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AN APPLICATION OF DIGITIZED SPEECH IN HYPERMEDIA

By

William Robert Richards

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ABSTRACT

AN APPLICATION OF DIGITIZED SPEECH IN HYPERMEDIA

By

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Today's technology has made digital sampling of audio for computer storage and playback a "desktop" venture. But the widely available capability has not resulted in widespread application. Perhaps a first step in finding a productive use for audio in hypermedia is to reduce our dependence on text displays as the accepted medium for presenting verbal information.

The hypermedia program, "Field Kit Workshop," (FKW) uses speech as the primary means of delivering verbal information. FKW introduces students to operating features of professional video production equipment. Formative evaluation was conducted to explore user response to speech as it was used in FKW, and to help guide the implementation of speech within the program's final design.

This study found that speech was accepted by users within a program that is well-designed overall, and in which the design takes into account the special strengths and weaknesses of speech as a medium for delivery.

To Anne McPhillips

ACKNOWLEDGMENTS

Thanks to Carrie Heeter, whose enthusiasm for this project almost has me convinced that "Field Kit Workshop" makes a real contribution to the field of hypermedia development.

Thanks also to Gary Reid, who made a comment about music in hypermedia that led me to develop the improvisational approach to providing theme and incidental music that is heard throughout FKW. It was a challenging and fun part of the program to develop, and I'm glad I got a push in that direction.

I would especially like to thank Bob Albers. Throughout my undergraduate and graduate studies, Bob has been my executive producer, program consultant and mentor. Any success I may achieve as a media producer will be a result of the opportunities and advice that Bob has given me in the seven years that I have worked with him.

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INTRODUCTION

Less than a decade ago, computer-based instruction was almost exclusively presented through on-screen text. From beginnings in this text-only environment, computer-based instruction has evolved into today's hypermedia. When the power of the computer is used to present information through a wide array of media -- including full-motion video; color illustration and animation; text; and music and speech -- this form of presentation has come to be called *multimedia*. When the individual user, with the assistance of a computer, can control the sequencing and pacing of multimedia presentation, then this type of information delivery earns the label *hypermedia*.

In practice, hypermedia applications have presented information through a variety of visual media, but the aural channel for information delivery has not been well developed. Locatis, *et al*, writing as recently as 1990, define hypermedia as composed of three subsets: hypertext, hypergraphics, and hypervideo (Locatis, 1990). This definition describes visual media -- no mention is made of "hypersound."*

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* *Hypervideo* as it is used by Locatis probably contains an implicit reference to sound. In interactive video programming (a form of hypermedia), sound is often present in the form of narration and/or music that is integrated into the video program controlled by the computer. But the sound is slaved to the video -- the user cannot access sound

Today's computer technology has made digital sampling of audio for computer storage and playback a "desktop" venture. But the widely available capability has not resulted in widespread application. As one columnist writes in the computer press, "nobody's even figured out how to use sound productively, and it's been built into the Mac for over a year now" (Zilber, 1992). Perhaps a first step in finding a productive use for audio in hypermedia is to reduce our dependence on text displays as the accepted medium for presenting verbal information.

Heeter and Gomes give guidelines for hypermedia developers toward creating a computing environment rich in meaningful, functional sounds, and declare that "it is time to fully integrate sound into computing environments" (Heeter & Gomes, 1992). Replacing on-screen text displays with digitized speech is a logical next step toward such integration.

For this project, a hypermedia program was created which uses speech as the primary means of delivering verbal information. Designed as an introductory step in training students to operate a professional-grade portable video tape recorder, "Field Kit Workshop" is a program that uses speech within a visual context of detailed images, both still and animated, and a rich audio context of realistic sound effects and music. Formative evaluation was conducted to explore user response to speech as it was used in "Field Kit Workshop," and

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information independent of the visual images, in true "hyper" fashion.

to help guide the implementation of speech within the final design of the program.

LITERATURE

SOUND IN COMPUTER-BASED INSTRUCTION

Information can be presented to the user of hypermedia and other computer-based instruction through a variety of visual and auditory means. The most common mode of presentation in computer-based instruction has been text displays, with graphics being the next most common. Sound as a presentation mode is an option infrequently used. When sound has been used, the sounds have often been nothing more than "primitive sound effects, such as beeps or explosions" (Alessi, 1991). Still, there are some important examples that hint at audio's potential in hypermedia.

