge sharing.

In figure 1 a basic model for an 'educational' knowledge transfer system was introduced. This model illustrates (in a generic way) the different actors and processes involved in transferring knowledge between different generations. The model makes no reference to technology or knowledge representation. System builders and implementors must therefore choose those technologies and techniques that are most appropriate to the situation in hand. In this context, each of the developments - (l) through (4) listed above - will have its particular strengths and weaknesses. Obviously the communication and information storage technologies that are employed will significantly influence the mechanisms that are used in order to store, retrieve, disseminate and present information to users. Furthermore, the ways in which knowledge is presented to consumers will also depend critically upon the technologies that are used for its communication and display.

In the past (and, to a large extent even today) paper-based technologies have been the ones most extensively used for knowledge sharing applications. However, in the light of new developments in information technology it is important to consider whether or not paper is still the most efficient and effective way to record and disseminate information and knowledge. Within educational systems the issues of efficient and effective knowledge transfer are particularly important - especially, in an era of diminishing financial support. For example, in many universities, lecture courses (that are augmented by books, journal articles, hand-outs and other print-based resources) are very often presented to large groups of students. Frequently, these lectures are relayed electronically (and in a non-interactive way) to various other sites - either simultaneously or in a 'canned' format. Naturally, there are many limitations associated with these 'traditional' teaching methods. Bearing this in mind, we believe that electronic course delivery is a viable alternative delivery mechanism to facilitate the efficient and cost-effective presentation of learning and training resources within a university and/or college context.

Electronic course delivery (ECD), is concerned with the use of electronic materials and delivery
platforms to support and enhance teaching and learning experiences - either on an individual or a group basis. In order to realise the goals of ECD there are a number of underlying areas which need to be addressed. These include the use of: electronic lectures; mechanisms to facilitate lectures-on- demand; the extensive use of teleteaching, teletutoring and collaborative learning at a distance; and support facilities such as electronic libraries. Obviously, the use of electronic libraries will be an important foundation for the successful use of ECD. It is

through such facilities that users will gain access to electronic books, magazines, journals, newspapers, Internet resources and various other artefacts that are published electronically using 'digital paper'.

Of course, as well as ensuring that the necessary storage, communication and delivery technologies are in place to support electronic course delivery, it is also imperative that appropriate software and courseware resources are made available. Naturally, the courseware products that are used must fully implement three important pedagogic activities. First, they must provide methods and strategies which will ensure that students are adequately assessed; second, they must embed appropriate remediation facilities (for use in situations where their use is deemed to be necessary); and third, they must make available suitable performance support tools which will facilitate effective and efficient skill development. Some of the issues involved in making provisions for these requirements are discussed in the following section.

3. ASSESSMENT, REMEDIATION AND PERFORMANCE SUPPORT

The provision of information is a fundamental pre-requisite of learning activities and problem solving. With the advent of the Information SuperHighway individuals are able to browse or search a vast distributed information resource and retrieve information in a wide range of media forms. What is often lacking, however, is any consideration of how such information is processed by the reader thus becoming usable knowledge. This section addresses some of the issues surrounding the facilitation of information use. Such facilitation can take place either with respect to the provision of working knowledge (to address current task problems), or to the provision of deep knowledge (providing understanding in the longer term). Information can be enhanced through the introduction of performance tools and/or assessment and/or remediation strategies. In other words, access to information is not sufficient to allow knowledge sharing. It is the changes that occur in end-users which are the key to knowledge sharing. These issues are addressed in this section.

Assessment and Remediation

In order to provide understanding in the longer term (deep knowledge transfer) reflection or reflective observation need to be initiated in users (Kolb, 1984; Race, 1994; Richards and Gavin, 1996). Refection implies an interaction with information without which knowledge transfer could not take place. Often, individuals reflect on their learning experiences while not actively engaged with an information resource. This can either be a subconscious process - typified by the Gestalt notion of illumination (Wallas, l 926), or the conscious processes that learning materials are intended to foster.

In other words, knowledge transfer implies processes that can be encouraged or facilitated and go beyond the simple viewing of information. There are several issues involved in the transfer from information into deep knowledge. First, it is important to develop mechanisms that can actually assist the conversion process. Second, it is important for users to be able to assess their progress. Third, any discrepancies that arise between information content and users interpretations must be remediated.

One of the most important techniques that can be used in this regard (and one that is used in many learning situations) is the use of assessment strategies. When people are engaged in learning they need to interact with the material. Unfortunately, for many people, information access can often be a relatively passive process unless targeted at solving specific tasks. Nevertheless, people often do access information to gain knowledge rather than to solve particular problems and it is under these circumstances that the provision of mechanisms for the application of information become crucial.

Assessment has a number of useful characteristics that can be utilised. These can be summarised by the following points: motivation; activity; completeness; and correctness. First, for many people, assessment is inherently motivating (Richards and Nott, 1995). People actually want to know how much they know. It also links into basic competitive drives which cause individuals to strive for high performance. Second, engaging learners in a practical activity allows them to apply what they have learnt. It takes students away from relatively passive information processing to an active style of interaction. Third, the corollary of individuals having an indication of what they know is that they can also become aware of what they do not know. This includes information that has been misinterpreted and/or misunderstood. Fourth, assessment provides the mechanism by which the need for remedial action can be identified. This can be action initiated by the student as a result of computer-based feedback. On the other hand~ it can originate from a learning facilitator who may be monitoring student progress electronically as might be seen in a computer-based distant learning programme.

Performance Support

As was suggested in the previous section, assessment is a useful mechanism for monitoring progress and giving learners an indication of how well they are doing. If necessary, remediation can then be used to help those who are under-performing. In contrast, performance support techniques are intended to extend human ability beyond the levels that are normally accessible to them. The study of performance support is therefore concerned with the design and provision of mechanisms, techniques, technology and tools to facilitate and augment an individual's (or a group's) skill and knowledge performance within a given task domain. The tasks that are involved may be of a physical or of an intellectual nature.

Increasingly, computer technology is being used as a basis for the realisation of performance support systems. A system that is based upon some form of embedded computer facility is often referred to as an 'electronic performance support system' (EPSS). According to Banerji (1995) an EPSS can be defined as 'a human-activity system that is able to manipulate large amounts of task related information in order to provide both a problem solving capability as well as learning opportunities to augment human performance in a job task by providing information and concepts in either a linear or a non-linear way, as and when they are required by a user.' There are two important implications of this definition. First, the use of a 'just-in-time' (or 'on demand') instructional paradigm; and second, the use of an 'on-the-job' learning/training situation.

Electronic performance support systems are now increasingly being used within educational settings. When used within this area an EPSS can help support staff and students in two important ways. First, by accelerating skill and knowledge acquisition. Second, by enhancing the ability levels of both staff and students. In order to accelerate skill acquisition, computer-based assessment tools can be used to provide assessment mechanisms that provide real-time monitoring and feedback. In addition, advanced knowledge-based tools (such as expert systems and intelligent tutoring facilities) can be used to deliver deep knowledge and remediation embedded within the context of original learning/training tasks. Through the use of EPSS techniques, students and staff can thus be provided with more complete, varied, valid and stimulating knowledge.

Numerous examples of the use of EPSS techniques within education are now starting to appear in the literature. Stephens and Stephens (1995), for example, describe the 'School Year 2000' initiative in Florida, USA. This is intended to provide students, teachers, administrators and others involved in the education of children with performance support tools in eleven different areas - including curriculum planning, instructional management, assessment, delivery of instruction, access to educational resource materials, and so on. Similarly, within a university context, Barker et al (1995a; 1995b) have described the application of EPSS techniques for the operation of an electronic 'open access student information service' (OASIS). The electronic OASIS is a basic mechanism to support electronic course delivery based upon the use of electronic lectures and various forms of automated (computer-based) assessment of students. This early prototype system that was developed within the University of Teesside now forms the basis for the work on distributed performance support that is described in the case study that is presented in the following section.

4.CASE STUDY-ECD AND DISTRIBUTED PERFORMANCE SUPPORT

The basic principle underlying electronic course delivery requires that teaching and learning resources (and other related study-support materials) are made easily accessible (in a global way) in electronic form. This implies that such resources can be made available both to local, campus-based students as well as to distant learners - that might be located virtually anywhere in the world. Our approach to the implementation of ECD therefore depends upon the application of EPSS techniques to the teaching, learning and administrative processes that take place within the organisational units that constitute our university environment. The initial step in realising this objective therefore involves conducting detailed needs analyses within the various departments and schools that make up the university infrastructure (Barker et al, 1995a; 1995b; Beacharn, 1996). The results of these needs analyses are then used to identify (for each organisational unit) those issues which are of most concern to students, teaching staff and administrators with respect to the creation of supportive computer-based learning and teaching environments. Each organisational unit is thus able to identify its priorities and integrate these into the overall developments that are taking place within an institution-wide development portfolio.

For many departments, the most urgent requirements are: (I) the conversion of lecture courses into electronic form through the more widespread use of electronic lecturing techniques (Barker, 1996); (2) the augmentation and enhancement of electronic lectures (using multimedia and hypermedia methods) in order to convert them into stand-alone, self-study resources; (3) the effective use of electronic communication facilities (such as Email, computer conferencing, bulletin boards and World-Wide Web pages) in order to support more effective interchange between staff and students; (4) the use of electronic publishing techniques (based upon digital media) as a means of making information and knowledge more accessible and current (Tan, 1996); and (5) the realisation of automated (computer-based) 'on demand' assessment and remediation procedures that are driven by staff, student and organisational needs.

Fundamental to the use of EPSS within ECD is the application of a number of different models, principles and guidelines which specify how performance support techniques should best be used to realise organisational objectives (Banerji, 1995). The basic models that we employ therefore include:
(I) a four-layer architectural model for creating electronic performance support systems (Barker and Banerji, 1995);
(2) a model for describing the role of multimedia within an EPSS (Barker and Hudson, 1996); and
(3) a model that describes how a distributed performance support system (DPSS) can be created within a complex institutional setting in order to implement organisational change (Beacham, 1996). Currently, we are using these models to create an institutional infrastructure that will support the co-operative delivery of modular courses from within the different schools that make up a higher education (university) establishment. We anticipate that this work will lead us towards the formulation of further guidelines and models that will be useful for creating 'enterprise support systems' that can be tailored to the needs of individual organisations within the framework of a 'Learning Society'.

5. CONCLUSION

Electronic course delivery represents a major step forward with respect to the realisation of more
effective and more efficient access to education through knowledge sharing. However, if this approach is to be successful it requires both inter-departmental co-operation and collaboration and an institutional commitment to the use of computer-based technology for the realisation of teaching and learning activities. It also requires a solid foundation and a supportive framework within which to develop and integrate pedagogic and administrative resources. When implementing our ECD mechanisms, we have found that the use of electronic performance support techniques provides a valuable foundation upon which to develop, maintain and deliver teaching and learning materials.

