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Moving outside of the box: Alternative instructional delivery methods in engineering graphics

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ABSTRACT- *While Internet and computer technologies have been employed in the engineering graphics classroom for a while now, emerging technologies have opened new avenues for instruction that have not been widely explored. This paper will focus on the development of streaming media, classroom management systems, and increased portability of networked computers. These three technologies, together with other more established trends, are opening up numerous opportunities for instructional delivery. These new technologies will be examined by looking at their impact on common existing methods of instruction in engineering graphics*

I. Introduction

While Internet and computer technologies have been employed in the engineering graphics classroom for a while now, emerging technologies have opened new avenues for instruction that have not been widely explored – in engineering graphics instruction, or other content areas. Some of the more exciting technologies include developments in the areas of streaming media, classroom management systems, and increased portability of networked computers. These three technologies, together with other more established trends, are opening up numerous opportunities for instructional delivery (Carlson, 2001; Griffioen, Seales & Lummp Jr., 1999). When these three technology areas are evaluated relative to common teaching practices in the classroom, new innovative possibilities in instruction arise. However, effective use of these new technologies will require an understanding of the technologies, how best to initially integrate them, and how to evaluate and revise their application (Ehrich, McCreary, Ramsey, Reaux & Rowland, 1998; Scanlon, Jones, Barnard, Thompson & Calder, 2000).

First, the basic attributes of these new technologies will be examined. Next, general issues will be raised relative to their usefulness in the classroom. Finally, common existing methods of instruction in engineering graphics will be used to create scenarios for possible applications for one or more of these technologies.

II. Streaming Media

Prior to the development of the World Wide Web, a primary use of the Internet was to allow the transfer (or ‘download’) of files from centralized servers. Once a file was downloaded, it could then be opened with the appropriate software tools and its contents viewed. The web revolutionized this process both by providing a common portal through which a single software program could open and view multiple media types, but also allow for ‘previewing’ of material prior to completely downloading it. Progressive downloading allowed both text at the beginning of a document (or at the top of a larger site) and images to be previewed prior to a complete download. Previewing meant that rather than having to wait to completely download information, the user could begin to start viewing the information. Internet technology, however, has been somewhat slow to catch up with all the potential types of media that could be delivered over the Internet. Up until recently, the ability to progressively download – or 'stream' – high quality audio and video was limited by a combination of: 1) lack of Internet bandwidth, 2) processor power of the user's computer, and 3) high-efficiency software tools to compress the media.

In 1995 RealNetworks released their first streaming audio tools. Using a new generation of software compression and Internet streaming technologies, Real and other developers were able to stream radio broadcast quality over the Internet. Though there was a short buffering period, users could listen to audio broadcasts without first having to download the entire file. The relatively small bandwidth requirements of FM radio quality audio meant that users with large bandwidth Internet connections at work or universities were able to take advantage of this streaming technology. However, users with slow modem connections to the Internet were still left out. Moving forward to the present, high bandwidth connections to residential users via cable modems and DSL, and a new generation of high efficiency media compression using the CPU power of current computer technology has meant that CD-quality audio and television quality video is now possible over the Internet to a wide variety of users. The current market leaders in this streaming media technology are RealNetworks (RealNetworks, 2001), Apple Quicktime (Apple, 2001), and Microsoft Windows Media (Microsoft, 2001).

In deciding if you are going to deliver some of your course content via streaming media, there are a number basic decisions that have to be made concerning how you are going to deliver the material. First and foremost is an understanding of who your target audience is. Knowing what kind of Internet connection the audience's computer has and which of the players they have on their computer -- Real, Quicktime, or Windows Media -- will help guide the production of the streaming content. The next important question is what kind of content you will be delivering. PowerPoint, consisting of still images containing text needs to have an emphasis on crispness of static elements, while a live lecture will have less detail but a need to handle motion. The answer to these questions will allow you to set some of the key parameters used to produce your streaming clip:

- Codec - The algorithm used to compress your video prior to delivery and then decompress it for viewing. This is often predetermined by which player you are delivering your video to.
- Target bitrate - The estimated rate, in bits per second, which you expect to be able to deliver your clip to the player; whether it is from a CD-ROM or over the Internet. This is often set by indicating what type of connection you expect your audience to have (e.g., 56K modem, LAN, etc.)
- Resolution - The total number of pixels to be displayed in the video frame. For example, 640x480 would fill half to two-thirds of a typical computer monitor.
- Audio - There are three basic settings to choose from: the sampling rate (in kHz), the number of bits per sample (in bits), and mono or stereo. Delivery of lecture materials can be done with a lower sample rate in mono (e.g.; 11 kHz, 16-bit, mono). These settings can often be preset based on your target bitrate and whether you are delivering voice only, voice and music, or music.