A major concern for hypermedia designers is the nature of the human/computer interface (Carlson, 1990; Failo & DeBloois, 1988; Fox, 1989; Tognazzini, 1990; Waterworth & Chignell, 1989; Wright, 1989) -- for the interface is the means by which the user accesses the information available within the computer and the various media it can control. The concern is that the more effort the learner must apply toward figuring out where to find information, the fewer cognitive resources there will be available for learning that information (Tripp & Roby, 1990).

Sound can be an aid to navigating through hypermedia. Apple Computer recommends using sound as a cue that indicates a change in location within a hypermedia program (Apple Computer, 1989). An example of sound supporting navigation in the hypermedia interface can be found in the program "Mission to Mars!" (Heeter & Gomes, 1992).

The hypermedia program, "Mission to Mars!" makes extensive use of sound as a response to each computer command input by the user. In a study that compared versions of the program modified for three conditions -- Varied Sound Feedback; Beeping Feedback; and Silence -- it was found that users strongly preferred the condition of Varied Sound Feedback (Heeter & Gomes, 1992). The Varied Sound Feedback condition represented the published version of the "Mission to Mars!" program, and was characterized by a wide range of primarily non-verbal sounds that enhanced the visual metaphors of the hypermedia interface.

Sound has also been used in hypermedia when the actual content being taught is some form of sound. "Ludwig Van Beethoven Symphony No. 9," gives music students non-linear access to a CD recording of the classical piece (Weiman, 1991). The program "German Pronunciation Tutor," (Brandl & Stoehr, 1989) is another example of audio as content. The program is made up of samples of correct German pronunciation, presented through digitized speech. Text displays play a small role, describing rules of pronunciation; graphics serve primarily as visual organizers of the audio material.

SPEECH AND LEARNING

The chief motivation for delivering verbal information through speech rather than text in the current project is to reduce the likelihood of overloading the visual channel of communication in a program that presents a great deal of information through graphic illustration and animation. Fleming and Levie's analysis of studies from a wide range of disciplines supports the notion that speech can be more effective than text in such situations:

> "Capacity [to perceive] appears to be larger where two modalities are utilized (audition and vision) rather than one. Two tasks involving the visual modality, for instance, will interfere more than where one involves the visual and one the auditory modality" (Fleming & Levie, 1978).

This makes sense when one considers that it is much easier to look at an illustration while listening to narration than it is to look at an illustration while reading text. Fleming and Levie caution that discrepancies across two modes can impede learning, and that "excessive redundancy" across two modes of delivery, such as text and speech that deliver identical words, "may induce boredom or inattention to one modality" (Fleming & Levie, 1978).*

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* Grimes refers to an unpublished study which supports these cautions (Grimes, 1990). The study examined how subjects processed information that was presented as text, while, simultaneously, a narrator's summary of the information was presented. The study found that subjects read the text and ignored the narrator's summary; and that there was interference with the message except when the text of the document and of the narration was identical.

Fleming points out that receiving information through speech can put great demands on short term memory -- since the meaning of a sentence may not be apparent until it is completely delivered -- and offers the recommendation that spoken phrases be kept short. Fleming and Levie also state that conversational speech (as opposed to written text that is read aloud) seems naturally divided into phrases that present no difficulty in perception (Fleming & Levie, 1978).

Although the need to present information in small units may seem to limit the usefulness of speech in computer-based instruction, it does not automatically follow that text is a superior mode of presentation; a consensus among hypermedia designers is that on-screen text also should be presented in small information units, commonly called "chunks" (Carlson, 1990; Failo, 1988; Knuth & Brush, 1990). It may be that the nature of on-screen presentation puts text on nearly even footing with speech regarding the amount of information that can best be presented per unit.

Literature on the process of reading tells us that a sentence usually contains old and new information, and that comprehension is improved if the new information is placed at the end of the sentence (Carpenter & Just, 1977). This method for improving comprehension may also be effective when applied to speech. Marics and Williges found that subjects transcribing from speech recalled words from the ends of messages more accurately than words from the beginning of messages (Marics & Williges, 1988).

Marics and Williges also found that errors in receiving information through speech can be reduced if the user has the option of repeating the display (Marics & Williges, 1988).

SPEECH AND COMPUTERS

Simpson and McCauley use the terms *voice displays,* or *speech displays,* to refer to verbal information that is delivered as speech by a computer. Two methods of creating and displaying speech are described: *synthesized speech,* which is speech that is generated by the computer from text information; and *digitized speech,* in which actual human speech is recorded as digital information that can be played back as natural-sounding speech (Simpson and McCauley, 1985).