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ASSESSING ATTITUDES TO ELECTRONIC LECTURES

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1. INTRODUCTION

Computer technology offers many new dimensions for the provision of support for teaching and learning. Until recently, most emphasis has been given to learners and the creation of more effective and more efficient individualised and group learning systems based on the use of computer-assisted learning (CAL), computer-based training (CBT) and computer-mediated communication (CMC) techniques. In the majority of cases, this objective has been realised through the development of supportive and/or collaborative learning mechanisms involving various types of interactive, technology- based environment (Barker, 1990; 1994; 1995). Nowadays, as organisational attitudes and infrastructures are changing, more attention is being given to the use of computers as support aids for teaching. This chapter therefore addresses the important issue of how computer-based methods can be used to develop, maintain and deliver 'electronic lectures' as part of a more holistic approach to 'electronic course delivery'.

Despite their many known pedagogic limitations, lectures undoubtedly offer a cost-effective way of delivering instructional material. It is therefore imperative that we think about the different ways in which computer technology could be used in order to:
(1) enhance and augment lectures;
(2) increase their accessibility (not only to local, campus-based students but also to distant learners); and
(3) improve their quality - from both staff and student perspectives.
With these objectives in mind, this chapter strongly advocates the use of electronic lectures as a viable mechanism for improving both the quality of lecture material and the ease with which it can be accessed by students. It is also proposed that this approach to lecturing can significantly improve the quality of students' exposure to lecture-based resources.

Essentially, an electronic lecture is one in which the use of a computer-based projection system is used to augment (or indeed replace) the use of OHP transparencies or a slide projector (Barker, 1996a). Obviously, the use of lectures of this type allows a range of new types of instructional mechanism to be developed. Very often these can be based upon the use of multimedia resources that incorporate text, sound, pictures, animations and video material (Hofstetter, 1995). The various materials needed to create these lectures can be retrieved from a wide range of sources. Typical examples of these include: local resource packs (that employ re-writable optical storage facilities or read-only media such as compact disc); and remote locations that involve the use of computer communication networks such as the Internet and the World-Wide Web.

Because of the many different types of resource that can be used for their production, the design, creation and delivery of electronic lectures differs in many ways from the analogous activities involving non-interactive media such as OHPs and slides. For example, it is possible to integrate the use of special types of 'build sequences', transitions, sound effects, animations and simulations in order to illustrate particular points. Materials can also be 'pulled in' dynamically from any source to which a lecturer can connect during his/her presentation. Naturally, using techniques such as these, lectures can become far more exciting and motivating than they have been in the past.

Bearing in mind what has been said above, the objectives of this chapter are now to describe and discuss the issues involved in producing and delivering electronic lectures that use currently available computer-based presentation packages. The chapter commences with a short description of our reasons for wanting to use this approach to teaching. Some different approaches that reflect current practice in this area will then be briefly described. Finally, the results of a student-oriented evaluation of electronic lectures will be presented and discussed.

2. MOTIVATION FOR ELECTRONIC LECTURES

Before discussing the different approaches to preparing and delivering electronic lectures, it is necessary to consider some of the important factors that underlie the growing commitment to this approach to teaching. Undoubtedly, one of the most influential factors to consider is 'institutional policy' and the hidden or direct messages that organisational 'fund holders' pass across to lecturers and teaching staff. An example of such a message is reflected in an editorial that appeared in a recent edition of a journal devoted to learning technology (Jacobs, 1994). In his editorial Jacobs writes:

‘*I was recently invited to give a lecture at the opening of a new high-technology lecture theatre at Leeds Metropolitan University It is one of the best examples of its kind I have seen Its impressive features include hi-fi surround sound, an enormous back-projected screen giving superb picture quality from either a VCR or directly from a computer for live demonstrations, online facilities, and the latest remote-control slide-projection equipment Clearly, this set-up involved major expenditure It was therefore presumably discussed at great length before the decision concerning such a long-term commitment was taken But a commitment to what? To the use of technology in education, obviously, but also to the stand-up-and-deliver lecture Typically, computer-assisted instruction involves a single student or small group of students sitting in front of a monitor, interacting with some software and self-pacing their learning The traditional lecture represents the very opposite of this approach: large numbers of students taking notes, with interaction at best limited and at worst non-existent, and with the pace of proceedings depending almost entirely on the lecturer 's judgement*’

The message embedded in this editorial would appear to suggest a somewhat negative institutional attitude towards the use of individualised instruction and computer-based learning. On the other hand, as Jacobs himself suggests, it would seem to offer considerable support for the thesis that lectures (in one form or another) will continue to be used as a major vehicle for university teaching in the years ahead.

In addition to institutional policy, there are many other, more pragmatic reasons why staff in higher education might want to use electronic lecturing techniques to support their teaching activities. Amongst the more important of these we must include the fact that, in general, electronic lectures are easy to produce - provided suitable authoring packages and appropriate automation tools are employed. Of course, we must also take into account the observation that, because they are in electronic form, lectures of this sort are easy to share with colleagues and with students; they can therefore be used to support distance learning and tele-teaching techniques. In addition, lectures that are in electronic form are easy to maintain and update; this important property enables high levels of re-usability to be achieved and, to some extent, allows us to combat obsolescence. Furthermore, provided that suitable design and development strategies are adopted, electronic lectures can form the basis for the production of ancillary learning support materials (Barker et al, 1995a; 1995b).

Because of their potential cost-effectiveness and their numerous pedagogic advantages, it is our belief that electronic lectures will become a primary mechanism for knowledge and information transfer within conventional establishments of higher education. In addition, as hinted above, it is our opinion that the electronic lectures which are used to deliver any particular course will also have to act as a foundation to support the creation of additional learning aids for that course (such as CAL and CBT resources) that can be used on both an individual and/or a small group basis. Using this approach, the very same resources that are used to support local campus-based students could thus also be used by distant learners.

Of course, as a longer term goal, it is important to visualise the role of electronic lectures as a ' stepping stone' towards the ultimate realisation of a totally electronic course delivery mechanism within the context of a 'virtual university' environment. Undoubtedly, by the next millennium many staff and students will teach and/or study by means of such an infrastructure.

3. THREE BASIC APPROACHES

This section outlines three different approaches to the preparation and delivery of electronic lectures. Each one differs with respect to the type of resource used and the kinds of facility that can be provided.

3.1 The Book Emulator

In their work, Benest and Hague (1993) describe the use of a powerful preparation and delivery tool known as the 'Book Emulator'. It runs on a UNIX platform and incorporates a book metaphor. Therefore, during their construction and subsequent presentation (either in a lecture theatre or to an individual student at a workstation) the electronic slides that are used have much the same appearance as the pages of a conventional book. An interesting feature of this approach is the fact that the slides contained within any given electronic 'lecture book' are accompanied by an audio narrative. Depending upon how the slides are used - single stepping (within a live presentation under the control of a lecturer), browsing or continuous play (for private study by students) - the narrative can be either enabled or disabled.

According to Benest and Hague:

‘The primary motivation for on-line lectures is to produce a lecture that is of higher quality than chalk-and-talk Quality gains arise from the production of electronic slides that are readable from the back of a lecture theatre, and that definitely indicate specif c items without human hands covering up vital material in the vicinity’

Bearing these comments in mind, as far as these researchers are concerned, a major advantage of electronic lectures is the wide range of 'revelation' techniques that can be employed (that is, the different ways in which the various parts of a slide can be covered and uncovered during an exposition). They also propose that the ability to use animation within electronic slides is an important attribute which can make such slides much more meaningful than their static celluloid counter-parts.

Although Benest and Hague do not necessarily advocate its widespread use, the continuous play presentation mode offered by the Book Emulator could be used to facilitate the automatic delivery of lectures - without any human intervention.
Consequently, they have shown that this approach could be used to achieve significant productivity gains, for example, in lecturing time; the time that is saved could then be used to support a different study mode - such as tutorial discussion or problem solving.

3.2 Using Commercial Packages

A more conventional approach to the preparation and delivery of electronic lectures has been described by Anderson (1995). In his work, he outlines the use of a commercially available package for the delivery of course material. For a number of reasons he strongly advocates the use of Microsoft's PowerPoint (Grace, 1994). In addition to aiding lecture presentations, Anderson emphasises how easy it is to use this package in order to prepare paper-based course documentation and student handouts.

Within the University of Teesside we have been exploring the use of PowerPoint as an in-house standard for course delivery. Many members of staff now use this system as a means of delivering their lectures and making lecture material available to students (and other staff) by means of a local-area network. When asked to comment on his use of this development tool, the author of one electronic lecture course replied:

‘PowerPoint allows me to produce handouts copies of the slides the students get the new 3 slides on an A4 page with room to make notes Production of the lectures was no slower than word processing slides in fact I produced a template lecture and worked off that The background, transitions etc I use are different for each but if kept the same then the process would be even quicker Student reaction has been positive the colours, effects etc make the material attractive I've seen students previewing the coming lecture and viewing ones missed’

Many other academic organisations are also using PowerPoint in a similar way to that described above. Busbridge (1995), for example, is using this system as part of his 'Electronic Course Delivery' project at the University of Brighton; this involves converting eighteen physics lectures into electronic form and then augmenting them with sound and video. Similarly, in his 'lectures on Demand project at the University of Ulster, Anderson is also exploring the problems of adding audio narrations to his PowerPoint presentations (Anderson, 1995). As is the case in our own work, audio augmentation is intended to compensate for the absence of a lecturer - for example, in situations where the electronic lectures are being used as a support for private self-study by students.

3.3 Using a Programming Environment

In the early work that we undertook into the creation of electronic lectures, we used a conventional object-oriented programming environment in order to develop our materials (Kowalewski, 1995; Barker, 1996a). The authoring tool employed was the Asymetrix ToolBook system (Barker, 1993). Since ToolBook is a relatively 'open' programming environment, and because it supports OLE technology, the implementation of tools to support the development and use of electronic lectures is fairly straight-forward. Once lecture material has been produced, it can be made available to students by means of a copyright free 'runtime' facility or as executable files (depending upon the version of ToolBook that is used).

When designing and developing our electronic lecturing support environment it was necessary for us to provide software resources that would enable seven basic processes to take place: (1) the creation and maintenance of a set of electronic lectures; (2) the storage of these lectures within an appropriate database facility; (3) the delivery of the lectures within a suitably equipped lecture theatre; (4) the augmentation of basic lectures using hypermedia techniques (in order to convert them into suitable self-study resources); (5) the provision of student access to the stored lectures; (6) the provision of appropriate student-oriented tools to support self-study using the augmented electronic lectures; and (7) the collection of appropriate monitoring data and usage statistics.

