Communication and Compatibility: Introducing Electronic Media Techniques in Computer-Based Engineering Laboratories

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Summary

Computer-based engineering laboratories, such as those used to present engineering graphics and simulation courses, provide instructors with an opportunity to introduce a wide range of additional topics to students, from basic computer use tutorials in freshman graphics to social issues of relevance and privacy in graduate-level courses. The professor that wishes to treat such areas will be most successful in a laboratory environment that includes computer monitor projection capabilities, as well as individual workstations. In examining the expanded utilization possibilities of engineering computer laboratories, though, other issues must be addressed before a strategy of implementation can be advocated. To explore the role of information technology in the college classroom, we must more clearly define its missions in both the education environment and the engineering workplace. We can then identify key areas that information technology and services (IT&S), and specifically engineering computer laboratories, can assist in achieving these goals, supported by examples from the University of Alabama in Huntsville (UAH) College of Engineering.

Approach

Engineering educational institutions must provide their students with computer facilities. Areas such as numerical methods, engineering graphics and systems simulation have evolved such that they cannot be presented without such facilities. However, several issues surrounding the use of information technology (IT) in education, and in the workplace, have not been examined in as much detail as perhaps is warranted by this inclusive implementation. Computers have been placed in classrooms across the country, but have they increased learning in a relevant fashion, in significant areas? We provide information technology and services (IT&S) to students, but do we also provide them, or even ourselves, enough basic operational training? Computers have increased productivity in the workplace, but have they increased the quality of the output? We're transferring more information, but are we communicating more effectively?

The Role of Computers in Engineering Education

Among the most important skills the college student must cultivate is the facility for critical evaluation of innovation and change, which are typified by information technology. The virtues of IT in the classroom have been extolled by many education administrators and public officials. The conscientious instructor, however, must be careful to distill for students the actual capabilities of the computer, and its limitations, from the hyperbole. According to Theodore Roszak, information and IT have been accorded an "exalted status" previously enjoyed only by gods and entertainers.[1] He is not alone in his assertion that this new status of IT has been cultivated by those who stand to profit from high-tech endeavors. A student's well-rounded understanding of IT&S can provide inoculation against getting bitten by exaggerated claims of vendors who tend to profit by promising more than they can deliver.

Students must be elevated to some level of computer competency before exiting the engineering curriculum. Some students have the opportunity and personal motivation to acquire computing skills, but the instruction by peers that typically takes place is usually informal and tends to be eccentric at best. (Engineering educators sometimes suffer the same handicap, having made the transition, perhaps reluctantly, from mainframe batch computing to desktop computing, after a huge investment in non-portable experience and coding). For an effective understanding of computer operation, basic concepts must be introduced early in the curriculum.

In the freshman-level Engineering Graphics course in the UAH Mechanical Engineering Department, new engineering students are introduced to computer maintenance and security issues. While not as interesting as multimedia, such mundane topics as installation and troubleshooting, periodic backups and virus protection soon acquire great relevance (unfortunately, usually at some painful pivotal point after they have been disregarded). Older excess computers provide valuable test beds for novice computer operators to practice these necessary operations, such as file maintenance, software and hardware installation, virus protection and repair, periodic backups and troubleshooting. Though the problems encountered on these vintage machines might be slightly different than those on newer ones, the problem-solving skills developed will be just as applicable. These precautionary practices are particularly necessary in laboratories, such as those at UAH, where networks have external connectivity.

This foundation can then be built upon, to provide a framework that the students can use to organize their knowledge of IT&S concepts upon. For example, the tree architecture of the basic MS-DOS operating system can be shown to be similar to the folder/sub-folder scheme of the Macintosh system. These two systems can then be contrasted to the complex, web-like structures that result from logical hypertext links on worldwide web (WWW, or just web) pages. These types of relationships can be explored in computer-based engineering laboratories, where cutting-edge information technology issues that arise and mature too quickly to be included formally in the curriculum can be introduced.