The developer who wishes to incorporate speech displays must decide between synthesized or digitized speech. Because synthesized speech is generated from simple text, input is easy and memory needs (disc space for storage and RAM for processing) are minimal. In contrast, input for digitized speech requires specialized hardware and software, and memory requirements are very high. "Field Kit Workshop," the program produced for this thesis, requires about 12 MB of disc space to store the digitized voice samples, music and sound effects.

Easy input and low memory requirements are strong reasons, from a developer's point of view, to use synthesized speech. But research supports what many of us know from a user's point of view -- that synthesized speech can be very difficult to understand (Schwab, Nusbaum & Pisoni, 1985; Simpson & McCauley, 1985). Digitized speech, on the other hand, can be of exceptionally high quality -- practically indistinguishable from natural speech.

The quality of digitized sound depends on a characteristic of the digital recording process called the *sampling rate*. The sampling rate affects the range of frequencies that can be recorded and reproduced. A sampling rate of 44.1 kHz -- the standard for hi-fidelity recording for Compact Disc (CD) -- makes it possible to record the full audible range of frequencies, typically described as 20 Hz to 20,000 Hz (20 kHz). As lower sampling rates are used, frequencies at the upper end of this range are lost. According to Bove and Rhodes (1990), a sampling rate of 22 kHz produces medium-quality recorded sound; 11 kHz produces the equivalent of television sound; 7 kHz produces the equivalent of AM radio sound; and a sampling rate of 5 kHz produces the equivalent of telephone-quality sound.

SUMMARY

Most presentation of information in hypermedia programming is through visual media. Sound has been used as a feedback device, as a cue in navigating hypermedia, and in cases where the content being taught is specific audio information (such as music or pronunciation).

Speech can be an effective medium for instruction, particularly when used to support the simultaneous presentation of elaborate visual information. However, the potential of speech for presenting verbal information in hypermedia applications -- as a form of hypersound -- has not been realized, and offers fertile ground for new research.

RESEARCH AND DESIGN QUESTIONS

The current study came about as the result of design challenges that were raised during early development of "Field Kit Workshop" (FKW), an interactive program intended to provide an introduction to the operation of video production equipment. The program was being designed to rely heavily on detailed visual images -- images that quickly became cluttered in early versions as text overlays were added to guide the user through the program and provide information about operating controls. The computer on which the program was being developed had a built-in capability for recording and storing sound, and a possible solution to "visual overload" presented itself. Perhaps speech, rather than text, could be used to guide the student through the steps of operating the equipment.

Review of the literature, as described above, supported the notion that speech might be used effectively in some hypermedia programming, and the decision was made to incorporate speech into the design of the proposed program. But designing a program that incorporates speech as a medium of delivery is an expensive proposition in terms of development time and disc storage space; therefore it was also decided to conduct formative evaluation to help determine whether speech display was appropriate for "Field Kit Workshop," and to guide the way in which speech display would be applied in the final version of the program.

One question to be resolved was whether speech would be effective in providing the brief tutorial and procedural information that comprised the verbal component of FKW. Doubts that the literature raises about the intelligibility of speech, and the listener's ability to retain spoken information, make this question an important one in deciding to use speech.

The literature cited above points out the need for speech displays to be repeatable by the user, as an aid to understanding. What is an effective design for repeating speech that can compensate for the shortcomings speech might have in terms of intelligibility and retention?

Another key question relates to user acceptance. Given that verbal information has traditionally been delivered as text in hypermedia and other forms of computer-based instruction, will users be open to receiving information in the form of computer-delivered speech?

Dual-channel presentation -- using speech for verbal information, in support of elaborate visual information -- is intended to reduce information overload in the visual channel. But will users need to repeat verbal information more often as visual information grows more complex?

There are also design questions related to characteristics of the speech display. There is information in the literature about acceptable rates of speech -- what rate of speech will work best in the current application? In digitally recording speech for a disc-based program, how much compromise will be acceptable when balancing sampling rate against the available storage space?

DESIGN PHILOSOPHY AND AESTHETIC

The use of speech to deliver information in "Field Kit Workshop" had an influence on the design of many other components of the program, just as the design of other components had some impact on how speech was used. Any program that is poorly designed overall will have too many negatively confounding factors to make it possible to make any sound judgments about the effectiveness and acceptance of speech, and about design factors that might influence effectiveness and acceptance.

To assure that the application of speech was explored in a well-designed product, three principles guided the development of "Field Kit Workshop." These three principles were developed as a result of the author's own experience as a producer of video programming and occasional user of hypermedia programming, and after a thorough review of literature on hypermedia development.

Don't throw out the old rules. Although hypermedia is a new form of electronic communication, the designer should follow the conventions of other forms of electronic media whenever it makes sense to do so.