Bearing in mind the above objectives, a generic presentation shell was prepared using the ToolBook environment. Essentially, this shell consisted of four basic types of slide: (1) an 'opening title slide' (giving the title of the lecture, its relationship to previous lectures and the name of the presenter); (2) an 'overview slide' (which provided access to more information - such as the objectives of the lecture, its viewing statistics and an overview of the material to be presented); (3) a 'conclusion slide' which was used to summarise the key points that had been made during a lecture; and (4) a 'template slide' which could be replicated and used as a basis for creating each of the remaining slides that a lecturer needed to use.

The template slide referred to above consisted of a fixed background within which was embedded a number of basic reactive control buttons that could be used for navigation purposes. Two basic types of navigation were possible: within-lecture (from one slide to another) and between-lecture. Three buttons were used for within-lecture navigation. These were labelled: 'next slide', 'previous slide' and 'goto slide ...'. The latter facility provided a mechanism for randomly accessing any of the slides within a given lecture sequence. The between-lecture navigation button was used to return control to a top-level menu facility that allowed users to move from one lecture to another. An additional background button labelled 'help' was available to provide basic information about using the system.

As a means of testing out and evaluating the package described above, we decided to convert a series of existing previously used OHP transparencies into electronic form. For this purpose the first ten lectures of a final year BSc course on human-computer interaction (HCI) were used for the experiment (Kowalewski, 1995). As far as was possible the first set of electronic slides that were created (Batch 1) directly mirrored the contents of the original OHP transparencies. As well as making direct copies, another sequence of 'augmented' lectures was also produced (Batch 2). The first batch of slides was intended for use by lecturers whereas the second batch

was aimed
at supporting students' self-study activities. Batch 2 lectures were derived from those in Batch 1 by modifying them in two basic ways. First, by converting certain words and phrases into reactive hotspots; and second, by adding 'information icons' that could be used to 'bring up' extra information relating to particular topics referred to in a particular slide.

4. STUDENT OPINION

In order to gauge students' opinions on our electronic lecture material (and this approach to teaching), two basic evaluative studies were undertaken. These studies were intended to assess student's attitudes and reactions to the use of the resources within two different contextual settings: (1) lecture mode and (2) self-study mode. Each of these studies is briefly described below.

Study 1: Lecture Presentation Mode
This investigation involved asking the lecturer responsible for the HCI course to deliver some of his lectures using the electronic course materials. After the lectures the group of students involved were given a questionnaire to complete (N=3 1; 52% return). This contained 10 questions which were intended to solicit their opinions and views on: the quality of the presentations; the quality of the resources employed; and the potential of this approach to teaching.

Study 2: Private Self-Study Mode
For this investigation the augmented electronic lectures were mounted on a server within a local area network. Students were then invited to access this material using PC-based computer terminals that were located at various points within the campus and remote to it. At the end of their evaluation of the material the students were asked to complete a questionnaire containing 38 questions (N=63; 100% return). The questions were organised into five basic sections that dealt with: the quality of the on- line lectures; their ease of use; the quality of the augmentation material; the potential of the electronic lectures as a learning resource; and details of the respondent.

Main Findings
When the questionnaires from the above studies were returned the data they contained was transferred to a spreadsheet package and analysed. A detailed discussion of the results is presented elsewhere (Barker, 1996b). Essentially, in both studies, students were very supportive of this approach to teaching - provided that copies of the materials would be made available to them. 61% of the lecture group (Study 1) stated that they would prefer this approach to the use of overhead transparencies. A similar percentage thought that electronic lectures were a much more effective way of presenting course material. Interestingly, given the choice between having paper-based and electronic copies of the materials, the majority of the students (77%) showed a
preference for paper-based copies compared to the 26% who would have preferred disk copies.

5. CONCLUSION

Despite their pedagogic shortcomings, lectures offer a cost-effective way to teach large groups of campus-based students. By using computer-based methods to support lecturing processes, the quality of lectures can be improved. Furthermore, through the use of appropriately designed augmentation processes many of their limitations and shortcomings can be overcome. Undoubtedly, electronic lectures that are made accessible through the Internet and the World-Wide Web will form an important building block for the development of courses that are to be delivered through any future virtual university facility.

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A/V Facilities and Guidelines for Paper Presenters

(from 3D and Multimedia on the Internet, WWW and Networks, 17-18th April 1996)

This document has been sent to all paper presenters at the Conference, well in advance.

This document is designed to help presenter give an effective presentation to a primarily technical audience and is derived from some past guidelines used for presentation to ACM Conferences in the USA.

This document contains the following sections -

1. Time Allocation
2. A/V Facilities and How to Use them
3. How to Structure you Presentation
4. Rehearsal of your Presentation
5. Your Presentation
6. The Time Limit
7. Radio Microphones
8. Questions

1. Time Allocation
The time of your presentation is given clearly in the program. It would be appreciated if you aim to speak for 5 mins less than your allotted time to allow 5 mins for Questions and Discussion.

2. A/V Facilities and How to Use them
We supply the following equipment at the Conference -

- single 35mm slide projector. Spare slide carousels will be provided.
- Triple standard VHS, SHVS and low-band Umatic video player
  (i.e PAL, NTSC, SECAM) with video projector. Also PAL Betacam SP.
- OHP
  We have the following rules about the use of the OHP-
  1. Not more than 10 lines per OHP transparency
     (with lettering around 25-30 point size minimum)
  2. We strongly recommend not using handwritten transparencies - use Word Processing or DTP facilities to lay out the text on your OHP's
  3. Professionally prepared OHP's are preferred

Slides versus OHP's
We strongly recommend using 35 mm slides rather than OHP's since they make your presentation look more professional.

There is a lot of software available now for preparing slides and it is easy to combine diagrams, text and images. PowerPoint is now example. Start with a good template and use font sizes > 18 point. Place boxes around important formulae and figures. Don't put too much on one slide.

The big advantage is that you have an editable version of your slides to modify for the next talk!

Rules about the use of Computers

1. We will not supply computers - you must bring your won laptop, software etc.
2. You must supply your own lead to connect from your PC to the video projector.

We recommend NOT using a computer unless you are very experienced and can always guarantee to get it to work. Given the time allocations in the program we wish to have very efficient change-overs between presenters. If you cannot get your computer to work at the last minute, this is likely to cause a major problem. We will not allow a time extension for you to get this working. Thus we recommend using slides and video. Computers can give very effective presentations (e.g. PowerPoint slides with fades and dissolves between successive frames) and for interactive demonstrations - but we have seen many examples of computer not working during the actual presentation even though they have been tested out beforehand. However, we know that real-time demonstrations are exciting, especially to the audience, and the resolution is often higher, at least compared to NTSC VHS videotape.

If you still wish to use a computer you MUST come with backup videos, slides and/or OHP transparencies that you can rapidly switch to in case of problems.

The Conference Auditorium has an ISDN2 line which you can use if you wish. Please contact Martin Oliver (address information below) about this in advance if you would like to use it for your presentation.

Rules about using Twin Slide Projectors

We can provide twin slide projectors, but once again we recommend not using this unless you are a very experienced presenter. Inexperienced presenters often get their slides out of synchronisation and then spend a lot of time looking at the screen and trying to get back into the right sequence. This is not easy to do if you are nervous. Your presentation will be severely affected - you will have lost the attention and concentration of the audience.

If you do require to use two projectors you can show two slides at a time synchronously. Duplicate your slides is necessary, do not rely on trying to move the slide projectors independently. You can also insert blanks (i.e. to give a black screen) when you want the audience to just look at one screen.

All audio-video material MUST be previously prepared and brought with you. Facilities for locally producing material are NOT available.

3. How to Structure Your Presentation

You must NOT read your paper that is already in the Proceedings. Everyone will have this with them and will have probably read it prior to your session. Ideally your presentation should complement your paper, not just re-iterate it. For example, you have opportunity to cover any developments you have made since your work was written up in Jan/Feb. This is quite important. With long lead times for today's conferences, you r work will have progressed considerably since the Proceedings were despatched to the printers. Take advantage of this for the benefit of your current work.

Concentrate on the main points you want to make. You are recommended to answer the following questions, and consider the following important points, when putting your presentation together -

1. What is the problem I am solving? Are there any previous solutions? If so, summarise them briefly
2. How did I solve the problem? How good is the solution?
3. What is the relationship of this work to other work in the field?
4. What lines of investigation does this suggest for future work?
5. What developments or advances have I made in my work since my paper was completed?
6. What are the unanswered questions or problems which still remain to be solved in this area? (i.e., your recommendations for future work)
7. If mathematical derivations are important in your work, refer you audience to your paper for most of the details, as mathematics is best absorbed in private at an individual's own speed.
8. Keep a logical thread running through your presentation which relates each part to the theme and helps the audience to comprehend the whole.
9. The main thing which will survive in the long term memory of your audience will be your visual images and/or animation, so be sure to include visual results in your talk, and make them of high quality.

If you answer these questions in your presentation and stick to the main points of what you have done, we can guarantee the audience will be interested. This is what everyone wants. Please ensure you do it!

4. Rehearsal of Your Presentation

All papers must be presented in English. If your natural language is not English or you have not done many presentations before, you are strongly advised to practice beforehand. Please ask your supervisor or manager to set up a session in your institution or company where you can deliver your presentation to a small group of colleagues. They can provide you with feedback and constructive help prior to the Conference.

Note that this IS also a very good idea even if English is your native language. ALL presenters are therefore recommended to do this.

A rehearsal will also give you a good indication of the length of your presentation. You need to ensure that your get the most important points in to the time available. Remember that at the Conference you do not get a second chance - you have only ONE session.

5. Your Presentation

We strongly recommend using slides rather than OHP's since they make your presentation look more professional. However, if you have to use OHP's then you are recommended to use professionally produced OHP's with large lettering, so that it is easy to read for an audience, and no more than 6-10 lines on each overhead transparency. Above all, you must not type 40 lines (e.g. as in this memo) and then photocopy it on to a transparency - it will be far too small to be read by the audience, and you will LOSE their interest in what you have to say. Similarly, photocopying diagrams from books or your paper is not good - generally they annotation and figure captions are far too small to be read on the screen. What you should do is take the substance of the diagram and add bigger captions etc (by a factor of 2-3).

Another alternative is to use and enlarging photocopier to enlarge the diagrams and captions before putting them on the OHP transparencies.

