

# UniServe

S C I E N C E

Proceedings of  
University Science  
Teaching and the Web  
Workshop

April 17-18, 1998  
The University of Sydney

# UniServe Science

**UniServe Science** was established in 1994, under a grant from the then Committee for the Advancement for University Teaching (CAUT), with considerable help from the University of Sydney, to act as a national clearinghouse for dissemination of information about teaching software in the experimental sciences in Australian universities — specifically in the disciplines of Biochemistry, Biology, Chemistry, Geography, Geology, Physics and Psychology. That grant was for three years. UniServe Science is now fully funded by The University of Sydney.

**UniServe Science** aims to enhance the quality of university science teaching in Australia by collecting, maintaining and disseminating information on up-to-date and innovative teaching materials. UniServe Science publishes regular newsletters which include product reviews and articles on developments related to teaching and learning materials in the earth, life and physical sciences. A database of software packages used in teaching is maintained and is accessible via the UniServe Science web site. Along with software details, the database includes UniServe Science solicited product reviews, usually done by Australian academics. Other activities include: the maintenance of electronic mailing lists for each of the seven disciplines covered; conducting workshops for teaching development; producing software guides and maintaining Australian mirrors for frequently downloaded overseas software.

## UniServe Science PERSONNEL

**Directors:** Associate Professor Ian Johnston, Dr Mary Peat

**Deputy director:** Professor David Patterson

**Educational technologists:**

Kaye Placing (Biological Sciences)  
Tel: (02) 9351 2960  
BioSciCH@mail.usyd.edu.au

Anne Fernandez (Physical Sciences)  
Tel: (02) 9351 5783  
PhySciCH@mail.usyd.edu.au

**Correspondence to:** UniServe Science  
Carslaw Building (F07)  
The University of Sydney  
NSW 2006  
Fax: (02) 9351 2175

# Table of Contents

## Summary Paper

- In the web we still delight .....1  
*Ian Johnston and Mary Peat, UniServe Science*

## Invited Papers

- Internet-based Teaching and Learning: The Past and the Future .....5  
*Shirley Alexander, University of Technology, Sydney*
- On-line Engineering Experiences .....7  
*Geoff Roy and Peter Lee, Murdoch University*

## Workshop Presentations

- The Evolution of Computer-based Tutorials Towards Web Delivery .....15  
*Charlotte Brack, et al., The University of Melbourne*
- An Author Usability Trial for the Networked Assessment Toolkit (NEST) .....18  
*Craig Burton and Lorraine Johnston, The University of Melbourne*
- WebMC: A Web-based Multiple Choice Assessment System .....25  
*James R. Dalziel and Scott Gazzard, The University of Sydney*
- Exploring the Value of the Web in an Undergraduate Immunology Program .....28  
*Elizabeth M. Deane, University of Western Sydney, Nepean*
- Thermal Physics Resources on the Web .....29  
*Pal Fekete, et al., The University of Sydney*
- Web-based Protocols for Bioinformatics Education .....32  
*Bruno A. Gaëta, et al., The University of Sydney*
- Learning Dialogues Using the World Wide Web .....34  
*David Green, University of Technology, Sydney*
- ActivPhysics and ActivPad — an Innovative “Webway” of Packaging and Delivering Physics...38  
*Suzanne Hogg, University of Technology, Sydney and Rosemary Penman, Addison-Wesley Longman*
- Filling the Role of Staff in Flexibly Delivered Atmospheric Science Practicals .....41  
*Peter K. Love, Macquarie University*
- First Year Biology Teaching on the Web: To Lure and Catch the Imagination of the Students ...48  
*Mary Peat and Sue Franklin, The University of Sydney*
- Online Resources — A Systematic Solution .....50  
*Ian Roberts, The University of Adelaide*
- Exploring the Value of Integrating WWW-Chemistry Teaching with the Hawkesbury Shell .....54  
*Deidre Tronson and Deborah Veness, University of Western Sydney, Hawkesbury*

## Poster Presentations

- A Virtual Resources Room: A Model in Equity, Access and Communication .....58  
*Sue Franklin, et al., The University of Sydney*
- Student Responses to the WWW as the Primary Educational Medium in the Classroom .....59  
*Scott Gazzard and James R. Dalziel, The University of Sydney*
- Option(s) for Mathematical Notation on the Web .....59  
*David Green, University of Technology, Sydney*
- Student-created Hypertexts and the Understanding of Psychology .....60  
*Stephen Provost, University of Newcastle*

## Workshop Participants.....61



## In the web we still delight

Ian Johnston and Mary Peat  
 UniServe Science, The University of Sydney  
 director.science@uniserve.edu.au

### Background to this workshop

The use of the web in teaching in this country in any sort of formalized way in any more than a handful of departments is a very recent phenomenon indeed. This statement is based on the following observations.

- (1) There have been some 40 CAUT teaching development grants awarded in each of the last 5 years. Many of these went to science departments and many, though not all, involved some form of information technology. The numbers which specifically involved the web are given by Table 1.

Year	Number of grants in the sciences	Number involving the web
1993	29	1
1994	28	1
1995	29	3
1996	18	2
1997	12	4

Table 1. Numbers of CAUT grants to science departments for web-based activities

- (2) Over the three years it has been in operation, UniServe Science has produced nine newsletters. The numbers of articles in these newsletters which describe teaching innovations on the web, written by Australian academics, are given by Table 2.

Year	Total number of articles	Number mentioning the web
1995	23	3
1996	20	2
1997	23	9

Table 2. Numbers of articles in *UniServe Science News* which discussed the web in teaching

- (3) Between 1995 and 1997, UniServe Science conducted a number of nationwide surveys. In 1995 all science departments in the country were surveyed (139 of a possible 207 responded). When asked whether they considered their use of IT in teaching was “significant”, nearly 80% responded yes. The fraction that specifically mentioned that they used the web in their teaching was negligible.

In 1996 a much more thorough survey of physics departments was carried out, asking exactly what use they made of IT in their teaching. Of the 32 departments surveyed there was 100%



response rate, but only two mentioned use of the web — and then it was merely for “putting materials up” for students to access if they wished.

