DOCUMENT RESUME

ED 362 236 JC 930 460

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TITLE Getting Started in Video Production for Instruction.
PUB DATE 25 May 93
NOTE 10p.; Paper presented at the Annual International Conference of the National Institute for Staff and Organizational Development on Teaching Excellence and Conference of Administrators (15th, Austin, TX, May 23-29, 1993).
PUB TYPE Guides - Non-Classroom Use (055) -- Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Astronomy; *College Science; Community Colleges; Computer Uses in Education; Educational Technology; *Instructional Innovation; *Program Development; *Science Instruction; Teaching Methods; *Telecourses; Television Studios; Two Year Colleges; *Video Equipment; Videotape Recordings
IDENTIFIERS *Brevard Community College FL

ABSTRACT

Arguing that the use of video in science instruction is an effective way to infuse both action and emotion into the educational setting, this paper chronicles faculty efforts at Brevard Community College (BCC), in Cocoa, Florida, to develop videos for science instruction and provides recommendations for producing similar videos. Following a discussion of possible uses of video in science instruction, a discussion is provided of two BCC science instructors' attendance at a 3-day course demonstrating the use of microcomputer graphics as video overlays. Videos subsequently produced by BCC faculty are then described, including two short tutorials detailing aspects of lab experiments to be performed by students in a physics course and an astronomy telecourse lesson using footage from Voyager 2 spacecraft transmissions of Neptune. Finally, the following suggestions are provided for producing videotapes for instruction: (1) once educational objectives have been determined, scripts should be written in everyday language; (2) storyboards may then be prepared to relate the script to footage through the use of sketches; (3) whatever tape format is utilized, a quality camcorder and steady tripod must be acquired, while high intensity clamp-on lights and a good microphone may also be helpful; (4) after footage is shot, a videotape editing system should be used which allows electronic control of the source deck and record deck to produce an edit; and (5) aside from equipment, the most important ingredients for successful videotape production are clearly defined goals and meticulous planning. (PAA)

International Conference on Teaching Excellence, at Austin, Texas
Tuesday, 9:45 - 10:30 AM, Hyatt Regency, Texas VI, May 25, 1993

GETTING STARTED in VIDEO PRODUCTION for INSTRUCTION

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ABSTRACT: A brief chronicle is presented to show how faculty members in a science department of a community college used staff development funds to support their interest in microcomputers and video production. Beginning with travel to a three day Chautauqua workshop, it was possible to produce several short videotapes and a 30 minute, broadcast quality lesson for an astronomy telecourse. During this presentation video excerpts from three different productions are used to illustrate some of the concepts discussed. These are indicated in the following text with brief verbal descriptions. There is a short discussion of considerations for planning a production and the necessary video equipment.

THE VIDEO MEDIUM

There must be strong if not compelling reasons for selecting the video medium to convey information in an academic setting. Since the medium is dynamic, it can be used to present action and emotion in a way that is impossible to achieve in printed media. Its use in the performing arts is obvious, but in the sciences there are also good opportunities for the use of video as an instructional medium. For example, a total solar eclipse is an event which has not only astronomical significance, but emotional content as well. A first-hand observation is the best way to witness it, but videotape does an admirable job of bringing the experience back to a classroom. In a student science laboratory many pieces of lab apparatus have small intricate details that need to be explained. Using a close-up and adding text and graphics as an overlay on the video will allow the enlarged detail to be seen on the screen with a much clearer explanation than the students could receive if shown the same apparatus at a distance by an instructor in a classroom setting. Sometimes live video might be used in the classroom with the camera feeding the monitor directly. A biology instructor strongly prefers video microscope views because of the additional details that are clearly revealed on the monitor screen. The live, pumping heart of a fish embryo can be shown. A unique property of video is the ability to control the playback of a recorded action. Following the flight of a ball slow motion makes some principles of physics easier to understand. A crucial moment during the motion of an object can be seen frozen in time in a single video frame. Although one might suppose that video is not well suited for the explanation of abstract concepts, this is not always the case. Many mathematical constructs such as electric and magnetic fields can be represented graphically. Since the patterns are three-dimensional they are difficult to visualize in their entirety. But by using computer generated animation on videotape, the viewer can see a nearly concrete visualization of an ethereal phenomenon. This is demonstrated with a NASA animation of Neptune's magnetic field in the video excerpt from a telecourse lesson. The same lesson also brings us images of the outer planets which come to us only in computer constructed video form.