Remember that is now increasingly the case that the audience assesses the technical quality of what you say not only by what is in your presentation, but also the by the effectiveness of your visual aids and how smart they look. Someone who has prepared carefully for the event will come across more effectively and make a better impression. Thus most people will not use handwritten transparencies today (even though they could use multicolour pens and write in big letters) simply because it makes the presentation look as if it has been done in haste at the last minute.

If you use overheads, and need to point to the text or diagrams, always point to the screen (preferably with a laser pointer) not to the overhead itself (since your body would now obscure the view for half the audience.)

Start your presentation by outlining the structure of the talk, i.e. the titles of your main sections. Then summarise the main points of your talk in the conclusions at the end. The old guideline for preachers and politicians is still true for Conference and technical presentations - this is -

(i) Tell the audience what you are going to tell them
(ii) Tell them
(iii) Tell them what you've told them

6. The Time Limit

You have a maximum presentation time of 5 mins less than your allocated time in the program. The Chair of sessions have strict instructions to stop you when your time is up, whether you have finished or not. The reason is simple - it is not fair on the next presenter for you to overrun, as the session then ends up by overrunning and everyone is then late for the next event in the program. Remember also that any video extract you wish to show has to be included in your allocated time - you are NOT allowed extra time for this.

Remember a short effective presentation concentrating on the main points of your work makes a more lasting impact on the audience that a longer diffuse one. Your written paper contains all the detail - this should NOT appear in your presentation. Your objective is to get the interest and attention of the audience in your most important results - so that after your session is over you can enter in to discussion with people interested in your work. They will have ideas that you can use in your future work. One of the main objectives of the Conference is to promote interchange and interaction outside the formal sessions. The formal presentations are a means to achieving this goal, so your presentation should assist this.

Remember - the audience do really appreciate a shorter presentation which covers the main points and allows time for discussion. Much better to patronise the few than confuse the many. Session Chairpersons appreciate it too since it will help keep the session to time.

7. Radio Microphones

Radio microphones will be provided for all presenters.

Rae Earnshaw
Huw Jones
John Vince
Roy Middleton
March 1996

The AT&T Teaching Theater

The AT&T Teaching Theater was setup in 1991 at the University of Maryland as a campus wide teaching facility, and was designed to encourage more interactive and collaborative teaching. As well as the hardware provided, full time support staff are also provided.

Specifications

- 20 custom designed student desks to accommodate 40 students Each desk has 386 PC, 8MB RAM 142MB local hard disk and 17" high res monitor. All computers are networked. ors and recording console.
- 2 Video players
- 35mm slide projector
- CD player
- stereo speaker system
- laser disc player
- OHP
- audio tape player
- closed captioning decoder
- 3 remote control video cameras, one of which is normally focused on the whiteboard
- ceiling microphones
- All the video equipment produced NTSC images and can be projected on to either or both 4½ ‘ by 6' rear projection screens. Two projectors provide 1024x768 resolution.

Most of the audio-visual equipment is located in an adjacent room, and controlled by a somewhat complex control panel.

Sample Uses

- using the instructor’s wordprocessor as a blackboard. When students are asked questions their replies can be typed in and notes generated ‘on the fly’. Important to know the packages very well - don’t want to be fumbling with menus in front of the class
- student presentations
- class exercises
- groupware software is used to allow the students to write comments which appear on the large whiteboard anonymously, encouraging participation.

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Fostering Multimedia Instruction in Mathematics

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Abstract.
We introduce a coordinated effort to teach Mathematics, Physics and Chemistry through the use of Multimedia presentations, electronic Data Acquisition experiments and computer assisted instruction.

Introduction.
During the last decade, major advances have occurred in the development and use of instructional technologies, such as hypertext-based computer software and multimedia presentation systems. Instructional technology is only now beginning to find its way into the college classroom. When properly used, it has the potential to produce significant gains in both student achievement and attitude.

Multimedia presentations have the advantage that students can be reached at levels not currently tapped in the traditional classroom setting. Typically, students do not expect to actively participate in the lecture. They expect that the professor will come to class and tell them what they need to know; i.e., what material will be on the exam. The students' role is to copy all of this information into their notebooks and memorize each problem without analyzing nor synthesizing the material. However, many of the national studies and writings in education stress the futility of treating students like empty vessels that need to be filled [2]. We should take a different role, such as that of a coach, or a guide, who leads students in the right direction instead of trying to fill them with facts.

In multimedia presentations, students are expected to participate more. The main points can be enhanced by visual and auditory stimuli. Full-motion video clips can be presented without the usual fumbling with video tapes, records or film strips, allowing students to mentally wander off, forgetting the point of the presentation. Video cameras can be used to project live demonstrations to the front of the room for all to see. This has the added advantage that every student sees the same view from the same perspective. So, the students at the back of the room can see the demonstration and the students on either side of the professor can see the same thing. Simple simulations can also be presented and points made, which cannot otherwise be done with a piece of chalk. Moreover, the professor doesn't have to be an artist to produce convincing arguments and pictures emphasizing the concepts being discussed. If correctly done, the students will come away remembering a little more.

The MCP Project.
The institutional Mission Statement of the University of North Carolina at Wilmington cites Undergraduate Teaching Excellence as its primary goal. The MCP project represents a major effort by several faculty in mathematics, physics and chemistry at UNCW, to revitalize our instructional methods in undergraduate education. The project was created as a response to alleviate three major problems in our mathematics and science programs: 1) declining student retention rates, 2) inability of the students to transfer and correlate knowledge from one discipline to another, and 3) lack of motivation.

The MCP project was started in the Fall of 1992 with the support of an NSF grant. The idea of the project was to redefine teaching methods through the use of multimedia technology, and to restructure the first year sequences in Mathematics, Physics and Chemistry with a number of goals and pedagogical methods common to the three disciplines. Our instructional methods have been well received by our colleagues. and the University supports our efforts fully, as evidenced by the recent influx of a large quantity of instructional technology equipment. Presently, there is at least one full multimedia technology classroom in every academic building on campus, and all faculty who have requested an office computer have been provided one by the University. Blueprints for our new science building and a new wing for the Mathematics building, include technology classrooms carefully designed with interactive input from thefaculty. In addition, the Provost's office has recently createdan Assistant Vice Chancellor for Academic Technology position which has been filled by one of the members of our team.

The Center for Teaching Excellence has sponsored a large number of two and a half day workshops in the use of multimedia and 1/3 of our campus faculty have attended the workshops.

If success is not measured by the sheer number of classes in our campus involving instructional technology, it is certainly evident by the renewed enthusiasm in teaching and learning exhibited by our faculty and students.

Project Goals.

The MCP project emerged out of our common concern for both locally and nationally decreasing enrollment and retention rates of students in mathematics and the physical sciences. In addition, while we are not aware of many documented studies on the ability of students to transfer and utilize their knowledge from one subject to another, we are well aware that a problem exists.

It is not uncommon to hear anecdotes of students who have just learned to integrate f(x)) =1/x in their calculus course and yet have trouble recognizing the integral of f(T) = 1/T in the context of entropy in their physics course. We have also heard chemistry professors complain that their students do not know any physics, and physics students claim that they were never taught the mathematical concepts that their professors expect them to know. This story is all too familiar.

In view of these problems, the MCP project was envisioned with the following goals in mind:
Transferability: Students should enhance their ability to transfer knowledge from one discipline to another. The importance of this goal was based on our continued observations that often students were not able to recognize concepts in one course which they had previously encountered in another.
Motivation: Traditional chalkboard lectures seem to have lost their appeal to all but a few of the best students. We wanted a new and creative idea to renew in our students the excitement and curiosity for learning, which we all possessed when we were children.
Retention: We are concerned with both the ability of the students to retain knowledge as they progress to higher level courses in their fields, and our ability to retain our majors. A common complaint we have often heard from our students was “Oh, we never learned that” when we knew quite well that the concept under discussion had just been introduced in a previous course, or sometimes even in the same course.
Synthesis. We want our students to crystallize the concepts and tools we teach them so that they can recognize when these concepts can be used to solve and model real problems. This requires that they gain a clear global understanding of the subject matter without sacrificing rigor and attention to detail.

There have been numerous national studies suggesting that we need to make changes in the way we teach. The National Research Council's 1991 report Moving Beyond Myths: Revitalizing Undergraduate Mathematics, states [1]

> “The way mathematics is taught at most colleges - by lectures - has changed little over the past 300 years, despite mounting evidence that the lecture-recitation method works well only for a relatively small portion of students. Moreover, the syllabi of many undergraduate mathematics courses and the template-style textbooks are detached from the life experiences of students and are seen by many students as irrelevant.”

Mathematics is not the only discipline to which this statement can be applied. Many of our faculty have very similar concerns in their disciplines. This has been supported through discussions with the participants of our numerous workshops on hypermedia instruction, which we have given recently. (In fact, we have attracted one third of our faculty and several small groups of educators and administrators from our local area to these workshops.) Typical comments we hear are: The students are not learning the material; they do not find it relevant; they are not excited enough to work; and, they do not retain what they have learned. In summary, we are all faced with the same problems and are looking for new instructional techniques.

The Classroom.

Our Calculus classroom serves a dual role as both a mathematics laboratory and a master classroom. The classroom tables are arranged in a double horseshoe with all of the student computers aligned along the walls and a multimedia instructor station facing the opening of the horseshoe. This arrangement makes it possible for the instructor to see all the computer screens from the front of the classroom. This proves to be the most convenient arrangement when students are taking tests, since the only computer directly in front a student is his/her own.

The instructor's station is a complete hypermedia 486, 66 Mhz computer with a 16-bit sound card, a video overlay capture board and dual spin CD-ROM. Connected to the system, we have a full color, full video projection panel, a pioneer laser disk player and an Elmo presentation unit which serves as our electronic "blackboard". The instructor's file server is connected through Lantastic 6.0 to the campus communication backbone and to a second multimedia file server used to support the classroom stations. The 15 classroom stations are 486, 33 Mhz computers each running MathCAD, Excel and AmiPro locally. The system is served by two HP laser heavy duty laser printers, and two CD ROM's resident in the file servers, from which students may access resources such as Microsoft Bookshelf.

Our calculus classes meet for fifty minutes, five days per week. On the average, two of these days are allocated to hypermedia presentations. These presentations are designed to cover the particular topic at hand, the fundamental theory and a few selected examples. The concepts are further enhanced by a few simple simulations, sound events, or a short video clip. In preparing these presentations, one needs to be careful not to pack more information than is typically put into a class lecture. The idea is to explore a variety of ways to get across that one point, which is important to the theme of the day. Students respond and learn in a variety of ways, so that having the availability of several media to present a concept will increase the chances that a student will relate to the material.