- (4) UniServe Science has mounted two annual national workshops before this present one. The first, in April, 1996, featured “Dry Labs”. Of six significant packages exhibited, none was web-based. In February, 1997 the subject was “Computer-based Assessment”. Of 11 packages exhibited, only one used the web as the delivery platform.

When we first announced that the next topic was to concern itself with the World Wide Web, as many as 23 Australian academics offered projects mature enough to offer as hands-on exhibits; and of these 16 were showcased on the day and a description of each appears on the following pages.

Our interpretation of these figures uses the classification system which Shirley Alexander drew attention to in her keynote address (see page 5). Before 1997, the *innovators* amongst us, those 5–10% who are keen to try out new things and take risks, have been beavering away developing materials for the web. Round about 1997 some sort of watershed was passed and the next group, the *early adopters* who lead opinion in their home departments, entered the scene and are right now working on systems that will demonstrate workability to the ones after them, the *early majority*.

It seems to us therefore that the time was singularly appropriate to mount our third national workshop, “University Science Teaching and the Web”.

## What happened at the workshop

Following on the experiences of the past we planned from the start that we would not run parallel sessions. There seemed no point in asking people to come from all parts of the country and not be able to hear everyone they were interested in. So the workshop was spread over one-and-a-half days.

We decided early that there should be two keynote speakers, one to cover theoretical/pedagogical issues (Shirley Alexander from UTS and CUTSD), and one to talk about practical aspects of a comprehensive working system (Peter Lee from Murdoch University). There were twelve contributed papers, all describing courses or developments which had been in use for some time. The poster presentation is a good way to make known what you are doing before it is in anything like a final state, and it is a shame that there were not more of these. Perhaps next time will be better. The total number of those who attended was 85.

It was less than ideal that some 75% of the speakers and 59% of attendees should have come from the Sydney metropolitan region. We all know how tyrannous is distance in the planning of academic travel budgets, especially for matters related to teaching. Perhaps it will help if we advertise our next workshop sufficiently far in advance to enable those who want to come to start organizing finances early.

As is always the case with these workshops, the most successful feature was the sense of belonging that comes from being part of a nationwide community of university science teachers — the chance to meet others and talk in an informal atmosphere. As one person put it: “simply being able to discuss web problems with real users”.

There were of course some small problems. Will we never see the end of technical hitches? And was it too much like a series of mini-lectures rather than a genuine hands-on experience? But by and large the problems seemed minor. Evaluations were overwhelmingly positive and we hope to see you all again.

---

## Issues raised at the workshop

As has become customary at UniServe Science workshops, the last session was devoted to an open-floor discussion of issues that had raised themselves during the two days. By and large these came down to a series of two-way choices.

### *(1) Add-on versus replacement?*

In the current financial climate, many of us state, in public, that we are potentially saving money by using the web. Eventually what we produce can replace other more tedious, cost intensive forms of teaching. We might, for example, be able to reduce the number of lectures by relegating the pure passing-on of information to web delivery, and concentrate the attitudinal aspects of teaching into fewer, but more involving, face-to-face lectures.

However students do not seem to agree with that. They approve of what is being done on the web, but they only want it as an add-on. They are used to having personal contact with us all the time, and definitely believe that the only *real* teaching takes place in lectures.

We are going to have to grasp this nettle and look at completely new approaches to delivery of courses which the students will accept without our holding their hands. Economic pressures may determine the course we take. In this we can only be aware of the debate and be prepared to give advice to our senior management.

### *(2) Salvage the work versus re-invent it?*

What worries many of us who have been interested in using IT in our teaching for some time is the fact that, as each new kind of technology comes along, all the good work we put into the last technology seems destined to be discarded. Furthermore the new generation of enthusiasts who are currently writing Java applets and the like, seem oblivious to many of the lessons we learned so painfully — things like the need for good screen layout and consistency of the user interface.

We saw a very good example in the area of biochemistry from Melbourne of how older CAL packages could be remodelled into a more modern delivery mode and the content (and concepts) salvaged. That was heartening. It makes no sense at all to waste the ideas and good points of a piece of work which has been proved successful. For one thing, re-using is cheaper than re-inventing. Even if, the second time round, a considerable amount of re-authoring needs to be done, the design, layout, navigation etc. can be the same and need not be thought out anew.

### *(3) Internal use versus external use*

There are great pressures on those who put a lot of work into developing web materials (or any form of CAL software) to recoup the cost by making their materials commercially available. However there seems to be a fundamental difficulty.

Most of us make these materials, in the first instance, for use in our own teaching. It is only later that we consider whether we might sell them. That invariably brings difficulties with long-term servicing. Very few of the teaching development grants which enable us to do this work provide money for paying the on-going salary of someone who will give the kind of technical support that any piece of software inevitably needs. The message seems to be, if we go commercial we should do so from the outset.

### *(4) Cottage industry versus benevolent dictator*

It has always been part of the ethos of university teaching that each teacher/lecturer is responsible for their own course. This has led, as many have pointed out, to a cottage industry approach to teaching, where developments are constructed afresh each time and there is little sense of the on-going accumulation of expertise. But as the technology becomes more powerful and our teaching efforts



spread far beyond our individual classrooms such determined amateurism cannot, surely, survive.

This workshop provided us with an example, from Murdoch University, of a tightly structured, faculty-wide template for putting complete courses on the web. It was quickly identified as the benevolent dictator model. In this model the talk is of niche markets being exploited. Whole subject areas are simply not taught if they are in competition with bigger universities.

It was clear from the audience reaction that many were unhappy with the dictator model, and its concomitant suggestion of a redefining of the role of a university. Yet there is no doubt that in the modern university we need to be much more careful about how we design and deliver courses, whatever the means. We do not easily operate comfortably in a business mode, but that is increasingly the way most universities are going. We are just going to have to adapt.

## **Conclusions from the workshop**

Every time we run one of these workshops we end up agreeing that we must collaborate with one another more. But though we can point to a few examples where genuine collaboration is occurring, it is a very difficult path to follow.

