Practical use of Multimedia in an Undergraduate Engineering Technology Program

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I. Introduction to multimedia

Multimedia, as a buzzword in education, has been pushed to the point of becoming cliché. The word invokes images of flashy interactive video and sound, promising brain candy for the MTV generation. The "flash," however, is usually the product of a professional multimedia publisher. Expert graphic designers, programmers, and editors work in teams armed with the latest technology. The product they turn out costs dearly and often falls short in terms of desired content. Now, with powerful and affordable technology available to the consumer and advertisements that promise the world, many faculty are inspired to author their own in-house multimedia. A common problem is to invest in multimedia technology without a clear plan of how to use it. This may well be caused by inexperience or as a response to pressure from above. In either case it can be very expensive when a special software or hardware component fails to live up to expectations. All-too-often these efforts lead to blind alleys, frustration, and incomplete or inferior results. A careful examination of the facts coupled with a realistic set of development goals will greatly improve one's chances of success.

This paper will present ways in which faculty can set realistic project goals with an emphasis on keeping expectations reasonable and quality high. A review of various software and hardware products will be included along with practical advice on their use and compatibility with other systems. The role of multimedia at State Technical Institute in Memphis, TN and its use in the support of Engineering Technology curriculum will be examined in detail.

II. Multimedia basics

The term “multimedia” has not only entered the English language but is thoroughly entrenched in everyday conversation. Vast resources and manpower have been devoted to the discussion of multimedia—and this paper is no exception. Try an Internet search for the word multimedia; Altavista will turn up nearly 10 million pages. Despite this fact, it is unlikely that most people truly understand what multimedia is. In general, it is understood to mean computer-based “text, graphics, animation, stills, audio, and video[7],” in a dazzling, fast-paced presentation that more closely resembles interactive video games than educational material. Indeed, the entertainment market must push the boundaries of technology and, often, good taste in order to sell their product. Since the 1980’s when music videos became the rage, popular culture began consuming this “brain-candy” at ever accelerating rates.

Multimedia is far more than entertainment; it is a tool that employs some combination of communication forms such as text, graphics, sound, and video. It is a tool that enhances the effectiveness of communication by combining media regardless of design intent. The first books were a great achievement in the field of communication but how much greater did they become

when technology permitted the addition of illustrations and photographs? By the second definition, illustrated books are a form of multimedia. Along this line of reasoning TV commercials become a form of multimedia as well[7]. Multimedia is an older concept than most realize and can be delivered through any one of several channels, from illustrated books to film and, now, to the computer.

The personal computer added two significant advancements to multimedia. First was the element of interactivity with the viewer. The second, and far more important advancement, was empowerment of the consumer to author complex multimedia presentations. Interactivity equals control, control for both the author and the viewer. In terms of instructional multimedia, the author may wish to focus the viewer on a series of steps such as a mathematical solution to a problem. When constrained appropriately, the presentation will require successful solution before allowing the viewer to continue. On the other hand, the viewer always has some control throughout the presentation. The viewer can skip sections that aren't needed and replay sections at will. This is a win-win scenario if the level of control and interactivity is appropriate for the audience and occasion. The modern PC, when loaded with sufficient software and hardware resources, can become a professional-grade authoring studio[5]. Never in the history of multimedia communication has so much power been placed in the hands of the consumer. The technology formerly required to produce professional presentations has become affordable and relatively easy to use. Educators can produce specialized presentations to detail specific topics or to reinforce repetitive information.

The multimedia presentation does not have to have every media form to be effective. Nor does the presentation have to be delivered through a computer. If the intended audience would be better served with videotape delivery, this can be easily planned for and accomplished. Presentations do not have to include extensive opportunity for interaction. Multimedia is primarily visual but can contain great quantities of text. Eye catching animation is optional as is video and sound, but the strength of multimedia is derived from the appropriate use of all these media. It should be a priority of the author to consciously look for situations where optional media will improve the impact and retention of the message. "Authoring in this new multimedia environment thus requires both new skills and access to multimedia materials—graphics files, sounds, video clips[5]." Keep in mind the effectiveness of video for "showing how things work…video can take an audience where they could not easily go and show them what they otherwise might never have a chance to see[4]." Educational multimedia is about successful communication. The remainder of this paper will deal exclusively with multimedia development for college level educators with a bias toward the needs of engineering technology programs.

