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Multimedia As A Desktop and Classroom Tool

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Multimedia As A Desktop and Classroom Tool

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Abstract

The major thrust of the study leading to this report was a quick, but in-depth, understanding of the process for using multimedia computer equipment for information exchange within our engineering office and within the school environment. That is, how feasible is it to augment the typical office memo or school instruction sheet with pictures, video, and sounds? What specialized skills, hardware, and software are needed by those of us who want to use the technology? The brief study period allowed for an examination of available hardware and software, observation of current approaches to multimedia within our particular environment, and the development of applications, all within the context of several project areas: The Sandia Science Advisors program; a Sandia scientific project associated with the National Information Infrastructure Testbed; the curriculum of Monte Vista Elementary School of Albuquerque Public Schools; and the University of New Mexico Medical School Health Scene project.

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Multimedia As A Desktop and Classroom Tool

Introduction

The work leading to this report was supported by a Sandia National Laboratories, Laboratory Directed Research and Development project, #3539-140, April through September 1993, titled "Multimedia Unit Process Development".

The major thrust of the study leading up to the report was a quick, but in-depth understanding of the process for using multimedia computer equipment for information exchange within our engineering office and within the school environment. That is, how feasible is it to augment the typical office memo or school instruction sheet with pictures, video, and sounds? What specialized skills, hardware, and software are needed by those of us who want to use the technology? If you can really say, "A picture is worth a thousand words", is it worth all the trouble and expense to create that picture?

The study observed several groups of people, all professionals in their field who are not, however, professionals in the area of multimedia computer program development. The chart on the next page, Multimedia Unit Development, illustrates the concept that we are dealing with the "everyday" user of multimedia. This distinction is important in that we find that the resources generally available to the casual user might be one tenth those available to the professional publisher of multimedia materials. The professional developer may use a \$15,000 Silicon Graphics computer workstation with a \$5,000 video capture board and \$5,000 worth of software, whereas many more of us may have a \$1,500 Macintosh computer with a \$500 video capture board and \$500 worth of software. Very likely, in a few years, the power available now at the higher price will be commonly available at the lower price. The basic skills and concepts that are required to use a system of any price are similar. We did not deal here with the process of developing a professional presentation or other multimedia material that would be used many times over on a specialized display platform. We were concerned with material that would be put together quickly, be constantly modified, and passed between many users and computers.

The main partners in the study were the teachers at Monte Vista Elementary School, Albuquerque, New Mexico, especially Sandra Simons-Ailes and Jeff Tuttle; the Health Scene pilot project at the University of New Mexico (UNM) Medical School with major representation from Mark Platt, Assistant Professor of Microbiology; and Sandia National Laboratories, Spencer Nelson, project leader, and Lawrence Tolendino.

Where can multimedia be used?

At Sandia, information exchange, in its general sense, uses a significant portion of our time. There are the obvious and easily identified instances of training which occur as scheduled classes and the use of instruction manuals. But there are also the more obscure and widespread instances, such as a staff member producing a small computerized database for members of a project team to use in tracking their work and the informal instructions and one-on-one learning sessions related to teaching everyone to use the database. Another example is the production of material to bring new team members and visitors up to speed in their understanding of the technical issues of a project.

In the school setting, the electronic form of traditionally printed material can be seen in many areas¹: the notes of a doctor, teacher, or science advisor, instructions for the student to use in doing an assignment or experiment, and as a substitute for the hand written report or composition.

Multimedia Unit Development

The preparation of computerized, interactive records and learning aids which combine text, pictures, and sound is now feasible for helping to make processes like the examples more effective. But the technology must be in the hands of the everyday users so that new instances and changes to existing material can be made on the data on a daily basis.

Student reviewing instructions for a hands-on science activity.

The Example Application Areas

The brief study period allowed for an examination of available hardware and software, observation of current approaches to multimedia within our particular environment, and the development of applications, all within the context of several project areas: The Sandia Science Advisors program; a Sandia scientific project associated with the National Information Infrastructure Testbed; the curriculum of Monte Vista Elementary School of Albuquerque Public Schools; and the University of New Mexico Medical School Health Scene project.

In the Sandia Science Advisors Program, one goal is to help elementary school teachers incorporate hands-on science activities into their curriculum. Here, multimedia was used as a method of advertising the available activities to teachers as well as an aid for students in accomplishing the activities. Pictures of the components of activity kits were digitized as an enhancement to the text catalog; pictures of the components and the key steps of doing the activity were used in brief instruction sheets and as partial explanations in soliciting interest in the actual activity sessions; short movies with sound were used as an addition to written or verbal instructions for students doing the activities. For example, Jeff Tuttle made short movies with sound, controlled by a simple HyperCard program, as an additional aid for students making clay pots so that he would not be distracted by repeated basic questions. For these items, it is important to be able to use the pictures and sounds of the local environment, timely and on the spot material, that could be collected and used within a few hours of its concept.