This particular workshop threw that dilemma into even harsher relief. The web is still relatively new and the new generation of enthusiasts is just getting into stride. It seems inevitable that many of the materials of the last five or so years will be re-authored. And, truth to tell, it is a safe bet that, five years hence, they will have to be done again when the next wave of technology breaks. We can no longer kid ourselves that, if we put in a lot of hard work now, what we produce will last long enough for us to relax. It won't. Therefore we must take seriously the idea of sharing the workload.

We *must* learn to collaborate.

# Internet-based Teaching and Learning: The Past and the Future

**Shirley Alexander**

Institute for Interactive Multimedia, University of Technology, Sydney  
S.Alexander@uts.edu.au

This article has been prepared from notes taken during Shirley's keynote address and the slides used in her presentation.

## Introduction

Three main issues: design, evaluation, dissemination.

## The past: How technologies have evolved

### (1) Teaching machines (1940s)

Claims: tireless examiners of students.

### (2) Computer-aided (-based, -managed) learning

Claims: patient teachers; scrupulous examiners; tireless schedulers of instruction.

For students: freedom to follow their own path of learning; work at their own pace in their own time; richer materials; automatic measurement of progress.

“Personal computers will revolutionize society and will create powerful new opportunities for those who can handle them”. [Collis, *Social Vision 1979/80*, 1996]

### (3) Interactive multimedia

Claims: facilitates immediate feedback to students; individualizes instruction; combines text, graphics and animation, provides “moving video segments, and dual sound tracks so that learning need not be dependent on language alone”. [Powell, J., *Fostering Multimedia in Higher Education*, 1990]

### (4) Internet-based teaching

Claims: makes teaching and learning richer and more effective; expands time, place and pace of education; provides improved quality of interaction; is highly motivating for students and teachers. [Harosim, L., *Learning Networks*, 1995]

“The information superhighway will revolutionize society and will create powerful new opportunities for those who can handle it”. [Collis, *Social Vision 1996/97*, 1996]

In other words, the claims for each type of innovation are really the same. The more things change, the more they stay the same! It is the design of the learning experiences that are most important, not the technology.

## So what do we want from these technologies?

Firstly there are learning issues: instant feedback; increased access to information; enhanced research skills; interactivity and communication; visualization and animations; enrichment materials. Then there are productivity issues: ease of editing and maintaining; distribution; cost savings.

## **The present: What has been learned**

### **Studies of teaching effectiveness**

Early work by Kulik and Kulik [1980, 1986, 1991] reported 0.25, 0.51, 0.3 of a standard deviation higher results of students using technology than those in a traditional classroom; but the 0.51 difference was reduced to 0.13 when the same enthusiastic instructor was used to teach all the face-to-face classes.

“While computer technology affords a number of important possibilities, none of them can be assumed to be automatically realized only because of the technology’s presence”.  
[Salomon, G.]

Soon to be released is a CAUT Commissioned Study: “Evaluation of Information Technology Projects for University Learning: the CAUT Experience”.

### **Evaluation**

“Aside from obvious research design problems, the main obstacle to multimedia and learning studies is that they are conducted without any benefit of why one would expect differences in the first place”. [Clark and Craig, 1992]

Kirkpatrick identifies four levels of evaluation: (1) reaction of participants; (2) changed attitudes to learning and improved knowledge; (3) change in behaviour; (4) increased production of materials, improved quality of results, etc. Of these, (1) and (2) are relatively easy to do. They can be done with students while they are doing the course. But (3) and (4) are much more difficult. They need longitudinal studies over several years, but without the learning materials/experiences changing during that time.

### **Dissemination of Innovations**

It is a fact that most of the materials produced die with the original developer.

“There are many examples of what can be done, but these examples tended not to be adopted for classroom use by anyone other than the original developer”. [Geoghegan, 1996]

Everett Rogers identified five classes of user.

- (1) Innovators: 5–10% of the population who are keen to try out new things. Risk takers.
- (2) Early adopters: opinion leaders who take the role of decreasing uncertainty of others.
- (3) Early majority: want to know if it works before they will use it.  
*These three categories account for ~50% of the population. The other 50% comprises:*
- (4) Late majority: Skeptical, adopt only under extreme pressure.
- (5) Laggards: not interested in change.

Attributes of a successful innovation: the relative advantage of the innovation over what it replaces or supplements (time, cost, effectiveness, etc.); the innovation’s compatibility with existing practices, values, needs, “culture”, etc.; the complexity of the innovation — how difficult it is to learn, to understand, and to use effectively.

Innovations: the innovation’s trialability, how easy or difficult it is to experiment with the new way of doing things before making an adoption decision; the visibility to other potential adopters of the results achieved by using the innovation.

## **Conclusion: Inventing the future**

We must: disseminate what we do; cooperate in development and use careful design; and evaluation.

## On-line Engineering Experiences

Geoff Roy and Peter Lee, School of Engineering, Murdoch University  
geoff@eng.murdoch.edu.au peter@eng.murdoch.edu.au

*Abstract: This paper describes the experiences gained through implementing on-line courses for Engineering education at Murdoch University. It describes the procedure by which the School of Engineering embarked on the process of developing its entire curriculum as suitable for web-based delivery, and the important considerations that led to a successful implementation of this strategy. It also describes both good and bad examples of web-based delivery, and suggests future developments required to further enhance the learning experience.*

### Background of Engineering at Murdoch

Engineering is a relatively new discipline at Murdoch University, having commenced teaching in 1996. It is located at dedicated facilities at the new Rockingham Campus, 45km to the south of the City of Perth. The new campus has been well equipped with state of the art laboratory and computing facilities.

Two engineering disciplines are currently offered: Software Engineering and Instrumentation and Control Engineering. The former programme is the only one of its type in Western Australia, while the latter is the only programme of its type in Australia. Both degrees offered are of 4 years duration, with a common first year curriculum. Both disciplines rely heavily on information technology in modern practice, and hence it was natural to consider the use of such technology not as a tool of the trade, but to assist in the learning process. One of the goals of both courses is to encourage students to use computer tools as tools of first choice, rather than purely for the more difficult engineering calculations. This philosophy has been extended to every subject, even if it is just to use a word processing package, spreadsheet, or presentation package. To assist this process, we have arranged for students to lease laptop computers under very favourable terms.