In other courses, common software tools, including word processing, image manipulation, and data analysis and presentation, allow students to explore issues of inter-application compatibility and effective format. Until recently, "desktop publishing" implied only the inclusion of graphics into a printed report. With the advent of the WWW and other standardized multimedia platforms, though, electronic documents can encompass not only many different technologies, but also different branches of knowledge. In an interdisciplinary course, conducted jointly by the Colleges of Engineering, Administrative Science, and Liberal Arts, a senior Mechanical Engineering Design project has been combined with graduate-level Financial Decisions Under Uncertainty, Technical Writing, and Industrial and Systems Engineering classes to design, cost and propose a hybrid rocket fourth stage for the Multi-Service Launch System. Laboratory networks enable students to share, explore, critique and integrate each other's work, and links to the Internet allow students to download and study the work of others in this area. Local web servers enable students to publish and inter-link their own pages, and linkage to these pages from externally-accessible university web pages provides additional motivation for excellence from the students, whose peers and distant relatives can then observe their progress through increasingly informative and captivating documents. Computer roles in this classes have ranged widely: probabilistic analysis of economic feasibility, transformation of CADD models into stereo lithography scale hardware, authoring worldwide web pages and automating them with Java (a platform-independent portable programming language), and demonstrations or tutorials of these and other processes to other students and faculty.

New electronic publishing media such as these should be introduced as soon as possible in the young engineers' studies, so that these capabilities can mature throughout their university experiences. Engineering computer laboratories can be used in conjunction with traditional labs and other courses to provide students with formal environments for specific instruction in these basic concepts, as well as topics dealing with report format, software techniques, and hardware usage. Templates and samples can be provided to allow students to investigate specific techniques for achieving particular results from software packages, including word processing, spreadsheet, graphics, and presentation programs. Further, these laboratories can also provide for proper presentation of multimedia-enhanced documents with computer presentation facilities. This provides demonstration capability for the instructor, as well as allowing multimedia briefings to be presented, not only to the class, but also to other groups, such as student organizations. In a classroom equipped with individual workstations and a presentation screen for the instructor, each student can learn to construct electronic media documents, such as multimedia presentations and WWW pages. Students can be shown simple techniques, using simple textual "tags," to convert text documents into web pages, which can be proofed with several web browsers (Figure 1), then linked together locally to form networks of information.

Figure 1: Web pages must be proofed for each of your prospective audiences' web browsers.

We compete for students' time with the super-sophisticated attention-getting techniques of music videos and psychological advertising. Must the engineering educator, then, resort to flashy graphics and catchy jingles to keep the students enthralled? Absolutely not. The dedicated engineering student must show some evidence of internal motivation. Effective engineering instructors, though, can use the tools at their disposal to demonstrate the relevance of their subject matter to students' career interests and aptitudes. In a computer laboratory or presentation facility that is connected to the Internet, students can be taken on a tour of organizations that employ engineers in their particular discipline, and be shown practical applications of the subject at hand to exciting cutting-edge projects. Mechanical engineers can see orbital mechanics and thermal transfer effects explored in the next generation of space launch vehicles, and industrial engineers can learn about implementations of novel processing theories in factories around the world. Electrical engineers can download information on new data compression algorithms from government laboratories. In the Kinematics and Dynamics courses at UAH, a computer program called "Working Model" (Knowledge Revolution, San Mateo, CA) can be demonstrated by the professor, then manipulated by students to show gearing concepts, simulate object collisions, and even model the suspension of the UAH entry in the yearly Moon Buggy competition.