A magnet covered by a sheet of paper and iron filings.

Students were directed by Sandra Simons-Ailes in using multimedia tools, specifically scanned pictures, drawings, recorded audio, and Hypercard programming, to prepare reports on various topics. Two topics chosen were a history of notable Black Americans done as a group project and individual reports on a student's family history.

For the Health Scene project, pictures are used to help illustrate the answers to health and biology questions. Students and staff of the elementary school, anyone with access to the electronic mail and bulletin board system, can ask questions that are then answered by students and staff of the UNM Medical School. Here it has been

important to have software and communications capability that are reliable and simple enough for a user community with a very wide range of computer experience. Some of the goals of the pilot project are: 1) To create an ability for rapid and up to date information

An ear illustration from Health Scene.

Processed Landsat image from the Earth Data System.

retrieval for the students. 2) Teaching the students to use electronic mail for accessing off site information (this is also true for the medical students). 3. Teaching the medical students to present medical information in a way that a young student can understand and not in complex medical terminology.

Associated with Sandia's participation in the National Information Infrastructure Testbed, Earth Data System application, still pictures were taken at various meetings of the project team and both still pictures and video with sound were used to demonstrate and explain the elements of the project. The stills were used on-line and in Testbed publications. The on-line versions needed formats compatible with Macintosh and IBM clone type PCs as well as Unix workstations. Video with sound was used to enhance explanations at the Supercomputing '93 Convention in Portland, Oregon and during informal laboratory work.

The Particular Environment - Hardware and Software

At Sandia, our department hardware is quite heterogeneous, having Unix workstations, personal computers using the DOS/Windows operating system and Apple Macintosh operating system. These are networked using Ethernet and faster media and TCP/IP protocols.

Monte Vista elementary school uses almost exclusively Macintosh computers with an AppleTalk network wired with twisted-pair cable to every classroom. A network connected modem allows connectivity to and from the school campus.

The University of New Mexico computers involved are a network of Macintoshes in the Medical School, used internally and also for connection to the elementary school for the pilot program in answering health questions called "Health Scene". Health Scene messages are passed by modem between the UNM Medical School team and the Monte Vista School network using a protocol of the mail/bulletin board system "First Class" by SoftArc, Inc., Scarborough, Ontario, Canada. Electronic mail can pass between UNM and Sandia personnel either through the Monte Vista school system or directly via Internet routers. A drawing of these network interrelationships appears on the next page.

There are constantly new offerings of hardware and software for digitizing pictures, viewing pictures, and manipulating sounds on computers. Many computer publications review hardware offerings in a timely manner. A few of the hardware elements and their qualities pertaining to capturing pictures and sound are mentioned here as a record of the systems available to us at the time of this work.

The choice of hardware depends on whether the user wants to capture actual motion video (perhaps with sound) or whether all the user wants to grab are still pictures. Moreover, if the work will include video with motion, will it be necessary to output movies to video tape? And last, will the users want to print pictures and will printing be in color or black and white? All these issues appeared quickly in the course of what seemed like a simple study.

The networks involved in the study.

First, a note about the term "resolution". Seventy two (72) dots per inch (dpi) with full color resolution can look great. For reference, a 13 inch color monitor with 640 pixel by 480 pixel resolution is about 72 dpi. By full color resolution, we mean display hardware that uses the RGB system (Red Green Blue) where each of the three primary colors is represented by an 8 bit byte for each pixel, making a total of 24 bits for each screen pixel. If colors are represented in an "indexed" fashion (a common display hardware type), 8 bits are used for each pixel and only 256 colors can be represented on the screen at a time. Picture quality will not be as good and some people find images more pleasing when they can be represented at a resolution greater than 72 dpi (for example 150 dpi) when using indexed color. Grayscale is similar to an indexed system with all 256 "colors" as shades of gray. The trade-off between color depth (or possible colors per pixel) and resolution becomes even more apparent when printing, as mentioned below.