The Program.

The MCP project consists of a coordinated (as opposed to "integrated") method of instruction targeted to the first year sequence of courses in Calculus, Physics and Chemistry. The courses are separately taught by faculty in their corresponding departments, but we share the same technology, software and pedagogical techniques.
The main innovations in our instructional methods are:
Full hypermedia presentations using Toolbook 3.0, laser disks and CD ROM's.
Electronic “blackboards.” No chalk is used in any of our lectures.
A Laboratory component utilizing electronic data acquisition (DAQ).
A writing component.
Cooperative learning projects.
All windows based software.

In our Calculus course the emphasis is modeling. All the major ideas in our course are introduced analytically, graphically and numerically. These are carried out through multimedia presentations; labs using data acquisition, numeric and symbolic computations; class projects, and writing lab reports.

Multimedia Materials.

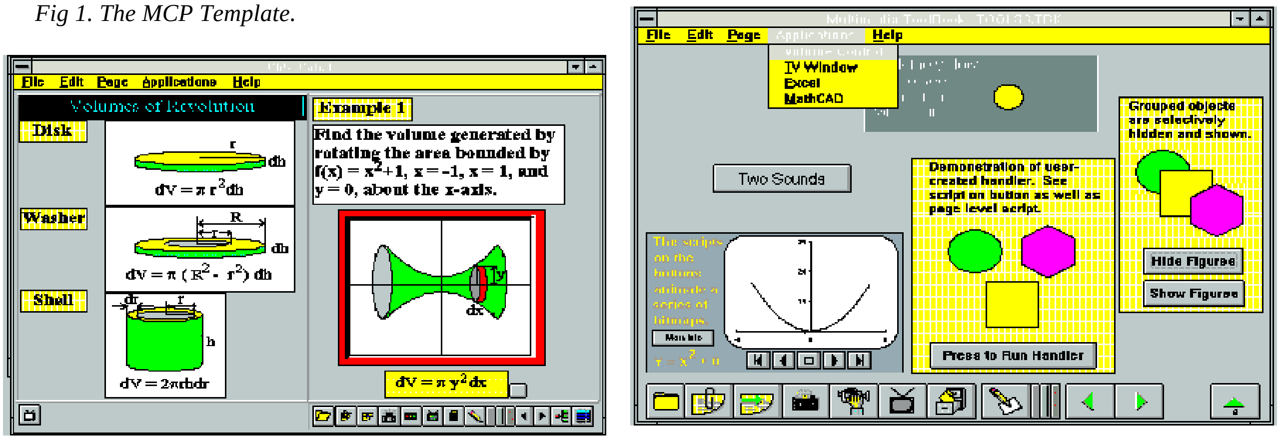
While multimedia instruction has received a much attention by publishers and other commercial enterprises, very few commercial materials have been produced for mathematics instruction.

Consequently, we have for the most part developed our own materials.

Our centerpiece for multimedia instruction is a Toolbook 3.0 template developed by our project. The template incorporates menu items to launch other applications, and has built-in buttons to navigate throughout the instructional toolbooks. It also contains a variety of features which make it extremely easy to create audio and video clips and to “clean up” pages when you leave them.

The MCP template had become very popular in our campus, and most faculty begin all their toolbook applications using this template as a starting point. Many faculty from other institutions have also participated in our workshops and seem to be pleased with the versatility of the template.

Fig 1. The MCP Template.



Our toolbooks are arranged by chapters, which follow closely the standard "fat" calculus text typically selected by departmental committees. However, since many of the interesting situations that we want our students to model involve exponential functions and simple first order differential equations, we strive to introduce derivatives of transcendental functions and Euler's method early in the curriculum.

The presentations, which we produce for the project, use Toolbook as a control center to navigate through video and audio events, other Windows and DOS applications, and simple simulations within the module itself. For example, imagine the favorite example of the cycloid. Typically, the professor will draw a wheel on the board and after waving his/her hands in the air, will hope to convince the class that a point on the rim of the wheel will trace out a particular path. In our presentation, we show an actual wheel rolling across the screen (see fig. 2). This motion can be repeated over and over giving the class the opportunity to describe the path traced by the moving point. After a few guesses, the actual path is displayed plotted on the background and the wheel is again allowed to roll across the screen. However, this time the class can see that the point on the rim does indeed follow the prescribed path.

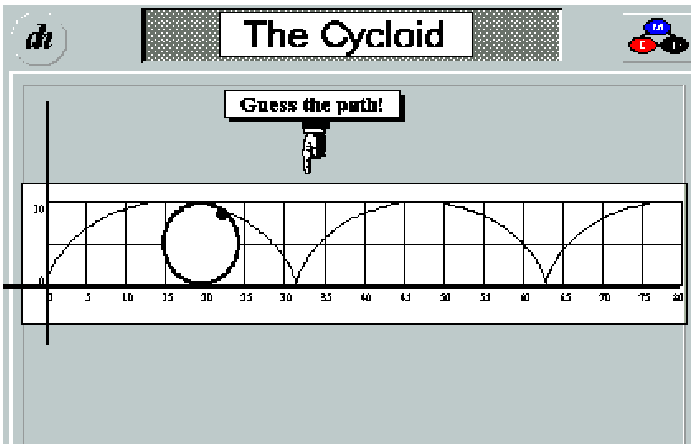


Fig 2. The Cycloid.

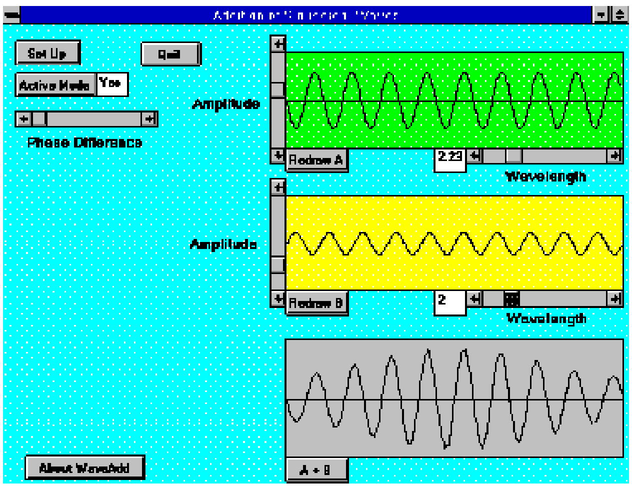
One of the benefits of such hypermedia presentations is this ability to go back and easily repeat the events. This is particularly nice for reviewing material from a previous class. The students can actually see the exact images and hear the same sounds as they had observed the day before. Typically, it only takes a couple of minutes at the beginning of each class to review the material covered in the last lecture, as well as emphasizing what is important.

One of the things that hypermedia brings into the classroom is the possibility of showing events that cannot be produced on the board or are impossible demonstrate in the classroom. This means that we can exemplify the concepts with applications that we never would have considered before. We can do more to show that our subject is exciting and relevant to the real world. By using this technology appropriately, we have the opportunity to widen the experiences of our students.

Finally, using a presentation device, such as ToolBook, we can access other software programs at the click of a mouse. There are numerous mathematical packages, which have appeared on the market in the past decade. Many of us have developed programs in languages such as Basic, Pascal and Fortran, which bring out interesting features, or problems, encountered in our courses. These can often be brought up and projected on the screen. In our classes we rely on software such as MathCAD, Visual Basic, and Excel. The MathCAD program is very useful for doing quick and/or tedious computations. It opens up the possibility of exploring the limitations of functions, strategies and techniques. What if questions can be posed and answered on the spot, instead of postponing the question until the next day (when the students have forgotten why they asked it!).

Visual Basic is relatively easy to use. It is windows-based and object-oriented. The finished product can be professional looking and even looks like an extension of the Toolbook presentation. The use of such software allows one to write simple programs for producing simulations, based on mathematics. It is more useful in developing an interactive module for student explorations in the laboratory setting. The sample on fig. 3 shows a simple module for demonstrating the addition of sinusoidal functions. In this case the student can control the amplitudes, wavelengths and phase difference for the two waves.

Fig 3. Addition of Sine Functions.



Some of the analysis of data obtained from computer based laboratory experiments is done in Excel. Thisl package can be used to easily produce professional looking graphs. Such graphs can then be pasted into reports, or used to make points in class presentations.

AmiPro is a Windows-based word processor, which allows easy equation insertion. Our students use AmiPro to write their scientific reports, including proper mathematical grammar and graphs cut from other packages, such as MathCAD and Excel.

In addition to our toolbooks, which are used mostly to introduce new material in a formal manner, we have also developed a large number of MathCAD worksheets and Visual Basic routines. These are provided to the students, or when appropriate, constructed by the students. With these interactive worksheets and routines, the students can explore and solve problems which are much more interesting, but otherwise intractable without the use of a computer. Many of our students use our course as the final leverage to convince their parents to purchase that computer they always wanted.
By the end of one semester of our calculus course, our students feel quite comfortable creating their own MathCAD

worksheets, and finding their own way around Windows. These ideas are reinforced when they use the same skills and software programs in their physics and chemistry courses. In fact, it is possible for our calculus students to perform an experiment modeling the kinetics of bleaching a dye and later redo exactly the same experiment in their chemistry course, stressing the chemistry of the oxidation reaction.

The Labs.

While our course is constrained by a traditional syllabus, it is our contention that mathematics is best learned when accompanied by exploration and applications. Therefore, we have written a laboratory manual to accompany the course. The labs range in scope from simple exercises to acquaint students with the sophisticated software packages used, to more challenging projects in calculus applied to physics, chemistry and other sciences.

There are basically three types of activities covered in the lab manual. To enjoy mathematics students must be given an opportunity to “try out” their own ideas and make their own discoveries, thus some of our lab activities are of an exploratory nature. The explorations may involve just looking at one parameter families of functions, or numerical simulations to understand the nature of derivatives and integrals. There are, of course, several highly structured labs focusing on specific skills that we want the students to acquire, such as the method of central differences, numerical integration and Newton's method. However, the concepts are introduced in an applied setting.

The emphasis of our laboratory instruction is mathematical modeling. The mathematical models may be continuous or discrete models with “canned” data, or they may involve modeling physical phenomena through electronic data acquisition. We often perform live experiments in the classroom, display the graph of the data "on the fly" with the projection system. Correlating the graph of the data as the event is taking place, greatly enhances understanding and makes a durable impression. The experience becomes indelible when the instructor engages the students in performing the experiment with different initial conditions.