The Role of Computers in the Workplace

Unfortunately, many managers in the US, even in technical industries, have been convinced by the IT&S professionals that the computer holds the key to solutions far outside its area of influence. Executives who might never try even to set the clock on their VCR become indignant when their computer will not execute their every whim flawlessly. These executives have not realized that "computer technology creates the need for greater coordination and integration of different units within an organization," i.e., it does not *provide* good management, it *demands* it.[2] In the office, the speed of accounting data processing has often produced the expectation that all other aspects of the business should be accelerated by automation as well. Casualties of unreasonable efforts at streamlining have included creative endeavors such as graphic arts, as well as technical areas such as engineering, which include a necessary stage of waiting for processes to complete or inspiration to come. Graduate engineers who venture into industry or government organizations must be prepared to counter these unreasonable expectations by knowing exactly what can and cannot be done with computers.

The MIS "priesthood," which descended from power in the financial industries in the 1980's, still exerts influence over other, otherwise reasonable, industries. In some industries, even some universities, the IT organizations modeled after this exclusive approach to resources still keep the full IT&S capabilities out of reach of employees and students. Even university faculty members, who justify the academic networks that helped spawn the Internet, are not always well-trained in computer operation or involved in the administration of the campus networks. In order for the faculty to be able to teach knowledgeably about the rapid advances in IT, they must be involved in these critical areas.

If there is one primary characteristic of today's engineering field which makes analysis of employee marketability and effectiveness difficult, it is the quickness with which the engineering profession is changing. In times easily within memory, engineering functions in each discipline were well-defined and plentiful. Prospective engineers entering the educational process could select a function in a particular industry, obtain the correct tools, and be productive after a short internship. They could also expect to forge competent performance into a successful career. Now, students who enter the engineering fields cannot even enjoy the guarantee of employment, let alone the promise of career stability.

The most successful engineers from that vanished era had something in common with those of today. Adaptability, which is the key to success in today's rapidly-evolving technical fields, was essential even in those more traditional environments. In those days, the best engineer was often promoted to a management position without the benefit of training for the radical shift in duties. One evidence of flexibility in an employee, the willingness to venture outside a comfortable specialty in order to satisfy a particular need, has increased in importance with the adoption of project-based organizational structures such as integrated product teams. This valuable characteristic can be encouraged in students by providing open-ended tools, such as multimedia authoring tools and network connectivity, that present enough possibilities to allow each individual to explore the medium and challenge the other students to imaginative uses of the technology.

Conclusions

New forms of presentation, from multimedia briefings to personal WWW resume pages, make each previous media obsolete. In today's engineering marketplace, results of engineering efforts often cannot attract adequate notice just being published on paper. Graphic enhancements to the text can help, but the inclusion of electronic media, such as animation and sound, can bring understanding much more quickly and easily, as well as extending appeal to a much larger audience. This can be the frontier for one of the most positive effects information technology can have on our industry: our chance to re-involve the world in engineering and the other technical disciplines.

Integrating computer usage more completely into more courses can provide students with diverse computer-based skills that directly enhance their other marketable skills. More importantly, though, students should be presented with realistic evaluations of the capabilities of IT. Instructors who undertake information technology education should make a commitment to continual self-education, for this area, like no other, threatens to rapidly leave educational systems in obsolescence. In the end, students must graduate into the marketplace with the knowledge that information technology can be a valuable tool, but it can never be as valuable as the people who created it.

References

[1] Roszak, Theodore; The Cult of Information. Pantheon Books, New York, 1986., p. 20

[2] Schultz, Duane P. and Sydney Ellen, Psychology and Industry Today. Macmillian, New York, 1990, p. 311.

Biographical Information

After years of totally confusing everyone he tried to communicate with, Eric Shaw finally figured out that he should have been an Engineer. Upon earning his BSME at the University of Alabama in Huntsville, he immediately and concurrently went to work for the Engineering Cost Group at the NASA Marshall Space Flight Center and embarked upon a Systems Engineering Master's. Mr. Shaw's experience includes twenty years of work with information technology and services, the area in which his teaching interest is focused. He and his wife Katherine, a music educator, have two children. His hobbies include a cappella vocal and jazz rock music.