Though there are an infinite number of possible permutations of these (and many more advanced) settings, there are general rules of thumb based on the type of material you are presenting to guide the production of clips. Slide shows with an audio accompaniment are the least demanding. You can typically use a codec preset specifically designed for a low framerate and high clarity. Capturing software demos off the computer monitor requires a compromise between handling some motion while also keeping the clarity fairly high. Live lecture often demands the capture of movement but less detail for the lecturer and writing on whiteboards. Generally speaking, the more detail you need to show, the higher the resolution of the clips.

Key issues with this and the other technologies discussed here break down into technical, pedagogical, and sociological spheres. On the technical side you need to determine if your students have access to computers with fast enough CPUs and/or Internet connections to play your clips. Similarly, you have to make sure they all have the player you are producing your video clips for. If many of your students are accessing the material via the Internet using 56K modems on older computers, there will be limitations in terms of image quality and resolution. A key pedagogical issue will be the instructional impact of having material such as software demonstrations and PowerPoint slides delivered remotely and asynchronously rather than live in a classroom. The sociological factors interrelate to the other two in that they address issues of motivation of students in the face of these new technologies. How do students' view the computer as a delivery vehicle of material that was traditionally delivered live and in person?

III. Content Management

The streaming video is of course just one component of classroom materials needed to support a course. Along with lecture materials and software demos will be background reading, a syllabus, homework, and tests. Potentially, all of these elements can be delivered electronically and are in need of supporting technologies to help manage them. The Internet -- and more importantly, the Web -- brought about an extremely powerful vehicle for collecting and delivering different types of media to a distributed audience.

The use of basic web authoring tools to deliver course materials continues to be extremely popular on campuses, with measures of what percentage of course syllabi on the Web as a common benchmark for how 'wired' your academic program is (Yahoo, 2001). As robust and flexible basic web delivery is, it still has some inherent weaknesses. First, organization of your course materials can potentially be organized in a non-linear network, a design task that many find daunting. Secondly, the Web is not inherently secure; it does not know who you are and cannot confirm your identity. With additional tools to confirm your identity, additional tools are needed to organize and manage material that only certain people should see at certain times. Finally, interactivity, where material is both delivered to individuals and received back from them, is not a robust part of the basic Web platform.

In response to these limitations of basic Web delivery, course management solutions were developed that both bypassed the Web altogether or incorporated the Web as part of a larger package of Internet-based course management tools. Two of the most powerful such toolkits, WebCT (WebCT, 2001) and Blackboard (Blackboard, 2001), use this later approach and serve hundreds of corporations and learning institutions. These tools provide templates to assist faculty in preparing their course site In addition, they provide centralized databases and data storage areas for the storage and management of course materials, student and grading information. This material is secured by access tools that allows instructors to manage who sees what material when. Realizing that at the present time, not all material is optimally delivered over the Internet, these tools also have facilities for coordinating with material burned onto CD's, distributed to the students, and used on their local machines.

The larger, more sophisticated course management technology solutions are put into place when the institution determines that this technology solution offers an effective means for delivering course content to their near and/or remote student body. The cost and complexity of these technologies make them near impossible to implement effectively by individual faculty. However, even if an institution buys into these technologies, the support they provide and the response of the faculty will determine their effective use. Both the expected pedagogical advantages and impact on their workload will influence faculty perceptions of the system. These systems are complex and require both substantive back end and front line support if faculty are going to use it. There will need to be a climate of trust established that convinces faculty help will be available in getting courses up in running, maintaining the course materials, and keeping the system operational around the clock. Again, issues concerning this technology involve an interrelationship of technical, pedagogical, and sociological issues.

IV. Mobile Computing

The third technology discussed involves the final delivery point of instructional materials, the computer being used by the students and faculty. More specifically, the technologies of interest are those that allow the computer to be highly mobile, where restrictions of weight, size, and physical connections to buildings is minimized. While laptop computer technology has been around for sometime, only in the last couple of years has the technology reached a maturity that allows for a high degree of cost-competitiveness with desktop computers. Miniaturization of motherboard and drive components, improvements in display technology, and effective human factors engineering of the interfaces have all made the laptop a viable alternative to desktop computers.

While all of the above mentioned technologies have delivered a cost-effective size and weight for mobility, the need to tether the laptop to power sources and network connections continued to limit their mobility. Long life, lightweight batteries have helped solve the power issue, while wireless network technology has provided the key breakthrough for unencumbered network access. While network connection for personal computers was not mission critical during its early history, the Internet, networked storage and printing resources has made network access mandatory for both students and faculty alike. Early implementations of wireless networking technologies lacked interoperability between brands, weak signal coverage, and low bandwidth. Standardization around the IEEE 802.11 specification (WECA, 2000) and increased technical sophistication has made wireless network connections on campus as fast and reliable as wired connections to LANs. With this standard place Lucent technologies and Apple pioneered the availability of a low cost wireless networking solution in 1999. (Apple, 2000; Orinoco, 2000). Virtually all other major computer and networking hardware vendors followed suit with similar product offerings within a year.