Through the network, the students can then load the data into MathCAD or Excel for analysis. We use a data acquisition system by LOGAL. It is Windows based, so that all tables and graphs can be cut and pasted directly into a word processor, resulting in professional looking lab reports. Students are expected to convey their knowledge orally and in writing. The latter can be at times a painful activity even for the students who excel in their composition classes, but at the end most students recognize that scientific writing is an important and necessary skill.

As mentioned previously, we have the students make use of MathCAD. Currently we are using version 3.1 and we have just purchased version 5.0; the instructor's station is equipped with MathCAD 5.0 Plus for presentations. The labs have been compiled in our lab manual [3]. Most of the calculus lab work is done using MathCAD for Windows, which is relatively free of the programming expertise needed in other mathematics packages, such as Mathematica or Maple. In fact, MathCAD has a menu for symbolic manipulation which utilizes the Maple kernel.

The labs typically involve graphing, analysis of functions, fitting data, and explorations of fundamental concepts in calculus. Data analysis begins with a linear regression lab, followed by power, exponential, and quadratic models. Examples of models in this portion of the course are predicting the age of the universe from Hubble's original data for moving galaxies, verifying Kepler's third law, and studying the exponential and logistic laws of population growth. The sample shown in fig. 4 is a worksheet for the application of Newton's Method to determine the minimum surface area of a soup can, which has additional material for the more realistic problem of a container with seals. (Try to solve this problem in a traditional classroom!)

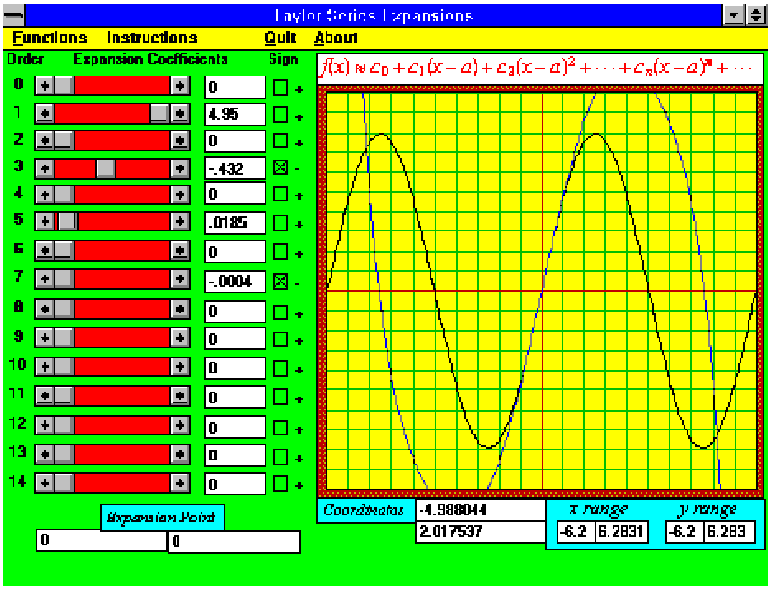


Fig 4. Surface Area of a Soup Can

Also, we have written some Visual Basic modules for the calculus labs. In these labs we use such modules for exploring differential equations as well as Taylor polynomials.

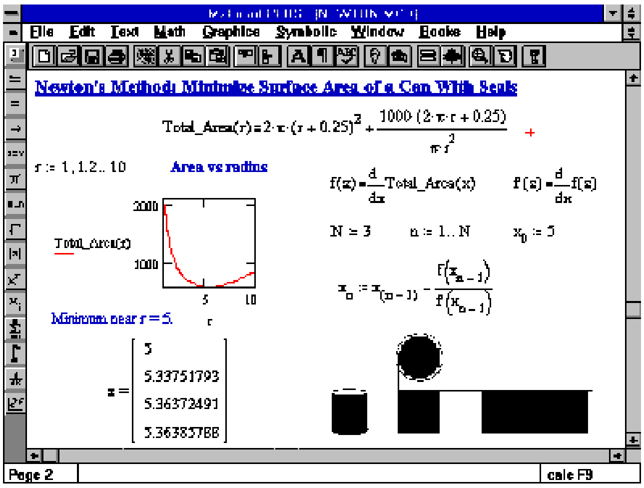


Fig 5. Visual Basic Routines.

Assessment.

The most challenging part of the MCP project is the assessment of the effectiveness of the program. Our exams are usually designed so that 50 to 60 percent of the problems are of the traditional type, and the rest necessitate the use of the computer. Our analysis show that our students perform about the same in the traditional problems as those who are not involved in the project. In this regard, we can at least say that no damage has been done. On the other hand there are so many other unmeasured skills that our students acquire that we now find it increasingly impossible to go back to the traditional classrooms. For example, by the end of the semester, we turn students who had never touched a mouse, into competent PC users. Their writing skills also show a tremendous improvement, and their final reports, after numerous corrections, exhibit features of good scientific writing. If nothing else, we have completely wiped out any absenteeism problems we may have had in the past. Our students enjoy coming to class, and they learn to enjoy sharing their mathematics experiences with other students.

Acknowledgments

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Enhancing Classroom Presentations ....

in General Biology Using Multimedia

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Introduction

The use of multimedia in instruction is not a recent development. Classroom instructors have traditionally combined oral presentations with text and various types of graphic illustrations. For example, beautifully illustrated flipcharts have a long history of use in anatomy and morphology courses. The projection of images from film has been used for most of this century, and overhead projectors continue to be standard equipment in most classrooms. Many of us may remember the days when reel-to-reel tape decks were the state-of-the-art and audiotutorial approaches were popular, or when closed-circuit TV was the new way to efficiently deliver instruction to large classes. Among the justifications for laboratory instruction is the claim that students learn better when they can "get their hands on" materials, and by allowing students to touch and manipulate objects we add another medium to their learning experience. We view all of these efforts to include a variety of perceptual aids in instruction as examples of the use of multimedia. The recent excitement over multimedia is centered on the use of computers and related peripheral devices to deliver information. Multimedia is a rapidly growing industry, and its presence is expected to increase greatly in homes and the work place by the turn of the century. A new term has been coined to describe this education and entertainment market - "edutainment." Entertainment giants like Disney, Viacom, and QVC are battling for control of large shares of these markets, and new periodicals devoted to multimedia seem to be cropping up monthly. Some universities are even offering courses for credit in multimedia. For instructors who are unfamiliar with this new technology, separating hype from realistic expectations may not be easy.

What claims have been made concerning instructional multimedia? Some view computer-based multimedia technology as a means of lowering the cost of education by reducing the human component in the learning process. There is a belief that multimedia will save teachers' time in preparing instructional material and, in the case of college professors, allow them to redirect this time toward other endeavors such as research. Others think that this technology is a solution to educational problems that are in the public eye, such as low scores on standardized tests in science and other disciplines. But, while computer-based multimedia presents the opportunity to improve classroom instruction, we suggest that instructors approach this new technology with a critical and cautious perspective. It's clear that computer-based multimedia will have important impacts on education, but what are the central issues that must be considered when bringing multimedia into the classroom? What should be the goals of using this technology, and what are the advantages and potential pitfalls of using multimedia technology? Does multimedia really save instructors time? Is it really cheaper to use multimedia to deliver effective instruction? We will address these issues in the context of describing a project, undertaken by the General Biology Program at the University of Minnesota in the summer of 1990, to use computer-based multimedia in large lecture courses.

Why bother with computer-based multimedia?

There are a number of ways to include computer multimedia in instruction. For instance, in the lab component of one of our courses we make extensive use of interactive computer simulations in small group problem solving activities. In this paper, however, we will focus only on the use of multimedia in large lecture classes. Given the caution we suggest, some may ask whether the investment of time and money required to bring computer multimedia to lecture presentations is worthwhile. This is the question that must be answered by all those who are considering the use of computer multimedia. Our primary motivation for adopting this technology was to improve the quality of students' learning through more effective use of visual materials. Pictorial representations of structures, processes, and relationships are widely used in biology education, as they are in other fields of instruction. As biology teachers one of our most challenging tasks is to help students understand complex topics that are far removed from familiar contexts. To do this we often use illustrations to make abstract topics more concrete or to convey concepts for which words alone are simply inadequate. The use of pictorial representations to accomplish these goals is strongly supported by research in cognitive psychology (Levie and Lentz 1982, Levie 1987, Levin et. al. 1987, Winn 1987). Although much of this research has focussed on illustrations that accompany text, the results of studies of illustrations in oral presentations show effects that equal or exceed those of illustrations in text (Levie and Lentz 1982). In studies of learners ranging from grade school to college, the effects of illustrations include increased recall and comprehension of material, increased motivation and interest, and the cultivation of cognitive skills (Fifield and Peifer 1994).

But what do computer-based images offer that chalkboards, overhead transparencies and photographic slides do not? Computers give us the ability to fairly quickly create illustrations, animations, and digital video for particular purposes and to integrate this wide range of media into lecture presentations. Since no two instructors or groups of students are the same, we also have the ability to customize images to suit their needs. Among the most common conclusions arising from research on illustrations is that students require prompting and guidance in order to process illustrations with adequate depth and in the proper context. Using our system, which keeps instructors engaged with students in the learning process, sophisticated illustrations can be analyzed during lectures to help students who might otherwise fail to benefit from the illustrations. We have also found that animations are a particularly powerful form of representation. By animating processes, such as chemical reactions and viral replication, we have added a novel, effective dimension to our presentations. Computer animations are not only more realistic representations of structures and processes, but they model thinking skills, such as three dimensional imaging, that we want our students to develop. Finally, computers and software that simulate processes such as genetic crosses and evolution allow our instructors to integrate interactive problem-solving activities, usually reserved for small groups, into large lecture classes.

The context of the project

The General Biology Program administers two introductory biology courses, which include both biology majors and non-majors, with a combined annual enrollment of 3000-3500 students. Instructors from four academic departments serve as lecture instructors in our courses, teaching once every 1-3 years. Graduate students from these departments serve as teaching assistants in the laboratories, but some have also played a significant role in our multimedia project. Funding for our project began with a $125,000 grant from a University fund dedicated to improving instruction in large undergraduate lecture courses. An additional $50,000, from varied sources, has been spent over the course of the project to add additional hardware and software.

Fundamental commitments of the project

A number of commitments guided the project from the start. First, it was not our goal to replace human instructors with computers. We were not looking for a way to reduce interactions among instructors and students, but for means to maintain and improve the quality of teacher/student interactions. Computer multimedia can be used in a number of ways to enrich the interactions between students and teachers; it should not be used to remove teachers from the learning process. Second, we wanted to produce and use materials that in our best judgement were appropriate for our students and would enhance their learning. We envisioned a rich library of images from which instructors could select material for presentations. Next, we knew that if our excursion into multimedia was to be more than an expensive and failed fad, instructors would need to be encouraged and supported in their use of this new technology. We needed a multimedia system designed with college instructors in mind; one that allowed presentations to be easily assembled and delivered with a minimum of technical knowledge.