A number of other innovations have also been developed during this initial implementation phase. These include the development of an integrated Bachelor of Technology (BTech) programme whereby students can complete an Associate Diploma at the local TAFE college located on the same physical site, and then articulate to the BTech programme with full credit for their studies at the TAFE college recognised. With 1 year further study they can complete their BTech programme, and with an additional 2 years of study can then complete their Bachelor of Engineering degree. In addition, an extension programme is currently operating with 2 local high schools whereby students at these schools can study first year engineering subjects as part of their year 12 programme, and subsequently gain credit for this study upon entry into Engineering.

Being a newly established School of study, the school had very few staff (2 initially). This implied there was little “baggage” to carry, and hence the move to a new paradigm of instruction was an easier culture shift, and there was not a lot of “sunk” infrastructure in available course materials to overturn. Indeed every course was being written and delivered for the first time.

There was also a strong desire to run with a lean staffing structure. One of the ways to implement this strategy was to ensure that courses were developed by individuals, but “owned” by the School. This necessitated courses being developed in such a way that any other member of staff could easily teach any other subject by using well established and documented course material. An on-line approach enhanced this process.

## **Important Issues**

When embarking on the process of developing whole degree programmes suitable for on-line delivery a number of very important factors must be in place.

### **Importance of Instructional Design and Programming Help**

Instructional design is itself a skill and to expect that domain experts should also possess such knowledge is unrealistic. It is also an emerging skill to design for on-line delivery as opposed to the more traditional paper-based delivery. People with such skills are still hard to find. Similarly, it is also unrealistic to expect domain experts to be fully conversant with the intricacies of HTML coding except for making obvious links through the many WYSIWYG editors that are now available. It is by creating a team that includes as much expertise as possible – domain, instructional design, and programming skill – that successful outcomes have been achieved in this project.

### **Importance of resources – monetary, physical and human**

The availability of such expertise is not without considerable monetary cost. Also required is the necessary infrastructure to develop and deploy such technology. We were fortunate that Murdoch University had committed itself to on-line delivery and the availability of seed finance. We were also in the unique position of not having “sunk capital” in past course development and were committed to developing new course material in any case. Thus, there was already available money to support this initiative.

## **Web Delivery – Good**

In implementing this development, we have identified a number of factors that we believe are essential to create a good learning environment for students. We do not claim that we have mastered all of these factors ourselves, but have at least clarified some of these issues.

### **Easy navigation**

One of the key factors that we believe has led to some success of our on-line units has been the development of an easy-to-navigate interface. We have developed two approaches to meet this objective. The first involves the use of frames to provide a static navigation aid always displayed to the student, while the other frame presents changing material. This permanent display of navigation material, shown in Figure 1, has allowed students to always have quick access to key information. In this design the course content is presented in the main frame through linked web pages and the left navigation frame provides a static set of navigation links. The student has direct access to a full range of support information (help, guidelines, assessment, rules and regulations and so on) from anywhere in the course. Within this paradigm, the material has been structured according to a fixed timetable of presentation to the student; i.e. the sequence of study is built integrally into the organization of the web pages.

A second initiative has developed a structure that is more course-concept driven – presenting the material according to key subject area concepts and providing navigation in the form of a concept map. This is shown in Figure 2. This strategy is still being trialed, but initial student reaction has been positive.