The IEEE 802.3 standard describes Ethernet networking over wire while the IEEE 802.11 standard describes Ethernet networking over the 2.4 GHz radio frequency. Within this standard there are two ways of sending data over the 2.4 GHz frequency. The Direct Sequence Spread Spectrum (DSSS) modulation is the most popular. The original 802.11 standard provided for data speeds up to 2 MB/sec, while the more recently adopted 802.11b High Rate standard provides for speeds up to 11MB/sec, slightly faster than the 10MB/sec Ethernet LAN networks most universities use. A new

802.11a specification has just been released and offers even more robust network performance. Highly compact network access points (i.e., antennas) can be placed in ceilings and closets to provide seamless coverage for classroom and office buildings. With ranges of approximately 1000-3000 ft in open air and 300-1000 ft inside buildings, this technology provides a network connection throughout a building with only a minimal number of access points. Because it is based on Ethernet, it allows for all of the network applications that users typically use.

The high mobility of wireless laptops means that computer-based instruction no longer has to be limited to desktop-based computer labs. Computers can now be brought into the classroom environment without many of the physical limitations of desktop computers. Smaller footprints remove many of the line of sight and workspace issues raised with desktop computers. Wireless connections give students and instructors tremendous flexibility in how students and computers distribute themselves about a classroom. There is the potential of lecture and lab activities to be seamlessly integrated into a single space. Against this bucolic vision stands a number of sobering realities. Among them is the fact that this scenario is likely to only happen if students own their own laptops and are responsible for bringing them to class. Similarly, the lack of infinite battery life means that some percentage of students will always come to class without mobile power and need to plug in. Finally, miniaturization does mean smaller monitor sizes and often the need to swap drive bays to get access to all possible removable media types.

For the instructor, the potential for wireless technology – as was seen with the other technologies discussed – lies to some degree in the hands of the larger organization and policies they put in place. Mandatory laptop ownership and the installation of building-wide wireless networks are key to the effective implementation of this technology. Once again, the faculty will have to weigh the pedagogical benefits of the technology and how it changes the perception of how a computer is integrated into the complete instructional environment (Carlson, 2001; Griffioen et al., 1999).

V. Putting it all Together

Streaming video and audio content, management of this and other media with Internet-based course management tools, and the delivery of course content to wireless, mobile computers will all have a significant impact on how we teach our engineering and technical graphics classes and interact with our students in the next five years. Some faculty and institutions have seen these technologies as central their future mission and have already put these pieces all together (Baxter, Lister & Laplante, 2001). What are some of the potential ways that all of these technologies can come together?

Lecture materials that, intentionally or unintentionally, are received as a one way communication from the instructor to the student can almost always be delivered in a streaming video content. Powerpoint, whiteboard, overheads, and lecture can all be packaged in a streaming video content at bandwidths that most students can access. What is lost in the spontaneity of the delivery is balanced against a permanent archive that can be played over and over. Students can now access lecture materials at any time of the day or night, view the materials in classroom buildings, dorm rooms, apartments, or on bus rides to campus. They can also stop, start, and replay the material at will. Flexibility in viewing this material is further enhanced when it is done via a wireless network computer. On-the-fly access to the streams now are not limited to CD-ROM based content and can be accessed in an even wider range of settings, including during class.

If there is a desire to support interaction in response to lecture and reading materials, course management systems support Web and email based discussion forums, chat rooms and bulletin boards for the sharing of typed responses. Currently, real-time audio and video interactivity via video conferencing systems is not in as widespread use, though the technology is readily available through systems like NetMeeting. These discussion tools provide support for both synchronous and asynchronous communications and can be brought together with lecture and reading materials within the course management systems. Paired with wireless mobile technologies, new dimensions for interaction with students are again opened up.

One of the standard components of most engineering graphics courses is the computer-based lab. Currently most lab activity is segregated from the classroom activity by the logistical problems of bringing the computer lab into a classroom and vice versa. This separation is further reinforced at many institutions by the separation of responsibilities, with faculty in charge of lecture and graduate assistants in charge of the labs. Wireless laptops now remove most of technical barriers, leaving pedagogical and organizational concerns as the deciding elements in this integration. Wireless laptops in the classroom means that activities using CAD and other graphics tools can now be interleaved with lecture and demonstration. Similarly, streaming video of lecture materials and discussion tools supported by the course management system may do away with the need to meet for lecture at all. Or, with software instruction delivered online, it may also do away with the need to meet for labs.

Piloting of these technologies and techniques, reflection on their implications, and reporting on the conclusions at meetings such as this will be critical for developing faculty prepared to make the most of these new technologies. Outlined above are just a few of the possible implications for these technologies. Also on the horizon are likely to be other technologies that will influence both our institutional and classroom practices.

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