It is very important to understand your capabilities and limitations in terms of resources and expertise. It is equally important to isolate exactly what material must be covered by the presentation. When a balance is struck between what you want to do and what you can do, a realistic goal can be set. A common mistake is to attempt too much material. For the entry-level author it is much better to narrow the focus as much as possible. It is also permissible for the first attempt to be somewhat Spartan in terms of extra links, asides, and other design frills. This is the essence of a reasonable approach to amateur multimedia development; consider a multimedia presentation to always be a work in progress. Begin with a simple design and build in an open architecture for further development. The presentation itself is, to a large extent, a cauldron of

discrete ingredients. Individual components can be changed later, usually with a minimum of rework to the rest of the presentation. This is especially true with simpler authoring software like Adobe Acrobat. The more complex the structure, the more difficult revisions may become. It is very important to keep and archive all project files that were generated by the various programs used throughout the project. To prevent clutter on the computer's hard drive, archiving of project files can be done on CD-R media.

Let us say a faculty member at a college wishes to create a presentation on the tensile testing of mild steel versus high carbon steel. The author understands from experience that a ¼ inch ASTM tensile test specimen will neck down and break very quickly and most students are unable to see the process as it happens. The author's goal might be to demonstrate the changes imposed on the specimen throughout the plastic range and the subsequent failure and then compare the results of the two tests. Assuming the author has access to video equipment but not to animation software, a film can be made. Later editing will allow enhancements to the video and the overlay of a sound track. Now assume the author has no video experience but can create an animation. The same presentation could be successfully carried out with either technique. It is normal for an author to shy away from media forms for which he has no expertise. Unfortunately this attitude can lead to creative stagnation. It is better by far to continuously improve one's skill set and as competence improves in new media forms they become potential tools in the author's arsenal. As previously stated, there is a balance between what you want to do and what you can do. It is unrealistic to plan for new media unless you have the luxury of planning-in training to beat the learning curve.

Another problem for new authors is estimating how long it will take to develop a presentation. It is not uncommon to re-create a design several times before the result meets the author's need. Wasted design time can be reduced through detailed planning. Common techniques for planning a multimedia presentation include storyboarding and scripting. Storyboards are sketches that layout scenes prior to production. They can be used to help spot design flaws and direct the author's focus. Not only does the presentation benefit from storyboarding, but so do individual media elements. A video clip is a perfect example of when to use a storyboard. Laying out the sequence of video shots in advance prevents poor performance later. Scripts are essential to quality sound and narrated video production. The purpose of these media in the presentation is to provide information to the viewer. The script is the heart of the message and the visual components are secondary. The script serves as an audio form of storyboard to facilitate editing.

State Technical Institute at Memphis (STIM) is a two-year technical college. Two of the oldest and most innovative departments in the college are the Mechanical and Industrial Engineering Technologies (MET/IET). Several years ago these departments began researching multimedia software and hardware in order to develop in-house curriculum-specific presentations and tutorials. Admittedly, professional offerings have improved in quantity and quality yet they are expensive and never quite live up to expectation. A strategy evolved in the MET/IET area in which the faculty and staff would learn to develop scaled-down presentations that would address very specific topics and be made available in departmental libraries in the form of videotape and CD-ROM. The departments were working blindly and made many mistakes attempting to locate the best equipment and software, but over time the learning curves were overcome and the processes simplified. The entire array of multimedia technology is now available to faculty and

staff. In-house training has begun that will bring everyone to a productive skill level in relatively short order. The single most effective boost to the program came in early 1999 when grant money was awarded to complete two mobile multimedia workstations including all hardware and software. This award made possible the timely completion of the project and its successful implementation.