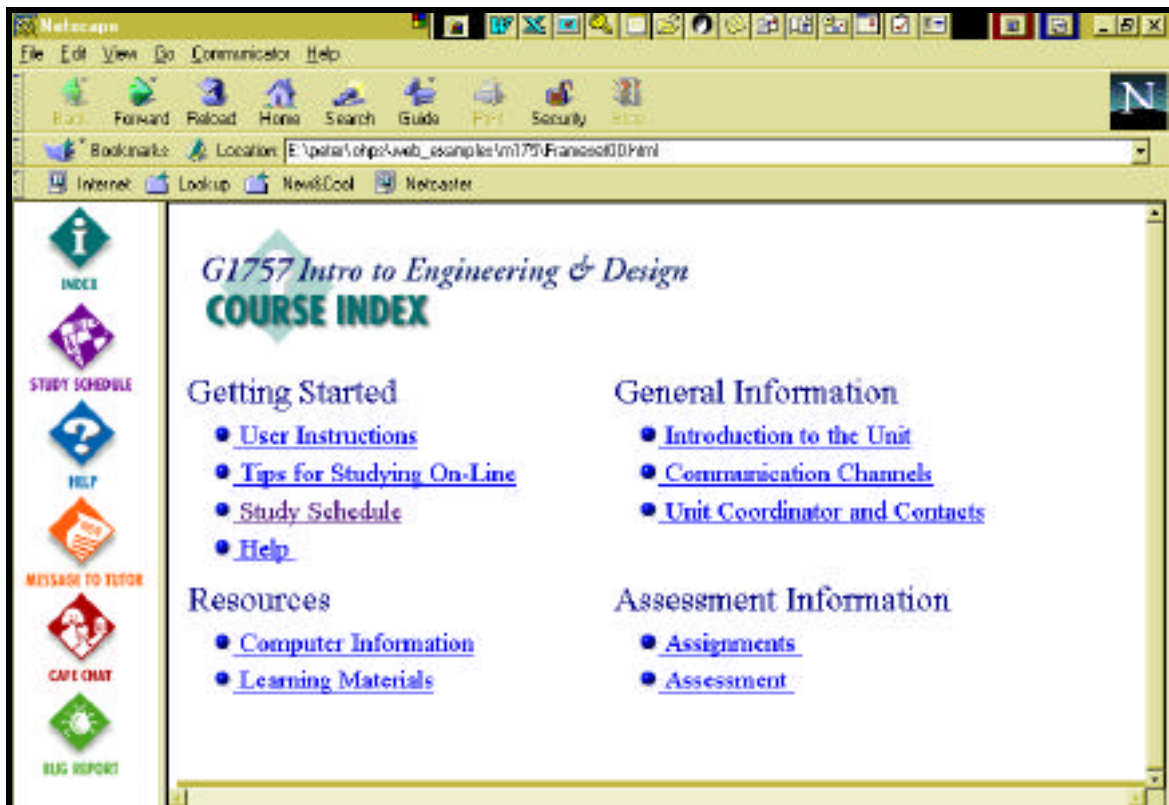


Figure 1. Navigation Aids

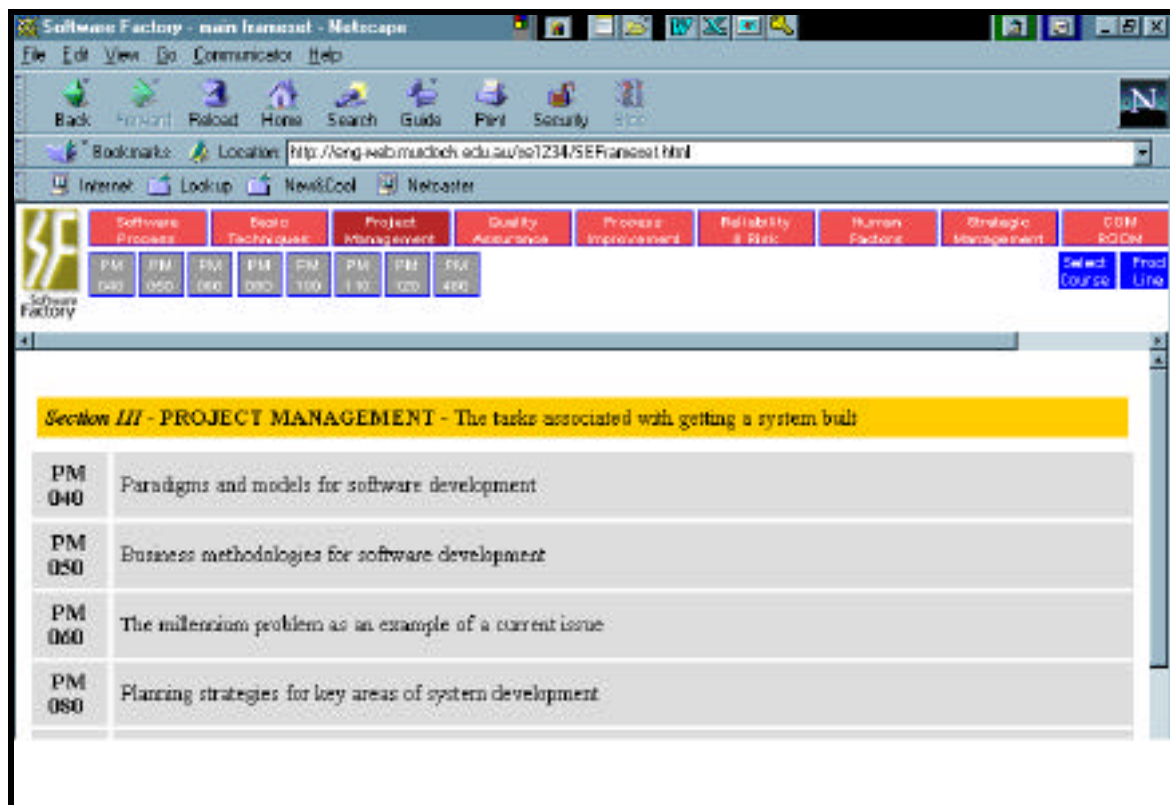


Figure 2. Content Driven Navigation

**Multi-threaded**

The technology also promotes the use of multiple threads. Such techniques allow students to explore material in any order that makes sense to their learning style. The use of cross-indexing and forward and backward referencing has proven to enhance student engagement with the material.

We are now experimenting with the “road map” as shown in Figure 3. In this facility students are provided with a pathway (and alternative pathways) for proceeding with their studies. They begin at the start (green node) and end at the stop (red) node. Required (blue), desirable (yellow) and suggested (green) pathways are colour coded to guide the student through the course of study.