For still pictures, we got the best quality by using a color scanner. We successfully used scanners made by Apple and Howtek; these happened to be already available. In this method, pictures were taken with a normal 35 mm camera, the film developed and printed,

then the print scanned at the resolution that suited the final purpose. For scanning in full color, 72 dpi can be fine. 150 dpi is even better, especially if scanning a 3 1/2 inch by 5 inch print. Higher scanning resolutions are needed only for images with small text and where there is truly much detail in the original image. The obvious downside to this technique is the time taken from taking a photo to having the scanned image ready to use.

There are specialized systems, such as ones made by Logitech and Kodak, for taking and storing pictures in electronic form, then transferring these to the computer though an existing port or specialized hardware. The price of this equipment can be from \$500 to \$15,000. We did not have the opportunity to use them.

For grabbing still pictures directly from a standard "home" video camera (this was done at the Supercomputing '93 convention), the same hardware is used as that for digitizing motion video. This requires some video capture card for the computer². Prices of video capture cards can range from \$250 to \$5000. The differences are in the size of the image that can be digitized, the number of frames per second that can be grabbed, whether sound is included on the hardware, and whether video/audio can be output to tape. We were able to use machines with a Macintosh Video Spigot (around \$350), Macintosh Radius Video Vision (about \$2000), PC/Windows Intel Smart Video Recorder (near \$600), and an HP700 computer (Unix) with Media Magic video hardware (near \$3000). The differences when grabbing still pictures is not enormous. All will get good quality stills from a video camera when the picture is well lighted and there is not much motion. Full resolution is not more than 640 x 480 pixels and the picture can be blurred when there is motion, from a combination of camera shutter speed and the fact that an interlaced scan is used to build up a full picture. Not surprising, the more expensive hardware does a slightly better job of grabbing a still. And grabbing directly from the camera rather than from a playback of the tape results in a less noisy image. Quality is also higher with "Hi 8" with the S-video output format rather than regular 8 mm or regular VHS recording. S-video has become a de-facto standard found in many brands of cameras and video capture boards.

For digitizing video, the less expensive boards can capture frames up to 320 x 240 pixels at 15 frames per second and need a separate sound board (like Sound Blaster for the PC or the built-in sound hardware of the Macintosh). Most software for manipulating video clips has options for compression quality which give you a trade-off between disk space used and picture quality during playback. However, all options result in a burden on disk space.

The amount of disk space needed for a short movie segment can vary tremendously. The variations depend on the resolution of the picture, the type of sound (if any) stored with the picture portion, and the quality of the compression used. Along with these matters, the disk space needed for movies is much greater than that required by text and still pictures and having a large disk capacity comes right along with the need to have movies. Where a 100 Megabyte disk may be fine for general text document use, an 800 Megabyte disk will be necessary for movie manipulation. The chart on the previous page shows the size of movie files as they are stored on disk for image sizes between 180 x 132 pixels and 640 x 480 pixels.

Magnified half-tone printed image.

Printing pictures is a complex matter in its own right. A really good quality grayscale picture (similar to a black and white photo) that has a 72 dpi resolution needs a 600 dpi laser printer for creating the half-tone reproduction. 300 dpi is OK, but it is easy to see the difference with 600 dpi. Color printing needs a corresponding resolution plus calibration software to allow adjustment of colors for consistent prints as the ribbons and inks are replaced.

Aside from all the above, there is the Kodak photoCD method of taking pictures with a 35 mm camera and having the pictures professionally digitized and put onto a CD ROM. This is very high quality and may be widely and quickly available in the near future. We had the opportunity to use but not create photo CDs.

While operating the software packages used for capturing, manipulating, and organizing multimedia material, a notion emerged that the user needs to become accomplished at a few pieces of software rather than a novice at many. Adobe Photoshop was used on both the Macintosh and PC for editing picture files; SoundEdit Pro on the Macintosh and Windows Sound Recorder on the PC for editing sound files; Adobe Premier, Hypercard, and Microsoft Word as well as KidPix for organizing and playing multimedia documents. The time needed to become comfortable and productive using a software package was close to eight hours of training and practice with each package.

Is this amount of time applicable to people who are already skilled at the basic functions? Probably, yes. But what about the relatively new computer user? A report in Electronic Learning magazine says, "Six hundred 'accomplished' technology-using teachers reported that it took at least five to six years of sustained tinkering and effort to achieve their competency with technology, and that they often had to overcome multiple barriers." ³

Mark Platt explained the concepts and advantages of software that can be locally modified and augmented for local curriculum development. He suggests that software be written, not in a programming language such as C or even Basic, but in a programming environment. "For this reason we have set the standard for the school of medicine as Apple Macintosh. "This means that we are able to use the built in Hypercard environment for multimedia presentations. Hypercard is a programming environment that has been designed to be used for multimedia presentations. Sound, still images and, with the inclusion of QuickTime

technology, video images can be added. We have chosen Hypercard and the Macintosh for a variety of reasons:

- "a: Productions in Hypercard are usable on all Macs of any vintage. There are no compatibility problems such as video boards, CPU type, etc.
- b: Hypercard stacks produced by anybody can be modified by anyone with rudimentary knowledge of the program, using the original work as a basis for a new locally adapted program.
- c: No prior computer programming experience is needed to program within Hypercard. The integrated language, Hypertalk, is a plain English programming environment many add-on packages are downloadable from large software sources such as sumex-aim at Stanford."