Multimedia hardware and software

We chose to base our system on the Apple Macintosh computer for a number of reasons. Because Macintosh software is designed around a simple graphic interface, those with little or no previous experience on a Macintosh can quickly learn to use the computer. Also, a wide range of software is available for producing multimedia content, and the Macintosh can be easily interfaced with peripheral devices (e.g., slide and flatbed scanners, CD-ROM drives, tape backup systems, removable hard drives) that are used to work with multimedia content. Because hardware and software developers must follow strict guidelines from Apple Computer, products produced for the Macintosh have few compatibility problems. Four years after our initial decision we have no regrets about choosing the Macintosh, but of course, those considering the use of multimedia should seriously consider the advantages and disadvantages of the other platforms before making a major investment of time and money. With our initial funds, we equipped three large lecture auditoriums with multimedia presentations stations. In addition a workstation in the Program office was dedicated to producing content and assembling presentations. The lecture auditoriums were equipped with ceiling-mounted color video projectors (5-inch lenses), videodisc players, Macintosh IIcx computers with 20 MB (megabytes) of RAM (random access memory) and 8-bit graphics cards, 40MB internal hard drives, color monitors, and external removal 44 MB SyQuest drives. The SyQuest drive reads a removable 44 MB cartridge, which is used to transfer presentations to the auditoriums. Videodisc and computer outputs are fed to the projectors through panels on the auditorium walls. The projectors are switched between displaying computer and videodisc output by pressing a channel button on a control panel mounted next to the computers. All the hardware sits on an inexpensive steel cart that can be rolled out into the auditorium and locked up between lectures. During lectures, instructors can position the carts as they wish, and easily move among the computer, the overhead projector (which remains a useful presentation tool), and their lecture notes.

The workstation in our Program office was earmarked to create multimedia materials, archive those materials, and assemble presentations. The workstation was initially equipped with a large hard drive, color flatbed scanner, external SyQuest drive, a videodisc player and monitor, and an assortment of graphics software.

Over the three years of the project we have added two more computers in our Program office because of the great demand to produce materials and assemble presentations (Figure 1). We also added a slide scanner, another flatbed scanner, and two large hard disk drives. In each of our computers we expanded the RAM to 20 MB and added 24-bit color graphic cards. The 24-bit color graphic cards gave us the ability to produce and display photograph quality images. JPEG (Joint Photographic Experts Group) cards, which allow compression and quick decompression of large graphic files, were added to each computer. As our collection of images grew, we added a 1.2 gigabyte digital audio tape (DAT) drive that is used to automatically backup our database on a regular basis. Each workstation was connected to a battery-charged backup power supply to prevent the loss of material work due to sudden electrical power failures. We added a 128 MB optical floppy drive so faculty could keep running archives of their presentations without filling up the computer hard drives. We also added an external CD-ROM drive to one workstation.

Figure 1. The workstations that are used toassemble multimedia presentations.

Recently, the CPU's (central processing unit) in our auditoriums were upgraded to Quadra 650 computers. Each has 24 MB of RAM, internal CD-ROM drive, and a 500 MB internal hard drive. In the near future, we plan to install new video projectors that have 8-inch lenses and throw a brighter, sharper image. Table 1 lists the current configuration of the preparation and presentation workstations. As is clear from our experience, multimedia technology changes rapidly and to stay near the leading edge of the technology requires ongoing investments of time and money.

Table 1. Current configurations of the three multimedia workstations in the General Biology Program and the multimedia presentation systems in three lecture auditoriums.

Workstation 1
- Macintosh IIci accelerated with a 33 MHz 040 DayStar accelerator card, 20 MB memory, 80 MB internal hard drive
- Macintosh RGB color monitor
- RasterOps 24mx color graphics board
- Mirror Quick! JPEG accelerator board
- Imprimis 1.2 GB external hard drive
- ClubMac 525MB external hard drive
- MagicDrive 1.2 GB DAT, tape backup
- Mirror 128 MB removable optical floppy drive
- Mirror Technologies RM42, removable hard drive
- Microtek ScanMaker 1850S, photographic slide scanner
- Pioneer LDV-8000 laser disc player
- Sony 13-inch color NTSC monitor
- Apple CD-ROM drive

Workstation 2
- Macintosh IIcx, 20 MB memory, 80 MB internal hard drive
- Mirror Quick! JPEG accelerator board
- Macintosh RGB color monitor
- RasterOps 24si Colorboard (24-bit)
- Rodime Cobra 650 MB external hard drive
- Mirror Technologies RM42, removable hard drive
- Microtek ScanMaker 600ZS, flatbed scanner

Workstation 3
- Macintosh IIcx, 20 MB memory, 40 MB internal hard drive
- Mirror Quick! JPEG accelerator board
- Macintosh RGB color monitor

- RasterOps 24si Colorboard (24-bit)
- Rodime Cobra 210 MB external hard drive
- Mirror Technologies RM42, removable hard drive
- Microtek ScanMaker 600ZS, flatbed scanner

Presentation system in three lecture auditorium
- Quadra 650, 24 MB memory, 500 MB internal hard drive, internal CD-ROM drive
- Mirror Quick! JPEG accelerator board
- Macintosh RGB color monitor
- RasterOps 24mx Colorboard (24-bit)
- Mirror Technologies RM42, removable hard drive
- Espirit model 1700 color video projector
- Covid model 700 graphic/video interface
- Pioneer LDV-8000 laser disc player

A major effort during the first two years of the project was the production of still images and animations for use in instruction. We now have an image library of over 2500 computer graphics, animations, and QuickTime movies, but we continue to produce new material and modify existing items to suit the needs of individual instructors. Most of the material in our image library has been created by graduate students in biology, and by the staff of the Program. The graduate students also assist instructors in preparing materials and assembling presentations. As discussed below these graduate students have played an indispensable role in this project.

To produce most of our illustrations we use 8-bit paint programs, such as Studio/8¬. Eight-bit images draw on a palette of 256 colors, whereas 24-bit images are created from a palette of over 16.7 million colors. These 24-bit images can be stunning, but they are also memory intensive. If you don't need images of photograph quality, stay with the smaller 8-bit images. DeltaGraph Professional and CricketGraph III are used to produce graphs and charts, and Adobe Photoshop is used to capture and manipulate images from slide and flatbed scanners. Photographs captured by these means are saved in 24-bit color, and then JPEG compressed to reduce their file size. Macromedia Director, Adobe Premiere, and QuickTime are used to produce animations and movies on topics for which motion, sound, and spacial relationships are important. For example, for instructors lecturing on speciation we have created a QuickTime movie featuring images of eastern and western meadowlarks, accompanied by their distinctive vocalizations. Commercial videodiscs are also tremendous sources of still images and motion video sequences, and they are used extensively in our courses.

Because there was little multimedia content available when our project began, we were forced to produce our own material. But with the growing interest in multimedia, the amount of commercially available multimedia content is on the increase. CD-ROM technology appears to be the vehicle for publishing multimedia content in the near term. On a single CD-ROM, 650 MB of multimedia content can be stored. Using MPEG (Motion Picture Experts Group) compression technology, 74 minutes of full-screen, full-motion video with CD quality audio can be stored on a single CD-ROM. Expansion cards, which contain the chips for playing back this MPEG compressed content, are anticipated to be available during the summer of 1994. They are also expected to be relatively inexpensive. Some experts predict that the MPEG chips will be integrated onto the motherboards of computers in the not too distant future.

Coordinating multimedia presentations

One of the challenges of using multimedia in classroom presentations is finding a way to conveniently organize and access material when you need it. At the time our project began, there was no multimedia presentation software that was easy to use, integrated a wide range of media, and was designed for use in an educational setting, so we developed our own. The presentation software we produced is called MacPresents - Multimedia Presentation Manager (MPM). It acts as a shell within which multimedia items can be organized and coordinated for lecture presentations. In the MPM, up to six pulldown menus can be defined by the user for text, MacroMedia Director animations, QuickTime movies, videodisc stills and movies, and any graphic that is in PICT file format (e.g., digital photographs, drawings, charts, and graphs). Items for use in a presentation are loaded into the pulldown menus, and sequences of the items are assembled using a script editor. These sequences are stored as separate presentations in a script pulldown menu (Figure 2). Keyboard arrows or a set of arrows at the bottom of the screen allow users to navigate through a sequence of items in a script. Using the script pulldown menu, users can always see where they are in a presentation, and quickly move to any item in the script. In addition, all items in the user-defined pulldown menus remain accessible while running a script, so users are not restricted to a predetermined sequence of items. Multiple thumbnail representations of PICT files can also be stored on screen in RAM for quick recall to full screen display. Computer animations are displayed with a control panel that permits instructors to fully control the progress of the animations. Finally, the program has text and paint tools for creating text slides, and a videodisc editor for previewing, selecting, and controlling the display of still images and movies from videodiscs.

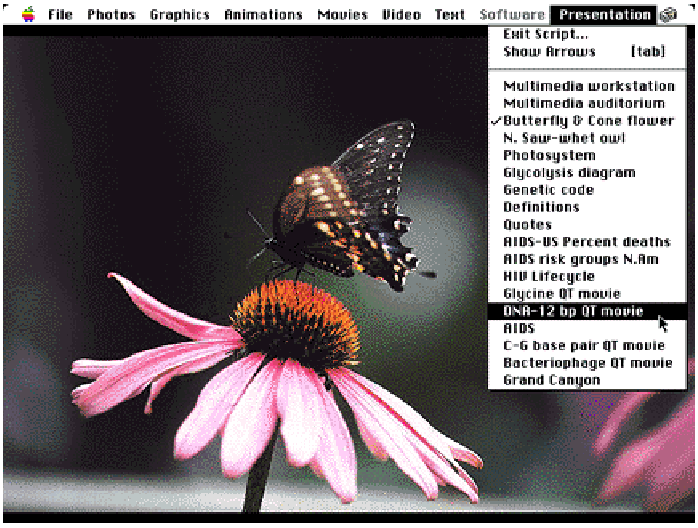

Figure 2.   A view of MacPresents - Multimedia Presentation Manager (MPM).Moving the cursor to the top of the screen as shown here, reveals pulldown menus containing all the items available for presentation. The script menu, entitled Presentation, contains all the items in the script currently being run. The check mark indicates the item currently being displayed. Items in a script can be randomly accessed through the script by selecting them with the mouse. Any of the items in the other pulldown menus can also be selected and displayed using the mouse.(Photo © 1991 Noel Dunn).