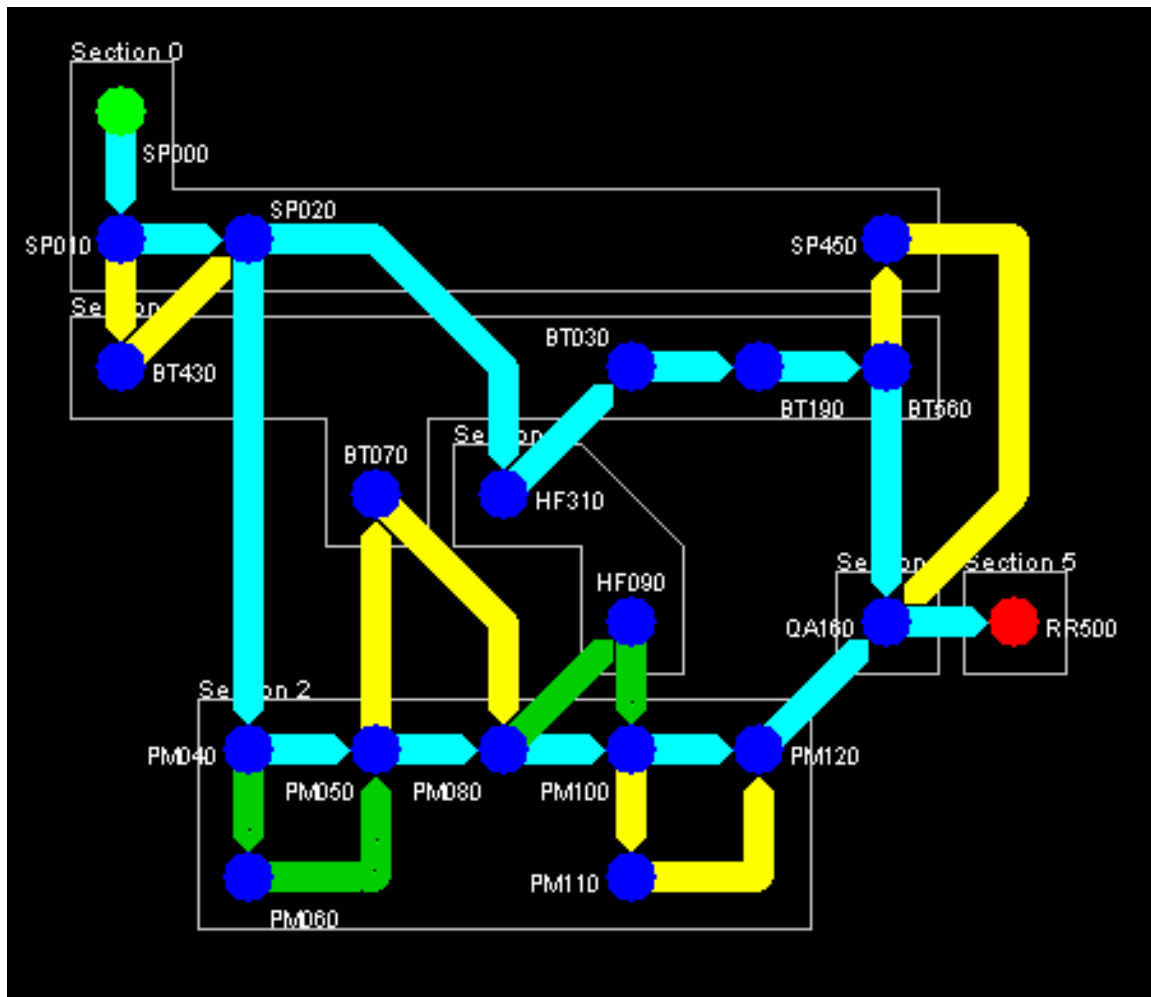


Figure 3. The Study Road map

Each node in the road map matches a study Topic as clustered into the Section classifications as shown earlier in Figure 2. Naturally, clicking on any node takes the student directly to that web page group.

**Interactive**

If the medium of on-line delivery is to reach its full potential, it must exploit the inherent interactivity available. We have attempted to pursue this by the use of Java applets, and by linking into the web browser existing software including *Matlab*, *LabView* and other programs. We also made use of existing commercial courseware and integrated that with our own web material. Our colleagues in Mathematics are utilizing “Scientific Workplace”, an environment that enhances the teaching of calculus via symbolic computation. One use of a Java applet is to demonstrate sorting algorithms, as shown in Figure 4. Another example in Figure 5 shows a *Matlab* program being executed from the web page.