Creation Versus Distribution of Material

As soon as a person begins to create non-text material, the problem of sharing with other users crops up. That is, if the material will not be viewed or seen on the computer on which it was created, how can it be distributed to other machines and what are the hardware and software required to use it? Here we get into the vast topic of computer architecture, networks, and mail systems which cannot be touched in a short report, but a few of the experiences related to our local use can be related.

Cross-platform standards will likely develop with the next several years, but currently users will have to make choices from the many non compatible systems available. In the particular school environment during the time of this work, we had a network of Macintosh computers, so found that video clips in the QuickTime format was the best choice there. Still pictures stored in the Macintosh "pict" format were the most useful across many viewing and editing programs. Sound, even on the Macintosh was a small problem. Sounds (separate from those recorded as part of a QuickTime video) can be either a "resource" appearing only within another file or can be a stand alone file. Hypercard and Microsoft Word are examples of programs that can accept sound digitizing directly and create an internal resource file. Extracting a sound resource file from one document to use in another requires the use of a program like SoundEdit Pro or the Power Tools kit of Hypercard. The sounds can then be inserted into another document as a resource or stored as a stand alone file for combining with other information using Hypercard or a multimedia programmer like Adobe Premier. Within the Macintosh network, virtually any machine can play a QuickTime movie and reproduce the sounds of any document. Any picture can be displayed on any Macintosh with the reproduction quality differences that come between machines with monochrome versus color monitors.

Windows 3.1 multimedia drivers.

Sharing multimedia between the Macintosh and the typical IBM clone style PC is more of a problem. Here, we'll use the acronym PC to mean a machine with an Intel 386 or faster processor running DOS and Windows 3.1. With the freely distributed Windows video driver software, most of these machines can share and play audio visual interactive (AVI) files. QuickTime as a format for PC video is available, but much more common now is the

Microsoft/Intel video format represented by AVI files. So in general, video clips created on the PC are not playable on the Macintosh and vice versa. The same state of affairs exists for sound files. The common formats between the PC and Macintosh are different, not directly playable on the other style machine, and not readily translated by simple programs although the expensive multimedia programming system software packages do have facilities for this.

Unix workstations and video formats are also in the technology development stage, so each hardware and software system must now stand alone when it comes to playing video clips, although still image interchange is in better shape. Sharing of multimedia documents between machines may get a boost from the popularity of the "mosaic" browser⁵.

A Bright Spot for Still Picture Interchange

Luckily, choosing one of several formats for still pictures allows transfer of picture files between Macintosh, PC, and Unix platforms without translation at any of them. The "TIFF"⁴ format and to a slightly lesser extent the "GIF" "JPEG", and "EPS" (encapsulated postscript) formats can be successfully transferred in binary format between machines and then clearly viewed on the target machine. Viewers, editing programs, and document creation programs that can incorporate pictures in these formats can be easily found. Indeed, during the course of the multimedia work here, we created still pictures on all the platforms and moved them successfully by network file transfer, diskette, and electronic mail between platforms.

Conclusion

In conclusion, it is perfectly feasible and useful to use multimedia computer tools to augment the typical office memo or school instruction sheet with pictures, video, and sounds. But the cost and ease of use will depend strongly on the heterogeneity of the equipment used by the group of people sharing the information. In a few years, if cross platform standards and communications standards overwhelm the diversity of systems now in use, heterogeneity of systems may not be so important. To be specific, a group intending to share multimedia information would be best off to pick a particular brand of computer and operating system, pick one word processing software package (with picture and sound links built-in) that everyone can access, and share some high quality expensive items like video capture equipment, scanners, and printers. This approach allows the sharing of the knowledge of how to operate the equipment and software; perhaps 8 hours of training and practice will have to be allocated to each software package for each user. On the other hand, if still pictures are to be shared among various users, then sticking to a few definite picture format standards will allow items to be transferred between computers of nearly any type (Unix workstation, PC, Macintosh).

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