The mobile multimedia workstations at STIM are fully loaded with software and with all necessary hardware at a cost of approximately $9,000 each, not a casual investment for most academic budgets. Nor is this a one-time cost when computer and software upgrades are considered. The unfortunate truth about multimedia production is that it requires a fairly wide array of software to produce the desired media components. A more frugal approach to gearing up for multimedia production would be to start with one media type and invest in a good software package to be installed on an existing computer. Since video often has the greatest initial impact on viewers, a video capture card and editing software make an effective starting point. A good capture card may cost only a few hundred dollars and Adobe Premier at the educational discount price sells for $350. You may be tempted to scrimp on these components but remember that it is cheaper to buy proven, quality components the first time rather than to buy them as a replacement for poor quality components later. As in State Tech's case, outside funding may be necessary before any substantial progress can be made. Look for partnerships with other academic areas as a means of spreading costs among budgets. Industry partnerships may also help locate funds.

It is important to know on the front end to what extent the institution intends to support the efforts of faculty. Support should be forthcoming if the college recognizes that "investments in technology are essential…to enhance the quality of teaching, learning, and scholarship[3]." Is the educator alone in this venture or do the department and/or college intend to provide resources? Money is only one resource and, though important, is often the easiest resource to come by. Support for a multimedia initiative must include training and time. Self taught development skills are well within the means of most educators, but the further one's background is from graphics and computer design, the more ground must be covered. For many educators, multimedia authoring is "a daunting challenge[5]." Technology has "assisted faculty at all levels of education in bringing new and innovative features into the classroom. Yet there still seems to be reluctance to utilize these resources among some[8]." Will the institution allow offloads for curriculum development activities? "With the influx of technology, ongoing staff development takes on a new meaning" and a new sense of urgency[9]. How deeply can the faculty who are involved commit to acquiring new software and design skills? There are few people who can maintain a productive workday and not spend some amount of personal time absorbing new technology. Especially in the computer-related fields keeping up with changes and building new skills is a full time job on its own. Often the best way to pick up new skills is to take a class. Most colleges offer graphic design classes as well as many vendors. Micron University offers a wide assortment of online courses that promise to take the student through various skill sets, many of which are needed for multimedia design. At State Tech the MET/IET faculty and staff have begun a combination of training initiatives that use focused in-house training where knowledge experts share their skills, and online training for broader, more generalized topics. Online courses are chosen either from campus offerings or from a recently established Micron University account. For example a course on Adobe PhotoShop would be an effective means of introducing

a person to the software. This could be followed up with in-house training on how to customize graphics for Acrobat screen display using PhotoShop.

When considering what forms an acceptable level of graphics and interactivity for a given presentation, it is a good idea to cast around for samples. The author can base design decisions on existing work, which can then serve as a starting point. Multimedia presentations typically use a graphic interface. The more graphic the interface, the more graphic manipulation will be required. If using a paint program is not an author's strong suit, then the design should limit those elements. Buttons, internal links, and controls are created as graphic elements that have some associated function within the authoring software. In that sense control elements are discrete objects. How these elements are assembled will depend on the authoring software. Interactivity is closely related to the control elements because it is these elements that define in what ways the viewer can control the flow of the presentation. A basic design rule for anyone new to multimedia is to keep the design simple. A photograph or geometric design can make an adequate background that does not require a graphic arts degree to create. Internal and external links can be created with text or with a button and the button can be captured free of charge over the Internet. Many graphical elements are freely distributed in that way, primarily for WebPage construction.

Another tactic is to use a more restrictive multimedia engine to limit interactivity. Leading author software like Macromedia Director is extremely non-restrictive. However, the interface is so powerful, using its own programming language called Lingo, that it is very hard to master. The learning curve for this software represents a substantial investment in time. Many professional multimedia publishers use Director but they also employ development teams to produce a professional presentation. Many educators will enjoy only a limited amount of assistance and would be better off using one of the more restrictive varieties such as Adobe Acrobat. There is no code involved in an Acrobat presentation, rather, a graphical interface not unlike a paint program is used to assemble and link the various elements. On the extreme end of restrictive are desktop packages like PowerPoint or Astound[11]. PowerPoint only allows a few choices and the author must operate within that framework. It should be noted that the less restrictive the software, the more there is to learn.