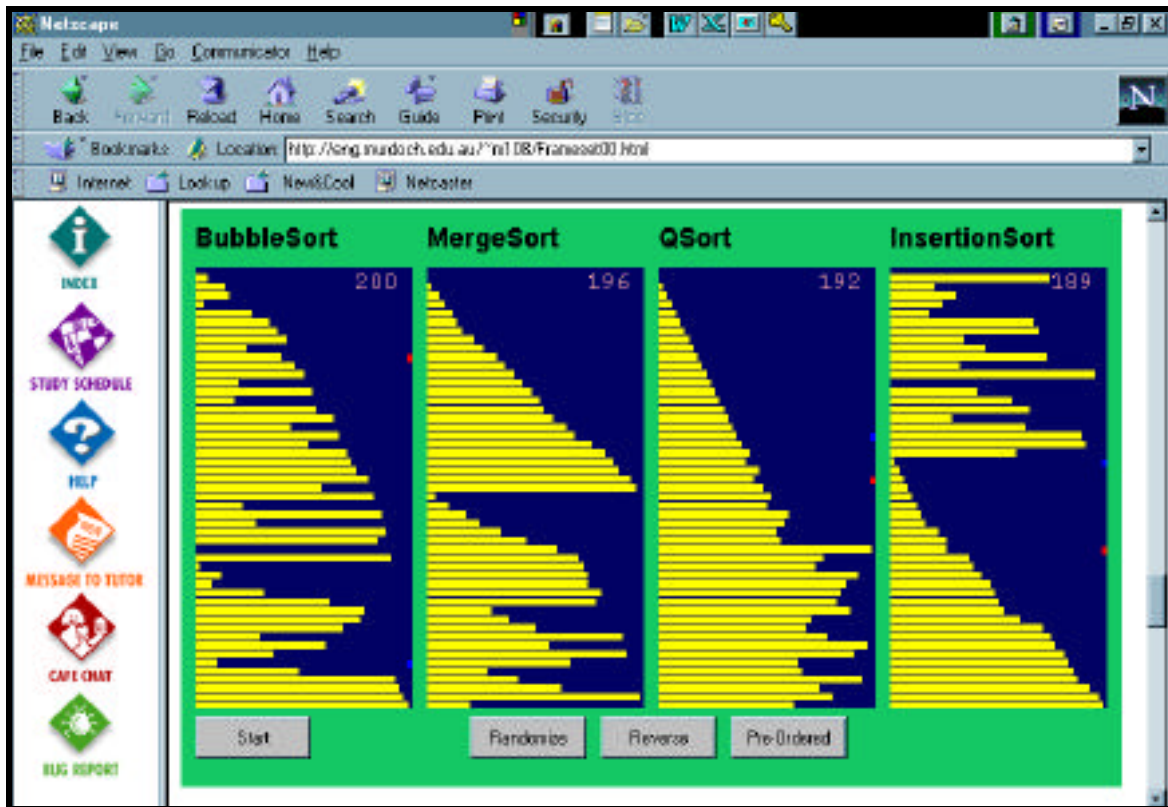


Figure 4. A Visualization of Sorting Algorithms included in the web page

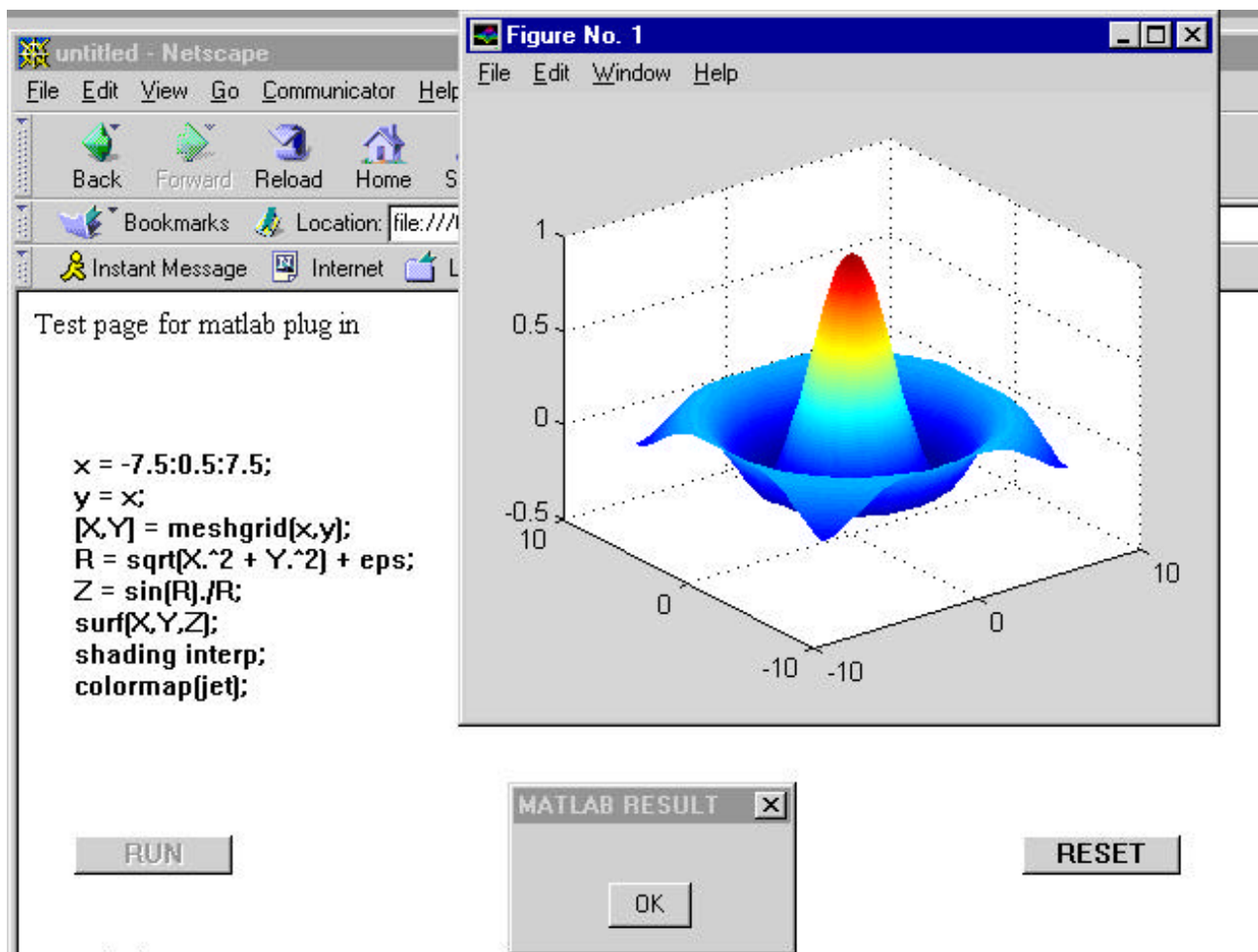


Figure 5. Executing a *Matlab* Program from the web page

## **Enriching**

The material should also enrich the learning experience. Links to other web sites can create great student interest in the material they are studying. The recognition that there existed “real” people behind the developments that they are seeking to understand has enriched students’ learning experience. This is helping to change the culture of engineering education, important in producing the next generation of engineers. It is also interesting to observe that female students tend to appreciate this approach more than their male counterparts.

## **Web Delivery - Bad and Ugly**

From our experience there are a number of features that lead to very poor web-based teaching structures. Our pet hates include:

### **Scanned Word and Acrobat files**

The technology should not be used to just scan existing paper-based notes, add a few links here and there and say that you now have an on-line course. While this may be a convenient way of distributing some lecture notes, it does not in our opinion constitute web-based teaching. It exhibits none of the features described in the previous section. We acknowledge that used sparingly to deliver background-reading material, it has a limited place.

Text documents by themselves do not make an appropriate basis for good quality web pages in teaching. There are some golden rules: viz:

- A single page to be read should be quite short, perhaps no more than 5 paragraphs
- Diagrams and graphics should be used to enhance explanations
- Students should be engaged by interactive tasks, i.e. tasks for them to do which require some thought, some action and some experimentation
- Tasks should be set to test understanding, to encourage re-reading of pages and re-working of examples.

### **“Where am I?” Syndrome, or “Lost in Web-space”**

Our second concern is that many designs lead students to places far beyond where they started. This may be fine, but there must be a clear trail back to the point of departure, and clear indications at all times of where they are in a concept map of material. Web pages can (and do) become complex sets of documents with many complex interlinks. Some of these are in place to guide study, others to enhance study (e.g. pointing to ancillary readings and related web sites). At all times the students must feel in control of where they are at, where they have come from and where they expect to go next.

### **Poor Quality Design**

The quality of the graphics and the design of the web pages plays an important role in convincing students that we are serious in the new approach to teaching. Particular attention must be paid to careful use of colour, preparation of graphics (diagrams and other images), and, most importantly, spelling, grammar and the general quality of the written text.

## **Future Directions**

There are a number of issues still to be addressed in our implementation of our on-line courses. We highlight some of these issues here so that others may also be inspired to solve these problems.

### **Progress Tracking**

Keeping track of student progress is not as easy as it first seems in an open browser environment. We have developed a prototype that uses a database residing on the server computer but still requires

the student to manually record their progress in the database. We have constructed a browser interface for both the students and lecturing staff to monitor and analyse progression rates. An image of the student record screen is shown in Figure 6. Here we see the current state of user “geoff”, showing what parts of the course are complete, in progress and yet to be attempted. A detail of the chart is shown in Figure 7.

