

## **Mosaic, Instruction, and the World Wide Web**

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### **Impact of Networked Computer Tools on Instruction**

The vision of the paperless society has been with us for a long time, but it certainly isn't here yet. At NC State University, though there has been an increased usage of electronic mail and public hard disk space ("lockers") to distribute material from instructors to students and vice versa, the majority communication happens verbally or through the exchange of paper-based materials. The College of Engineering has the highest usage of on-line information exchange, and that can probably be attributable to a networked computing environment highly conducive to such activity.

The computer system for the College of Engineering computer system (the Eos network) consists of nearly 1,000 client Unix workstations, 96 servers and 28 public printers (McDaniel, 1994). In addition, this network is linked to similarly structured networks in two other colleges and the computing center, adding 200+ more workstations to the overall realm. In this model, only the operating system is on the local machines; all user files and applications software is accessed remotely via the Andrew File System (afs). All users have password protected accounts authenticated and managed by the Kerberos system. Though students and faculty can copy individual files onto floppy disks, the system is designed to keep all information within the Eos network realm. A large bank of modems and connection to the Internet provides access and file exchange from outside the network.

Within such an environment, there has been considerable inducement to move away from paper and to explore electronic methods of instruction. One of the difficulties, though, has been the lack of multimedia tools available on the Unix workstations which make up the Eos network. As powerful as these workstations are, the Macintosh computers we have in some of our local labs have a better ability to prepare multimedia material. By in large, material which is being exchanged on the Eos network has been either ASCII text based or binary files specific to a particular software package. Ideally, what would be desired is a method of integrating graphics (color and black and white), text, sound, animation, etc. into files which are independent of platform or operating system. This instructional material would run in all these communication modalities on all operating systems with software which costs little or nothing to install (in our case) on 1000+ machines. In addition, this material should be take advantage of the burgeoning Information Highway by allowing easy exchange and access to material over the Internet. Until recently, this goal has been primarily a dream, but as has been already noted, Mosaic and other World Wide Web tools meets many of these requirements. It is not a cure all for the development of on-line instructional material, but it does point the way for many intriguing possibilities.

### **On-Line Tutorial Case Study**

#### **Initial motivations and frustrations**

The Graphic Communications Program has been using CADKEY in an introductory engineering graphics course for a number of years. We had decided that rather than having students purchase a tutorial-based text as a compendium to their engineering graphics text, they would purchase a less expensive user handbook which gave a brief overview of each of the commands. In order to get the students started on the software, we developed

handouts for configuring CADKEY and a series of 6 tutorials introducing them to basic drawing techniques. Though the tutorials were very effective at getting students to the point where a combination of demonstrations in class and the user handbook was sufficient for further learning of the software. The disadvantages of using the handouts are the same for most any paper-based instructional material:

- The tutorials and configuration instructions, more than 40 pages of material, had to be printed and paid for by the department. With 300-400 students per semester, this was a considerable expense.
- There were the inevitable revisions which meant discarding the leftover copies and making sure everyone was using the most current version.
- There were always those few students who misplaced or lost their handouts so they did not have them in lab with them.

Looking for a way to continue to use the tutorials but avoid the disadvantages, in the summer of 1993 I began looking at ways of putting the tutorials on the Eos network. One of the immediate concerns was that Eos was a Unix-based network while all the tutorials were developed on the Macintosh. Though I knew converting the raw text over would not be a problem, preserving all of the formatting and the graphics would be more of a challenge. The first approach was to try to find a word processing package on Eos which would read binary Microsoft Word files. When that approach failed, I began trying to convert the tutorials to postscript files. This resulted in huge files, any one of which was larger than the 5Mb partition we had for our class on the Eos network. Next I looked at splitting the text and graphics into separate files and using suitable binary formats for both the text and graphics. I quickly realized that this would put a considerable burden on the students to coordinate a text processing package, a graphics package, and CADKEY simultaneously while trying to run through the tutorial.

About this time, I was first told about Mosaic. After taking a look at it, I realized the software had the potential of answering many of the problems I had run into, both in terms of the disadvantages of paper-based tutorials and the difficulties I was having getting the material on-line.