The author must also factor in the means through which the presentation is to be distributed. Not only will this detail affect the final recording media, it will dictate the authoring software, graphic and video content, and interactivity. Possible distributions include CD-ROM, Kiosk, LAN, Internet, and videotape. Immediately the issue of throughput becomes obvious as each technology offers differing limitations. Modern CD and DVD players run at sufficiently high speeds to handle most modest video playback requirements. They also support any level of interactivity that is required. This is the distribution of choice for most multimedia. Presentations larger than the 650 MB capacity of a CD-ROM can be placed on multiple volumes. Embellishments like autorun.inf and install programs offer increased flexibility for more involved presentations, however that is beyond the scope of this paper. Finally, a CD-ROM distribution assumes the audience has access to a computer of sufficient sophistication to allow quality viewing.

A Kiosk distribution involves designating a specific location where a computer with all necessary software and network connections is available for use by viewers. This undoubtedly offers the fastest access and best video playback quality for the presentation but requires an investment in hardware. It also limits distribution to the designated locations.

A more flexible solution is the LAN. Again the playback equipment must be provided, in the form of computer labs and office machines. However, the centralized location of the presentation on a server means distribution on demand. Throughput is the limiting factor in this distribution where the speed of the network and the traffic already present can cause delays and choppy or unsatisfactory video playback. This would indicate that the author should restrict the use of video as much as possible.

Video tape recordings of computer-generated presentations may be the only way some audience members can utilize the instructional information. While videotape will have no throughput limitations, it also has an imposed linear presentation sequence with no opportunity for interactivity. Normal VHS has around 250 scan lines and Super VHS has around 450 scan lines. Both numbers fall short of computer resolutions that must be converted to analog prior to taping. This dummy-down process can make text unreadable and blur screen icons beyond recognition. Production of a multimedia presentation for videotape distribution is a unique challenge and must be considered on the front end. An advantage to this distribution is the ubiquitous nature of VHS machines in classrooms and homes.

A possible hybrid distribution, one used at State Tech is the combination of two or more distributions. To provide maximum accessibility for MET/IET students, tutorials and presentations are produced for CD-ROM when graphic content is high and there is video content or the Internet when there are few graphics and no video. Then the presentation is recorded onto VHS. Libraries are maintained with both distribution forms to suit the needs of the students who need to view the information.

III. Multimedia Software

Authoring Software

Authoring Software is the glue that holds all the presentation elements together. It provides the author with the ability to create a user interface and to set the rules of the presentation. The choice of which authoring software to use is fundamental to the success of the presentation. As previously discussed, the multimedia engine, or code that controls the presentation is subject to varying amounts of freedom[11]. The more restrictive it is the easier it is to learn and the more limited it is. The following list begins with the two authoring software programs that provide the best compromise between control and ease of use.

Table 1 Multimedia Authoring software comparison.

Title	Cost	User level	Notes
Adobe Acrobat	<$100	beginner	Acrobat works by taking an existing document and converting it to a Portable Document Format (PDF) file. Many user manuals and documentation packages come in PDF form and the Acrobat reader that is needed to view the document is already on most computers. Key to Acrobat's success is the way Adobe saturated the market with the free reader software. Documents are converted from their native format to PDF form before objects are embedded, actions defined, and links made. Acrobat supports video objects, sound objects, forms, Internet links, internal links, and much more.
Macromedia Director	>$600	expert	Truly professional grade authoring software and as such is complex and beyond the needs of most in-house multimedia productions. However, an author who invests the time to master the software could become a valuable resource. There are components within Director that are used in the MET/IET departments such as its ability to create technical animations.
Demoshield	>$300	intermediate	Though easier to use than Director, it is capable of producing self-installing multimedia presentations that do not require additional readers.
PowerPoint	NA	beginner	Not an effective platform for unguided multimedia presentations. As a communication tool in the classroom it is highly effective and versatile enough to meet most reasonable design needs. When a presentation is released to its intended audience, it proves to be inferior. The ability to embed objects in PowerPoint and the graphical emphasis of the interface make it a good primer for the aspiring multimedia author. Comes bundled with Office 2000.