Managing a multimedia database

To help us store, locate, preview, and select images from our image library, we developed MacPresents - Multimedia Database Manager (MDM). Although PICT files, movies and animations can be stored with each MPM presentation, it is more efficient to have a centralized database of files stored on a large hard drive so it can be administered by a central manager who can control the quality of materials being added to the database. Using the MDM, the image library can be searched hierarchically, alphabetically based on file name, and relationally based on key words (Figure 3). Information stored with each image includes its location, size, file type, color depth, file size, dimensions, source, description, and a memo field for notes. Using the MDM, images in a database can be previewed, selected, and automatically exported to pulldown menus in the presentation software.

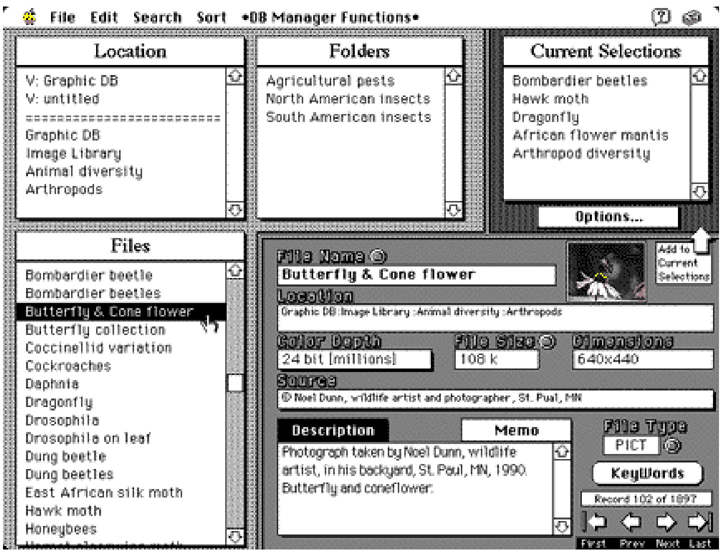

Figure 3. MacPresents - Graphic Database Manager (MDM) helps manage multimedia libraries, and allows users to locate, preview, and export still graphics, animations, and QuickTime movies to pulldown menus
in the MPM.

The role of graduate students

We knew that the success of this project rested largely on encouraging faculty to use multimedia appropriately in their lectures. Therefore, in our original grant request, we asked for permanent funding to hire graduate teaching assistants to work with faculty members. These graduate students are selected on the basis of their teaching experience and interest in learning about multimedia technology. Even if they are completely inexperienced with Macintosh computers, a relatively brief period of training provides them with the skills they need to assist faculty.

The graduate students acquaint faculty with the hardware and presentation software, help them become familiar with the contents of our image library, consult with faculty concerning multimedia materials needed for upcoming lectures, create new materials, and assemble presentations in the MPM. Through training provided by the Program and their experience working with a number of faculty members, the graduate students learn how to design effective materials and how to use those materials appropriately in lectures. They pass this knowledge on to instructors who, at least initially, are less familiar with the technology. In this model, the faculty/graduate student mentor relationship flows in both directions. As a result of faculty/graduate student collaboration, faculty are encouraged to critically examine their teaching and to integrate new technology, and graduate students learn how to use multimedia technology in undergraduate instruction and have the opportunity to exchange ideas with experienced teachers. Since these graduate students are the faculty of the future, we expect their experiences in this project to have impacts well into the future.

Focusing on content

With the software and hardware available today, the challenge is not so much to create multimedia presentations as to create instructionally appropriate presentations. We do not have the space to discuss all the design issues that producers and users of multimedia encounter, but we can highlight a few. We have found that it is best to keep illustrations as simple as possible. Include only what is really needed for a particular instructional goal, and leave the rest out. If different instructors want different amounts of detail, several versions of a single item can be produced. A related issue concerns the use of labels in illustrations. Illustrations with too many labels or with labels that are too small to read frustrate students. Keep labels to a minimum, and be certain that your illustrations and labels are large enough to be seen from the rear of the lecture room. Color can be used very effectively to convey meaning in an illustration, but again, the fewer colors the better. Another issue concerns the use of items consisting only of text. Although a screen of text containing a pertinent quote or lecture outline is occasionally useful, we believe that multimedia systems are not the way to convey text to students. Rather than filling screen after screen with text, use a lecture hand out. Finally, if you are interested in producing computer animations, is the effort required to create 3D animations worth the investment, or could you produce effective 2D animations in less time?

These are some of the issues that we have encountered in the process of producing and using multimedia content, but many of the same issues apply to commercially produced material. The number of companies supplying multimedia instructional materials will certainly increase in the near future. Just as with instructional items we create for ourselves, we must ask whether commercially available materials are appropriate for our students. In the process of trying to please a broad audience, multimedia producers sometimes supply products that are appropriate for no one. Be a critical consumer or you may spend money on material that gathers dust on a shelf.

Reactions of instructors and students to the use of multimedia.

Twenty different faculty members have used the multimedia system since 1990. As would be expected, some instructors use the system more than others, but the system is generally used in every lecture. In a few cases the system has been used without adequate planning, but most of the faculty have used it thoughtfully and effectively. Here are some of their comments:

"Having good quality slides [multimedia items] already prepared means that all of the focus during lecture can be on the interpretation of the contents of the slide. This is in contrast to a chalkboard presentation, where some considerable amount of mental effort must be devoted to deciding just how to draw a scheme to most effectively convey the desired message (often such schemes drawn on the spur of the moment lack a great deal of detail and also suffer from a lack of organization)."

"The animations have been remarkably well received, since they illustrate processes which can be observed through animation, whereas with static images, verbal descriptions must compensate for the lack of observable action."

Commenting on his interactions with the graduate student assistant, an instructor noted:

"...he is acquainted with the images that are available in the data base and which have been used by other instructors. He has often provided pertinent information which is necessary to make some of the images meaningful for the context of a particular lecture, e.g., circumstances of an experiment whose results are illustrated but for which experimental details are not depicted in the image."

Since our project began, eight graduate students have been assigned to assist faculty and to work on our project. Some of these graduate students have also been lecture instructors in our courses and have used multimedia extensively in their lectures. Here are some of their comments on working with faculty and using multimedia in their own teaching.

"By far, the most positive aspect of my experience assisting faculty is the opportunity to interact with faculty at a level that is usually not obtained, other than maybe with one's advisor...Talking with faculty about not only course material, but also about different approaches to teaching, lecturing and presenting often difficult material has been rewarding. This experience has, by far, been the best "mentoring experience" I have been involved in while a graduate student."

"Being able to present information from many different angles really works. A series of still graphics and images of cell division, followed by a motion picture or animation actually showing the sequence of events is a very effective and interesting way to present biological processes that operate at a scale which is often difficult to grasp...The multimedia system allows students to actually see what is happening within cells...and appreciate the complexity of cellular processes."

Through the winter of 1994, over 10,000 undergraduate students in two introductory biology courses had received instruction that incorporated multimedia. In their evaluations of the multimedia system, students often describe effects similar to those cited in the research literature on illustrations. For example:

"The AV materials helped make the subject matter concrete."

"I could see what he [the instructor] was talking about and make a mental picture "

"With DNA, the visual aids helped me to understand structures and I could visualize this when taking my test."

"AV materials were helpful in showing detail and function that can't easily be conveyed by speech. Especially helpful were the visuals that conveyed motion."

"It made me more interested in the material. I told people about it. My friend is taking the class because of it."

What have we learned?

To conclude, we will offer some suggestions based on our experiences with this project.

1. The use of multimedia in lectures is motivating for both instructors and students. With a new tool, faculty take a fresh look at what they are teaching and how they are teaching it. Students too are intrigued by this new classroom tool, and based on both formal evaluations and informal feedback we believe the use of multimedia promotes more positive attitudes towards biology. We hope to be able to conduct more rigorous empirical evaluations of the effect of multimedia on student learning, but in the mean time we are pleased by the reactions of students and instructors.

2. Using multimedia is not a time-saver. Those who think that a good multimedia presentation can be more quickly created than a traditional lecture are mistaken. Some time savings may eventually be realized, but certainly not on the front end, and not until presentations have been given several times and refined. The faculty and graduate students who have worked on this project will testify that integrating multimedia with lectures takes additional time, but the more important question to ask is whether they believe it is worth the effort. The overwhelming response to this question is "Yes."

3. Use multimedia materials that are appropriate for your students, and then use them parsimoniously. The lure of

multimedia and the flexibility it provides can create the mistaken impression that more is always better. The temptation to use material that is perceptually stunning, whether or not it is instructionally appropriate, is great, but must be avoided. Our tools have changed, but the principles of effective presentations have not.
4. Using multimedia is not a way to reduce instructional costs. Prices are declining for hardware and software while their performance is increasing, but to incorporate the kinds of multimedia we have described requires a consider investment of time and money. If you focus on designing delivery systems that can reach large numbers of students, such as in large lecture classes, you can keep the cost per student relatively low. If you plan to use multimedia to deliver more individual or small group instruction, the cost per student will rise dramatically. Also, do not ignore the costs to maintain and regularly upgrade a system.

5. Consider the need for support personnel to assist faculty in the use of the technology. Involve graduate or undergraduate students in the project. Our graduate students are quick to grasp the fundamentals of the hardware and software, and they make significant contributions to the creation of content.

6. There is no one multimedia system that is appropriate for all contexts. The time you spend designing a system that is right for your needs is well worth the effort. Here is an example of a high quality multimedia presentation system (based on the technology available when this article went to press in spring 1994), which could be modified to suit your needs.
- Macintosh Quadra 650 with 500 MB HD, 24 MB RAM, internal CD-ROM
- Macintosh RGB color monitor
- RasterOps 24mx color graphics card with pan and zoom feature
- Mirror Technologies Quick! JPEG accelerator card
- Mirror Technologies RM42 removable hard drive
- Pioneer LDV-4400 laserdisc player

7. A poor quality display device can turn a sharp image into a disappointing blur of dim, muddy colors. What you want is a display device that produces an image that can easily be seen by a student with the worse seat in the house. The appropriate display device therefore depends upon the size of the room, and the kinds of materials (e.g., 8-bit or 24-bit graphics, digital video, analog video, etc.) you wish to present, and whether audio output is important. Here are examples of devices for various instructional settings.
- Large auditoriums (200-800 capacity): Sony 1251 or 1271 color video projector (8-inch -lenses).

- Medium classrooms (25-200 capacity): nView Luminator or Proxima model2800 active matrix LCD projectors.
- Small classrooms and small group viewing: nView Luminator or Proxima model 2800 active matrix LCD projectors, or NEC 2710 color multisync monitor.

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