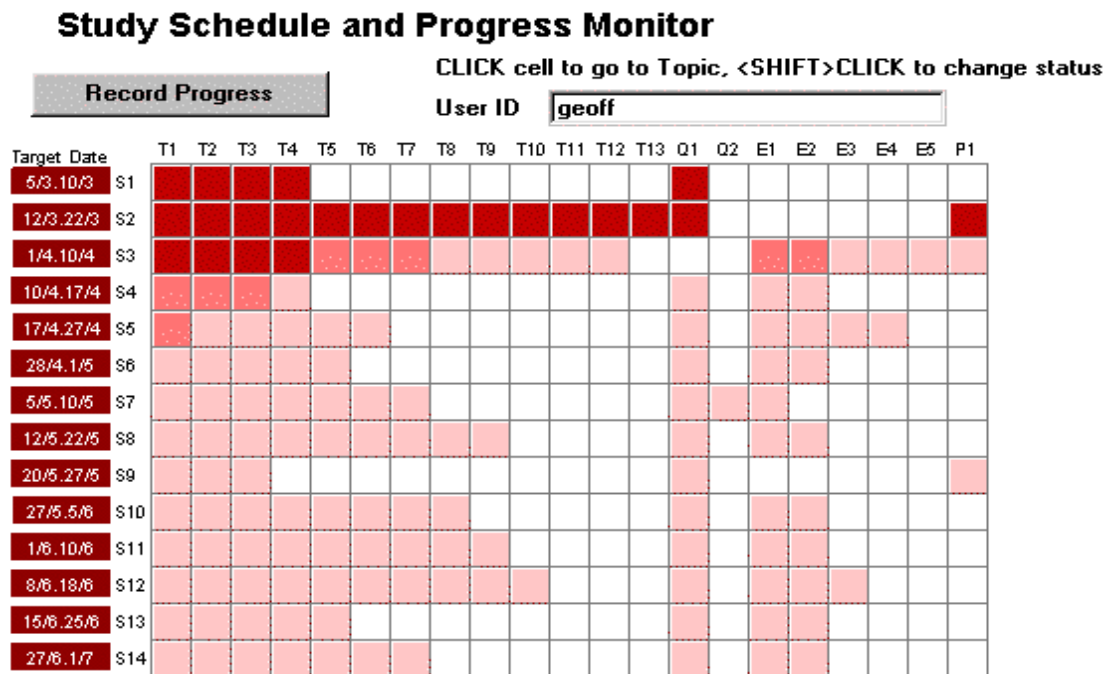


Figure 6. The Study Schedule Planner and Progress Monitor

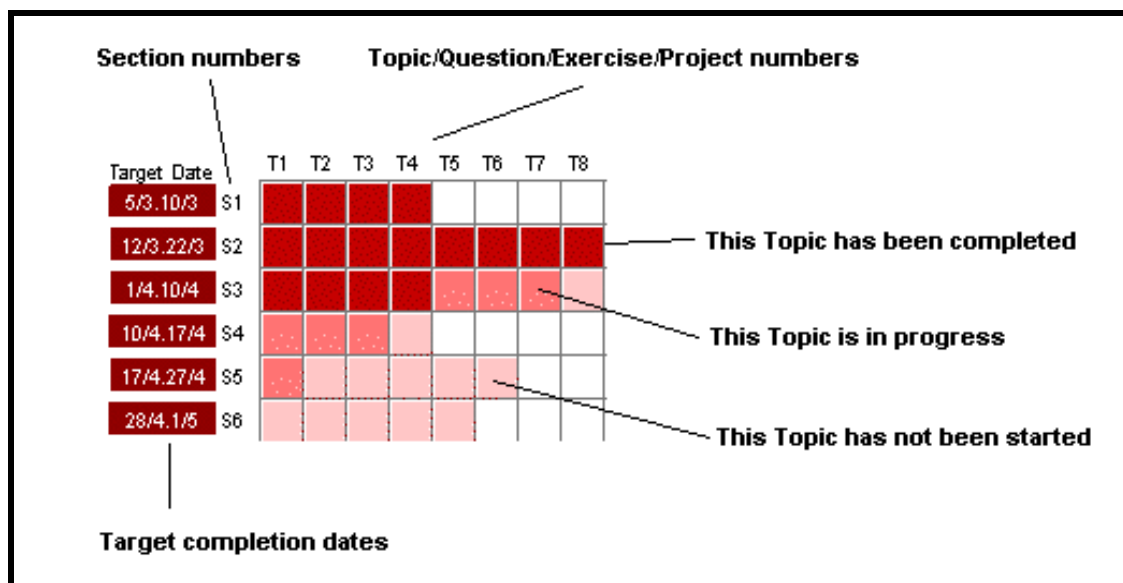


Figure 7. Detail Study Schedule Planner and Progress Monitor

A system that automatically tracked a student’s progress through the material, and even diagnosed that the student required extra tuition or could progress faster would be very useful. Such a system would enter into the world of intelligent tutoring systems, an area of very active research.

### Electronic Submission and Marking

The problem of receiving student submission of assignments and returning marked versions to students is still not solved technically. Issues seem to revolve around ensuring that submissions received originate from the student in question, and not submitted from elsewhere.



### **Electronic Whiteboard**

The use of electronic whiteboards, whereby a lecturer could use a writing tablet in one location and have the image displayed to a number of students in other locations and vice versa still does not seem to be straight forward – at least in an open browser environment. The advantages of such interactivity to display equation development and problem solving strategies are obvious.

### **Remotely Operated Experiment**

One of the key challenges to address will be the role of experimentation. “Dry” laboratories or computer-based simulations do not provide the full rich learning experience of laboratory experiments. Operating some experiments over the web is possible but the communications bandwidth available and the safety issues involved currently limit the scope of such activities. The future may solve the former, but is unlikely to solve the latter.

### **Student Response**

We have had one year’s experience with web-based teaching and the feed back we have from students is very encouraging. We can say that we are doing at least as well as more traditional methods with some indications that it may be better. Some particular responses from students include:

- Positive support to having course materials available any time, and especially from home.
- Reduction in numbers of formal lectures
- An appreciation that the quality of the web-based materials is supportive of a productive study programme

### **Acknowledgments**

The authors wish to acknowledge a number of people who have contributed to the development of Murdoch University’s Engineering School on-line delivery units. In particular, the work of Romana Pospisil who contributed much to the initial template design, Nick Nelisen who contributed much of the code to implement the vision, other colleagues within the Engineering School and within the Academic Service Unit are all gratefully acknowledged.