GETTING STARTED

During the last few years, video and microcomputer technology have been combined into what is now called desktop video. In February of 1991 a National Chautauqua Short Course was hosted by William McCord and William Stillwell at Valencia Community College, in Orlando, Florida. The course advertised that it would explain the use of microcomputer graphics as video overlays to help explain concepts in physics. This offering attracted the attention of two physics instructors from Brevard Community College, Dr. Joel F. Sherman from Melbourne campus and Dr. Bart Lipofsky from Cocoa campus. With travel support from Staff and

Program Development they commuted between Brevard and Valencia for the three day short course. The short course showed that an academic department could produce its own videotapes for instruction as McCord and Stillwell had done for their physics course at Valencia. Cameras, lights, tape decks, and the Amiga microcomputer with a Newtek Video Toaster were all demonstrated. The Toaster has made a place for itself in the history of video production since it can produce many professional video effects (and some never seen before) at a cost of a few thousand dollars. Many principles of video technology and production were explained and Sherman and Lipofsky were encouraged to apply for a longer workshop at Valencia to be held in August. In the meantime they would be traveling to Hawaii to witness the total solar eclipse on July 11, 1991. Lipofsky had planned a special course in astronomy to be offered through the Adult Education Division of Brevard Community College in conjunction with the college Studies Abroad Program. Classes were held on campus prior to the trip so that the students could understand the astronomical nature of the event they would later observe. It seemed only natural to bring back videotape of the event and edit it into a documentary.

VIDEO EXCERPT: 1991 Solar Eclipse
Opening scene shows ship and total eclipse, then title.
Class meeting at Cocoa Campus observatory.
Using telescope to see sunspots and prominences.

There were two major reasons for choosing a cruise ship in Hawaii over the Baja Peninsula as the eclipse viewing site, even though the duration of totality would have been longer at Baja. First, an important fringe benefit of visiting several Hawaiian islands would be the opportunity to observe volcanoes and their associated geology. From the active side of the island of Hawaii with its fresh, barren lava flows to the older lush island of Kauai, the chain is almost a physical textbook of geologic change. The complete videotape shows Iao Needle, an intrusive igneous formation uncovered by erosion, students walking through Thurston lava tube and into Kilauea crater with its steam vents. A nighttime passage around the south side of the island of Hawaii shows glowing, red-hot lava falling into the ocean. The second reason for selecting Hawaii was that a cruise ship is mobile and so it can move to an area of clear weather to view the eclipse. The prevailing weather pattern for summertime was thought to be very favorable for clear skies on eclipse day, but as chance would have it, tens of thousands who had traveled to the island itself were only able to witness overcast skies. We were very fortunate that the ship's captain was able to find a clear spot in the cloud cover.

VIDEO EXCERPT: 1991 Solar Eclipse (continued)
Part of our group watching progress of partial phase.
Series of video freeze frames of partial phase.
Action video of total solar eclipse.
Close-up of still photo and discussion of details.