There were however, a number of unknowns. These included specifics on exactly how difficult it would be to convert existing tutorials, create new tutorials, and maintain them on-line in Mosaic. Though the initial development effort answered many of these questions, there are still a number of ongoing concerns. For example, there is the inevitable question of compatibility with future upgrades or replacements for the current software. In addition, there are issues of instructional effectiveness which still need to be addressed.

### **Development strategy**

The development of the Mosaic documents was done on the same platform as the original tutorials: the Macintosh. Because of the cross-platform compatibility, documents developed on the Mac were supposed to be 100% compatible with the Unix version of Mosaic. Eight different software packages were used in developing the tutorials. Fewer could have been used, but each package had a unique capability which facilitated rather than slowed down the development process. Many of these software packages would be open simultaneously and used for a specific stage in the development of the on-line tutorials. Even working with eight packages, there were not many expenses

incurred. Only one of them was a mainstream commercial package of any notable expense. Below is a brief description of each package and how it was used:

<b>Software</b>	<b>Source</b>	<b>Function</b>
MacX	Apple	Used for creating screen captures of CADKEY running under Unix
NIH Image	freeware	Clean up and notate the screen captures from MacX
GIF Converter	shareware	Convert the screen captures from PICT format to GIF format
Word	Microsoft	Used for the original writing and formatting of the tutorials. Also used to create RTF format files.
BBEdit Lite	shareware	Used to create and edit HTML format documents.
rtf-to-html	shareware	Convert RTF format files to HTML format files.
Fetch	freeware	Transport Macintosh Mosaic files to the Unix Web server via ftp
NCSA Mosaic	freeware	Display environment for tutorials

The above table represents the current evolution of the development process. Needless to say, there were a number of experiments and dead ends encountered before this current process was settled on. No doubt, as new tools become available and as techniques are refined, this software list and the development process will change again.

For the initial creation of the tutorials, MacX was used to run CADKEY under Xwindows on the Macintosh. Screen captures were taken at critical steps during the tutorial and annotated with leaders, notes, etc. using NIH Image. Though in the original tutorials, the graphics were dropped directly into the MS Word document, for the on-line tutorial, the graphics each needed to be saved to an individual file (19 total for the tutorials). The screen captures were originally created in PICT format, the generic Mac format, but had to be converted to GIF, the default format for Mosaic, with GIF Converter.

Initially, the text portion of the tutorials were converted from MS Word into ASCII files. These files were then marked up in HTML by hand in BBEEdit Lite. This markup was done in BBEEdit because someone out on the Net had developed a group of built-in macros which helped automate the markup process. Even with these macros, the markup was a slow process; bold and italicized words, bullet lists, figure inserts, etc. all take a special markup. About half way through the conversion process, I discovered rtf-to-html (another gift from the Net) which directly converted 90% of the special formatting in the tutorials to HTML. The RTF format is Microsoft's equivalent to DXF and preserves all of the special formatting done in MS Word. With rtf-to-html, only the links to other HTML documents and minor editing had to be done in BBEEdit Lite.

The first step in the actual development process was to test the compatibility of the Macintosh and Unix versions of Mosaic. Using Fetch, a

test tutorial consisting of a HTML file and a couple of GIF files were moved over to our locker space on the Eos network. After all my struggles trying to display the tutorials in the Unix environment, I was pleasantly surprised at how easy Mosaic made this platform move. The next step was to design the overall structure of the tutorials. Like working in any hypermedia environment, there are numerous structural decisions to be made concerning how much information will be presented at each level, what the branching structure will be, how paths through the information will be defined, etc. The tutorials lent themselves to a single home page off of which branched each of the individual tutorial modules (Figure 1). From each tutorial, you could either go back to the home page, any of the previously completed tutorials or to the next tutorial (Figure 2). Part of the home page construction involved the design of an appropriate logo. The multimedia capabilities of the Mosaic have meant that most home pages have logos and these logos become an increasingly important points of reference out on the Net. Logos are used as a recognition tool not only for more marketing type applications, but also for guidance through a hypermedia structure; a road sign, so to speak.