Production Utilities

Paint Programs, Technical Graphics, Animation, Sound, and Video Paint programs are what draws the viewer's attention and sells the presentation. Anytime a graphical interface is involved, some degree of graphic work will be required. The author must learn how to manipulate images before any serious multimedia work can be attempted. "The key word…for educators…is easy. Easy, as in point and click, plain English, and ease of use[6]." All of the following products are used at STIM.

Table 2 Multimedia Authoring utility software comparison.

Title	Cost	User level	Notes
MS Publisher	NA	beginner	Layout program needed to use Acrobat. Publisher is very effective for beginners. Comes bundled with Office 2000 Professional Edition.
Adobe Page Maker	>$350	expert	Layout program needed to use Acrobat. Page Maker is a professional level layout program but is cumbersome for the amateur to use.
Adobe PhotoShop	>$350	intermediate	Paint program by Adobe that makes it possible for amateurs to produce professional results. The software is rather complicated and requires a modest effort to learn, however, once mastered, PhotoShop will likely become one the most used programs in the multimedia arsenal
JASC Paintshop Pro	<$100	beginner	Paint program that was the first paint program used for departmental graphics work at STIM. This was because of its shareware status and availability on the Internet. The software turned out to be feature packed and a good choice for a technical staff that lacked a graphic arts background.
Bluesky's Software Video Camera	NA	beginner	Screen capture software that produces AVI video sequences. Absolutely essential for tutorials, it is not recommended for other forms of animation. Comes bundled with Demoshield.
Windows Sound Recorder	free	beginner	Sound is an optional media that can have a lot of impact on the presentation if used appropriately. Often background music can add enough interest to improve viewer attention. Sound can also include narration and special effects. Unfortunately sound files can become large and represent a costly investment in storage space. The best advice for new authors is to use sound sparingly. Comes bundled in Windows.
Adobe's Premier	>$300	beginner	Video editing software that makes it possible to edit and assemble video clips. Premier is intuitive, powerful, and produced great results with little training.

IV. Multimedia Hardware

Do not try to save money on computer hardware. A simple choice between processor speeds can drastically change how long it takes to export a video sequence. Early video attempts conducted on a Pentium 200 MMX for a one minute video, 200 x 200 pixels in size, at 24 frames per minute resulted in a file just over 10 MB in size. The exporting of the movie required nearly 12

hours to complete. This was not an exceptional video in size or quality yet it was a resource hog to create. Since these early attempts at video production much has changed. The mobile multimedia workstations have Pentium II, 450 MHz computers. With just this change comparable videos can be exported in less than an hour. Memory is, predictably, important. Consider 128 MB as a minimum for multimedia work.

With a good computer to work with the issue of specialty hardware can be dealt with. The majority of video work can be accomplished on IDE drives, assuming there is enough free space. It can not be recommended strongly enough that a dedicated drive should be used for video work. Several gigabytes will suffice. IDE drives are suitable for short sequences but cannot provide the performance of SCSI hard drives. An AV-rated SCSI drive will perform best for long write activities. Frame dropping is the loss of continuous recording due to excessive heat at the write heads in the hard drive. To protect the drive from crashing the heads against the disk media when continuous writing activities occur, writing ceases for a fraction of a second. This allows the head to cool but looses video data. The resulting video is choppy. The AV rating stands for Audio Visual, which means the drive can withstand continuous writing with no adverse thermal effects. A good drive for long, high-frame rate video work is the Quantum Viking II AV-rated SCSI. Properly terminated, its writing throughput is roughly twice that of typical IDE drives. These drives are costly and not needed for average presentation development.