After the eclipse trip, Sherman and Lipofsky returned to the video production workshop at Valencia Community College to produce their first videotape, a physics lab tutorial entitled "Centripetal Force". Further Staff and Program Development funding and production support from the college television station, WBCC-TV, helped them continue their work and produce the physics lab tutorial "Ballistic Pendulum". These lab tutorials are short (5 to 10 minutes), and show in detail many aspects of experiments which are to be performed by students as part of their physics course at Brevard Community College. The videotapes show the actual equipment to be used in the physics lab and are available to students at all campus libraries. Very often, small or intricate parts of an apparatus need to be explained to the students. (A humanities instructor has a similar problem and uses video close-ups and projection to show the details of Egyptian antiquities to a class as he explains their significance.) Labels can be created with microcomputer graphics and used as video overlays. In the following example, a ballistic pendulum is demonstrated. This is a device which uses the laws of momentum and energy to make an indirect determination of the muzzle velocity of a projectile. In the student laboratory, a brass ball and spring gun combination is used in placed of live ammunition. In the "Ballistic Pendulum" video tutorial, the major parts of the apparatus are clearly identified, followed by a close-up of the ratchet mechanism which is essential to the operation of the apparatus. When the apparatus is fired, a freeze frame is used to show the brass ball in flight, just an instant before it collides with and is captured by a cup at the bottom of the pendulum arm. The original video frame (one field, actually) was enhanced using the Video Toaster's capability for bit-mapped editing in a frame. Given sufficient skill and patience, virtually any desired change can be created. This ability of the Toaster has been used effectively on several occasions. Finally, the graphic overlay capability is used to produce an integration of the equations for momentum and energy analysis with the freeze frames of successive moments in the action of the apparatus. In addition to the excerpt shown here, the videotape also shows how to carry out the trajectory and range measurements which are also part of the experiment.

VIDEO EXCERPT: Physics Lab Tutorial, "Ballistic Pendulum"
Titles followed by apparatus with parts labeled.
Close-up of ratchet mechanism and track.
Action video for demonstration of apparatus.
Freeze frame of ball just before collision, "touched up" to improve on reality. Graphic overlays connect physical action to the theory of momentum and energy.

A new videotape tutorial, "Measurement", has just been completed showing how to avoid parallax error in measurements and the details of the scale readings on the vernier caliper and micrometer. "Music and Sound" uses students from the Brevard Community College music department and an oscilloscope to show the connection between the sound of an instrument and the vibrations of air column in the instrument.

In August of 1989, the Voyager 2 spacecraft passed by the planet Neptune and returned images of the planet, its rings and satellites. Since the astronomy telecourse lesson "Uranus, Neptune and Pluto" was part of a series which had been produced years earlier a new telecourse lesson was needed to present these new scientific discoveries to students at Brevard Community College. The copyright law imposes significant restraints on production resources which are to be used for broadcast purposes, but NASA allows its imagery to be public domain. Thus, by combining the NASA footage with some narration and graphics which could be produced locally, it seemed possible to do a production of broadcast quality which could replace the old telecourse lesson and serve the traditional on-campus students as well. A script was written keeping in mind the educational objectives which had to be covered by the specific lesson and including the new information. Graphics were created to illustrate some of the physical data relevant to the three planets which are included in this lesson. Then an on-campus videotaping was done with the college observatory as a backdrop and stage. This provided an introduction for the lesson, a discussion of the relevant science issues and findings, and a summary for the conclusion of the lesson. Because the NASA footage would have to be edited to fit the needs of the telecourse lesson, a separate narrative to explain the video was recorded. This would be added as a "voice over" after the video editing was complete. Accompanying music was selected from the television station library.

VIDEO EXCERPT: Telecourse Lesson, "Uranus, Neptune, and Pluto"

Opening theme, moving graphics, and titles
Narrative introducing the lesson.
Voyager 2 images of Great Dark Spot on Neptune.
Animated graphics of magnetic field of Neptune.
Animated graphics of Triton's orbit and approach of Voyager.
Animated graphics of Triton's surface, including geysers.
Voyager imagery of Triton's surface, including geysers.
Computer simulation of flight over surface of Triton.