Next, the individual tutorials were constructed and linked to the home page. All of this development work happened on the Macintosh with the "Open Local" option in Mosaic used to open and debug the documents. Once the complete set of tutorials were ported to Mosaic, they were reviewed by the faculty. After the review, the tutorials were ported to the Unix web server where they would be accessible to all the students on campus. I discovered how important it was to use consistent file and folder naming conventions and would be compatible on the Unix system. Once on the web server, all the path links in the HTML documents had to be updated to match their new location on the server. Because the file naming was consistent, this process was fairly straightforward using global search and replace tools.

Though I had a majority of the conversion completed by the end of the Fall '93 semester, it wasn't far enough along to be ready for the Spring semester. Instead, work was finished in the Spring '94 semester and then piloted in one section of the engineering graphics course in the first Summer '94 session. After feedback from the instructor and the students, the tutorials were further refined and used with all the sections for the first time in the Fall '94 semester. A majority of the refinements being made during the Summer and Fall semesters were not specific to Mosaic, but just further refinement of the tutorial content. The difference being that now with the tutorials on Mosaic, glitches uncovered during the morning classes could be discussed with the other faculty at lunch, and the tutorials edited in time for the afternoon lab sessions. With the paper tutorials, if a rough spot was uncovered, it would be marked, put in a folder, and (hopefully) updated for the printing next semester.

### **Lessons Learned**

Going through the process of converting the paper tutorials to on-line documents in Mosaic and using them in the classroom was a worthwhile learning experience. Presented below are some rules of thumb which came out of this experience:

1. Avoid coding in HTML directly for complex documents. Our tutorials had a considerable amount of bold, italicized, or otherwise formatted text; each instance of which needed a special code before and after it. Use a word

processing package such as MS Word to format the document and then use utilities such as rtf-to-html to convert the documents. On the other hand, if the documents have a minimal amount of formatting and consist mostly of links to other documents, you may not want to bother with the conversion and code the HTML file directly in BBEdit Lite or some other word processor.

2. Graphics are a critical aspect of a successful document. What is evident to most people working with CAD and engineering graphics is well designed graphics can make a big difference in a tutorial or other instructional material. Mosaic has the capability of a true multimedia presentation; including 8-bit color graphics, animation, and sound. Wise use of these capabilities can enhance the instruction. On the other hand, excessive use clutters and adds unnecessary complexity to the document, hogs disk space, and slows document loading to crawl.

3. Related to rule #2 is to keep your graphics as small as possible. Added size and added complexity in the image adds to its size on disk and can take up unnecessary space on the computer screen. Even with the black & white still graphics in our tutorials, some students got impatient with the speed of loading. One thing you can do is recommend to the students that they set the option which stops the automatic loading of images; students then click on the graphic when they are ready to see it.

4. Even on a 19" monitor, having both CADKEY and Mosaic open on the screen side by side makes for a crowded screen. The step-by-step nature of the tutorials means it is tough to have Mosaic behind CADKEY and switch back and forth. One option is the students can print out their tutorials (at their expense) and use them like a traditional paper tutorial. This solves the screen crowding problem but loses the on-line capabilities of Mosaic.

5. You can never proof the tutorials enough. Not only do you have all the problems you would have with a paper document, but you have the added complexity of linkages to other documents. You should do a dry run through the tutorial on-line, testing all the links in the document.

6. Have a clear line of responsibility for maintaining you on-line material. Just as with maintaining electronic engineering documents in industry, revision management is of critical concern. If every instructor feels free to go in and change the on-line information to suit their needs, then a lot of other instructors are going to start finding a lot of unexpected changes when their students are using the tutorials.

7. Using Mosaic or any other new software has its up front costs in terms of instructional time. Though Mosaic is very intuitive, there will still be a need for getting a student up and running on it. We got rid of our paper based handouts for the tutorials, but we did have to create a new one page handout to get them going on Mosaic and locating the tutorials. It probably goes without saying that those students who are struggling with CAD and computers in general will also struggle a bit more with Mosaic than the typical student.