Several forms of mass storage will be necessary. As convenient as CD-R/RW can be, it is often easier to deal with **Zip** drives or the superior **LS-120 Superdisk** for transporting working files. At State Tech the **CD-R/RW** is reserved for distribution copies and archiving. A promising technology that is nearly ready for consumers is the **DVD-R** drive. The increase in storage capacity will help remove current limitations. Surprisingly, it is not difficult to fill a 650 MB CD-R disk. The downside to DVD-R media is that there are far fewer drives in the hands of consumers. It may take a few years for DVD to become as common as CD-ROM.

Video capture hardware is improving on a daily basis. Two years ago the **DPS Edit Bay** would have been the recommendation. Since then a new wave of consumer capture hardware has swept the market. Matrox makes the **Marvel 200** multi-functional video card. It combines an AGP video card loaded with 2D and 3D acceleration with TV input and output and video capture capabilities. The card has proven exceptional in all applications and is easily the equal to the Edit Bay at 1/3 the cost. Spring 1999 pricing for the Matrox Marvel 200 was $250.

Additional hardware will be needed to cover all the input and output possibilities. A **USB scanner** is a basic necessity for graphics work. An optional video input device that offers great versatility is a high quality conferencing camera. The camera adopted at State Tech is the **Cannon Vizcam** desktop camera. The unit is mounted on a jointed arm and can be used for 3D scanning, video conferencing, or video capture feed. The camera has both focus and f-stop adjustment in the optics and white balance controls in the base. This $1200 camera provides enough quality to replace the hand-held video camera for many applications. Some kind of video camera will be needed for video production. Image quality does count and the camera that exhibits the best video image should be chosen for presentation work, but whether it is some flavor of VHS or digital makes little difference in this application. Both camera types must be sent through the capture card to be edited.

Digital Cameras are quick and convenient ways to acquire still images[2]. If budget allows, the best cameras to buy at this time are in the 3 Megapixel range. Some, like the **Nikon D1** have interchangeable Auto Focus (AF) lenses. The Nikon is being introduced at a price in excess of $5,000 and is likely to not fit in most budgets[10]. There are very good cameras on the market that sell for under $500. However, even the older models can produce excellent images for multimedia work. The camera used at State Tech is a **Canon Powershot 350**. This camera is three years old and still produces images that exceed production requirements.

Should video tape be a desired output, it is strongly recommended that **Super VHS** be used. With nearly twice the resolution, the improved VHS format can help maintain legibility in the presentation. Tapes with Super VHS formatting can be read on standard VHS machines though loss of picture quality is inevitable. Finally, network connectivity for the workstation is an important factor. The Internet holds vast resources for multimedia developers. A wire network connection is unsatisfactory in situations where the cart is moved, therefore a **wireless network** connection is being planned. The STIM workstations will be outfitted with wireless network cards in the summer of 2000.

V. Conclusion

State Tech developed its current multimedia resources over time through a painful process of trial and error and the solution that came of it is well suited to the engineering technology environment. Resources are shared among faculty and staff through the use of mobile carts. The cart concept is not new. The University of Tennessee in Martin uses just such a concept[1]. The significance of the State Tech model and its ultimate validation is how much use, as an educational resource, will the carts see. It is not enough to throw together a few components without paying close attention to how each component will be used, the costs associated with upgrade and maintenance, and how to support the system's users. The mobile multimedia workstations have seen increasing use as more employees beat the learning curve. When not in use as a development tool, the carts are used to present lectures in classrooms that traditionally never had access to computers. Consequently, the level of consistency between lectures has increased, as has the atmosphere of professionalism. Students are better able to follow lectures and demonstrations, and retention appears to have improved. The carts have become hubs of faculty activity as new materials are developed.

Multimedia is no longer the exclusive domain of professional publishers. Advances in hardware and software have placed professional tools into the hands of consumers. With time and the desire to develop new skills, educators can economically create effective presentations with graphics, video, and sound. Funding for quality equipment and software, while not exorbitant, does require a strong commitment on the part of school administrators. This fusion of various forms of communication is changing the way educators work and with time students' expectations will include multimedia in their curriculum. It is not a topic that can be ignored and the work we educators do today will set the tone for the generations to follow.

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