PLANNING A PRODUCTION

The traditional method of planning a production is to produce a script, then visualize the video which will be needed to support the script and put the two together in the editing process. One caution should be noted at the start. Video production is a very time consuming activity. It can take weeks of production to create minutes of videotape. Since the medium is very powerful only in certain cases, be sure that the project warrants the necessary expenditure of time and plan thoroughly.

After an analysis of the educational objectives to be achieved, write a script for the production using something near to colloquial language, not the formal language of textbooks. A storyboard which uses simple sketches to relate the script to the video is a very helpful tool. A good trick is to put the story board sketches on "Post-It" notes so they can be easily re-arranged. Read the script aloud with stopwatch in hand to determine if the time for the script is about equal to the time required for the accompanying video action. If there is so much more text than action that the script can not be trimmed down to size, it is possible that a video freeze frame can be used to span the gap, but this can be a difficult problem to resolve effectively. The reverse case is much easier since video action with some background music can often carry itself without constant narrative support from the script.

At the time of the solar eclipse in 1991, the author had very little video production experience so the traditional model for production planning was not followed. Videotape footage of the class at Brevard Community College, the cruise, and the solar eclipse was obtained from the camcorders of two class participants and the author. Some still photos of the eclipse were later recorded on videotape. The available footage was reviewed, the best parts were selected and edited into a video without words. A script was written so that the narration would just fill in the necessary amount of time for each video scene. This was a difficult task, but it was much more difficult to put together a cohesive, flowing video from bits and pieces of tape that had no pre-planned relation to one another. This was accomplished only by making maximum use of the professional skills of the production staff at WBCC-TV, the college television station. The lesson is that there can never be too much attention paid to the planning process before the first millimeter of videotape is recorded. The physics lab tutorials, like "Ballistic Pendulum", and the telecourse lesson have all been produced with some degree of scripting and visualizing beforehand. The results are better.

VIDEO EQUIPMENT

There are several videotape formats which seem to be reasonable for instructional productions. The high end of the spectrum would be broadcast quality, professional 3/4 inch format. At the low end there are the very common VHS 1/2 inch and the popular 8 mm formats. In between these are the related S-VHS and Hi 8 formats which. The major problem associated with the common VHS and format is that the editing process is really a copying process. There is no practical way to alter the video information after it has been recorded. The only way to edit is to play back a tape and make a new recording of selected sections. Each time this is done, a new generation of tape is created with degraded quality due to the imperfections of the copying process. The inherently low quality of the VHS format allows very few edit generations before the degradation of image quality is significant. The 3/4 inch professional format allows more generations, but uses much more expensive equipment. S-VHS and Hi 8 are reasonable compromise formats providing better quality without exorbitant expense. Most S-VHS decks can play VHS format (the reverse in not true), so the very large amount of material already available on VHS makes this a logical choice. But the compact size of the 8 mm equipment and its growing popularity is a counter argument. The author has no crystal ball to predict which of the many formats will be the dominant one in the future. If budget considerations make 3/4 inch out of the question, then there is a level of semi-professional VHS and 8 mm equipment which should be considered. Most of the lowest cost, home video equipment will not produce good results if much editing is required.

Whatever format is chosen, a quality camcorder is the obvious first step in assembling equipment. Its portability allows the possibility of shooting on location in the most convenient manner and it can serve as either record or playback deck for later editing. Even high quality multiple chip cameras with interchangeable lenses are often configured to accept "docking" record decks so that they can be as functional as an amateur camcorder. A sturdy tripod is very important in order to eliminate the shaking and wobbling images which are the result of a hand held camera, especially when making telephoto shots. A few high intensity, clamp-on lights can add significantly to the quality of the original video footage. Camcorder microphones will not often do an adequate job of picking up the voice of a subject or other sound. A separate microphone with correct positioning is necessary to consistently acquire good audio. Wireless clip-on microphones were used almost exclusively for the productions in this presentation and they performed very well, including the recording of live music. Most classrooms will be acoustically "live" and add unwanted reverberation to the sound. This can sometimes be fixed by hanging sound absorbing materials in the room. A studio environment is not a necessity, but extraneous noise can be very frustrating during a taping session.