8. As it stands now, copyright laws are virtually meaningless on the Net. Keep in mind that anything you put on-line in Mosaic can be seen by anyone and copied by anyone on the Net. Password protection and other security tools are on their way to Web software, but they aren't here quite yet.

### **Summary**

There is no question that the conversion of our tutorials to be on-line in

Mosaic was worthwhile, but it was not without cost. Probably the single biggest cost was the time spent in converting the documents. If the tutorials were designed to be on-line to begin with and if I had rtf-to-html from the start, a significant reduction in time could have been achieved. The most significant amount of time was put into the actual content of the tutorials, time that would have had to have been spent whether they were on paper or on-line. It was a sobering reminder how difficult it is to produce high quality instructional materials. Now that the conversion has been completed, we are reaping the savings in printing costs, confusion over older version floating around, and ease of updating.

Another added advantage not discussed so far has been the tutorial's use as a marketing tool. The graphics program at NC State University is a service oriented program which is heavily dependent on other departments requiring our courses. We, like many graphics programs, have been unfairly saddled with a label of being technologically backward and not teaching content relevant to the 'modern' engineer. Putting our tutorials on-line has been used to counter this problem. Indirectly, the on-line tutorials are a reminder that we are (and have been) willing to explore new technologies to assist in the instruction of students. More directly, the hypermedia nature of Mosaic allows us to hook our tutorials to the home page of our program where students can learn about the other courses we offer. Students no longer have to come by our office to pick up a brochure, they can view it and print it directly from Mosaic.

### **Future Directions**

Future plans for the use of Mosaic and other Web tools includes not only instructional material, but also use of these tools in the area of professional and administrative activities. NC State University has made a strong commitment to the use of Web tools as a means of disseminating information. All course listings are on-line as are phone listings, job openings, and public memos out of the Provost's office just to name a few. All the Colleges at the University have home pages and many of the departments and programs have followed suit with their own. These home pages become a vehicle for both recruiting students for courses or degrees and for professional exchange. Recently, the Engineering Design Graphics Division got an email listserve up and running to promote exchange between graphics professionals. The future probably points towards the use of Web tools which allow a broad spectrum of media and interactive exchange between users. That is, unlike Mosaic where one individual "posts" for everyone else to see, there will be public areas where anyone can post material in any media to be shared and discussed.

In the instructional area, critical issues concerning copyright protection on the Net will have to be answered before publishers will seriously consider it as a medium for publication. Publishers are slowly warming to CD-ROMs but that is because they can treat them largely like they do a textbook. On-line material in software like Mosaic is a different medium with different possibilities and different difficulties. There is no long a physical object such as a disk or textbook which acts a vehicle for financial exchange and controls (to some degree) is dissemination. There is no longer a physical object to control this exchange and new mechanisms will have to be put in place to offer publishing companies and authors reasonable compensation and instructors and students good value for their money.

As mentioned earlier, on-line instructional material opens up new areas for research. Now, in addition to content, the delivery mechanism for this material needs to be examined for its instructional appropriateness. For example, just dealing with straight text, there are differences in performance reading off a screen rather than off a printed page (De Bruijn, De Mul & Van Oostendorp, 1992; Dillon, McKnight & Richardson, 1988). When you get to more complex effects concerning hypermedia and multimedia, many issues — such as performance, learning styles, perception, to name a few — are just now beginning to be explored (cf., Alty, 1993; Barrett, 1989; Begoray, 1990; Nielson & Lyngbaek, 1990). Instruction in the area of technical and engineering graphics, with its unique demands for the use of multiple media sources and heavy reliance on computers, is an excellent starting point to explore many of these issues.

### **Web Paths of Interest**

NCSA Mosaic Demo Page

<http://www.ncsa.uiuc.edu/demoweb/demo.html>

CADKEY Tutorial Home Page

<http://www2.ncsu.edu/ncsu/comp/cadkey/CADKEY-HomePage1.1.html>

Graphic Communications Program Home Page

<http://www2.ncsu.edu/ncsu/cep/oed/gc/gchome.html>

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