When selecting edit decks, consider the need for precise tape positioning. Virtually any deck will position tape to the nearest second, and most will be consistently accurate to 2 or 3 frames within the 30 frames that make up one second of video. A requirement for single frame accuracy will significantly increase the cost of the deck. Clear, stable freeze frame capability is not always present even on some broadcast quality 3/4 inch decks. Some semi-professional VHS decks can do an excellent job of locating and freezing a single, specific video frame.

A minimal editing configuration allows only a simple cut from one scene to the next. This can be achieved with the camcorder functioning as a record deck and any compatible deck playing back the original tape from the camcorder. An edit can be made by stopping the record deck and advancing the source or playback deck to the next desired segment of videotape, then continuing. The record deck should have a flying erase head so that edits can be joined together without a video "glitch". High editing accuracy can not be obtained with a minimal configuration, but it is possible to assemble a collection of useful cuts on one tape so that a classroom presentation does not have to include fast-forwarding or changing tapes to avoid showing videotape that is not desired in a particular lesson. If each cut is simply added to the end of the master tape, the process is called assemble editing and some of the better home video decks now have the ability to automate the process of doing several edit cuts in a series. A more ideal configuration is one in which both the source and the record decks can be electronically controlled to produce an edit. Both the source and tne record tapes should be rolling for about 5 seconds prior to the edit so that the deck mechanisms are running smoothly, and so a pre-roll capability is desirable on both decks. Now, the addition of an edit controller will provide a means to mark an "in point" and "out point" for the beginning and end of the edit. At the pre-selected edit points, the edit controller switches the source signal onto the record deck. This facilitates editing in the insert mode where one piece of video can be recorded on top of another.

A complete "A/B Roll" editing facility will include two source decks and a record deck. Each deck has its own monitor so that all three can be seen simultaneously. The decks are linked with an edit controller and a switcher which is capable of creating wipes, dissolves or other electronic effects during an edit transition. The switcher may be a dedicated device or an accessory which plugs into a microcomputer. Although the Toaster for the Amiga was first in its field, similar devices and software are now available for PC-compatible and MacIntosh computers. Most of these offer the capability of a character generator to do titles and some degree of graphics capability. Time base correctors help maintain the technical quality of the video from the source decks by allowing re-calibration of white and black levels, chroma and hue. An audio mixer is needed to adjust levels and bring in sound from auxiliary sources such as CD or cassette. When all of this equipment is assembled, it will fill a small room and generate surprising quantities of heat. Adequate ventilation will be important.

SUMMARY

A clearly defined goal and meticulous planning are the most important ingredients for a successful video production. The technological side of the issue is best mastered one step at a time. Getting started can be accomplished with an inexpensive VHS camcorder and a single deck for not much more that $1000. Equipment for a complete studio with A/B roll editing on 3/4 inch format will cost somewhat above $100,000. Most production facilities will be somewhere in the middle ground and should probably be built up in stages as an understanding of local requirements is obtained.

ACKNOWLEDGMENTS

William McCord and William Stillwell showed what could be done during their Chautauqua short course and workshop at Valencia Community College in Orlando, FL. At Brevard Community College, all of the staff of WBCC-TV have been helpful, but James Robinson and Jayne Salvo have contributed their video production and editing skills to such an extent that much of the finished result is more theirs than mine. Both of them have been patient teachers of the kind that make progress possible. Finally, the continued encouragement of Dr. Rosemary Layne and funding from the Brevard Community College office of Staff and Program Development have helped to initiate and continue these projects.

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Because of the merging of microcomputer and video technology, all of the Amiga, PC, and Mac magazines are interesting to scan for occasional articles relating to desktop video. In addition, two sample articles from the specialty video publications Desktop Video World, and Videomaker magazines are cited. The book by Zettl on video production is typical of many that are oriented toward studio professionals.

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