Design for function. Everything serves a purpose, making a contribution to the instructional goal. If one thing can serve two purposes, that's even better.

Make the delivery system invisible. Hypermedia designers concur that the program interface is one of the most important factors in designing a successful program. An invisible interface -- one that does not interfere with or draw the user's attention away from the program content -- is a good interface.

METHOD

PRODUCTION DESIGN

An instructional hypermedia program was produced that uses digitized speech to present informational content. The subject of the program is the operation of a professional-grade videotape recorder for use in field production. The program, "Field Kit Workshop," was designed for presentation on the Apple Macintosh II family of computers, using the software program, HyperCard (version 2.1).

Instructional Goals

The program, "Field Kit Workshop," is not intended as a device to train students in the operation of the VTR -- rather, it is the first step in a training process that includes hands-on, in-the-field, on-the-job training. The following describes a training procedure that the author has used to train students in the operation of field production equipment. This training program has been used with small groups, with six to ten trainees in attendance.

Equipment Introduction. Using lecture/demonstration format, the instructor describes the primary operating features of the equipment: the location of control panels, connectors, etc.; and demonstrates certain procedures, such as connecting cables or loading a battery. There is little or no opportunity for hands-on experience for the students at this stage.

Controlled Exercise. In a controlled environment, such as an empty TV studio, students work in small teams (two or three to each field kit) to set up a camera, recorder, lights and microphone, and each team videotapes a short interview. Students gain hands-on experience with most operating features of the equipment, without the distraction of the unusual and unexpected that can occur in the field.

Experience. Each student assists an experienced operator in actual field production activities, until judged qualified to operate equipment "solo."

The hypermedia program, "Field Kit Workshop," was designed to provide the Equipment Introduction stage of training, replacing the lecture/demonstration format described above. Hypermedia presentation was seen as a way to provide more detailed information about the equipment than was feasible in a lecture/demonstration format; at the same time, the interactive, "hands-on" feel of hypermedia would make this detailed information more meaningful to the student.

The instructional goal of the program, "Field Kit Workshop," is to familiarize the student with the basic operating features of the Sony BVU 150 video tape recorder (VTR), in preparation for a controlled, hands-on exercise that involves setting up a field production kit for an interview.

Program Audience

The program is intended for use by students who already possess some hands-on experience with video production equipment. The criteria for participation in this study was enrollment in or completion of basic media production coursework. This minimum requirement for participation assured that users had a working knowledge of typical VTR transport operating controls (PLAY, REC, PAUSE, FFW, REW, STOP); proper audio recording levels; and common cable connector types (BNC, XLR, RCA)

Program Type

The program was designed primarily as a simulation. Simulation has advantages over other forms of computer-based instruction; advantages identified by Alessi and Trollip as enhanced motivation, better transfer of learning, and increased efficiency (Alessi & Trollip, 1991).

The underlying model for the simulation is a *logical* model, common as a form of simulation in instruction, and defined by Alessi and Trollip as a model in which the computer follows a set of *if-then* rules (Alessi & Trollip, 1991). FKW consists primarily of graphic displays with "virtual controls" that the learner manipulates -- *if* a certain switch is activated, *then* a certain event occurs. The FKW program can also be described as a *procedural* simulation, in which the student learns to perform a sequence of steps (Reigeluth & Schwartz, 1988).

Program Content

The program introduces the student to the Sony BVU-150 video tape recorder by guiding the student through the procedural steps necessary to prepare the VTR for recording an interview.

Using the Program

The program begins with a series of introductory modules that describes program operation and navigation. Speech, in the character of a "workshop instructor," guides the trainee through the introductions; bulleted text is integrated into visual displays to highlight key points, but the text of the instructor's narration is not displayed. No data relating to user behavior is recorded during these introductory modules.

Program Intro: Organizer. "Field Kit Workshop" begins with an advance organizer which briefly describes the subject and purpose of the program.

Program Intro: Study and Questionnaire. A short segment provides the trainee with a random number which is used to link the computer record with a questionnaire, and gives instructions for recording this number on the questionnaire.

Program Intro: How-To. The instructor leads the trainee through an interactive tutorial that teaches how to use the computer mouse to flip switches, turn dials and connect cables as they appear on the computer screen.

Program Intro: Navigation and Presentation. Two navigation panels appear in the "control bar" at the bottom of the screen, and the instructor describes how the trainee can use these to move forward or to repeat within the program. Here the trainee is also introduced to the Text Window that can be displayed in the control bar, and is shown how to select Speech Only or Speech & Text options for presentation.

Operating the Sony BVU-150

The body of the program can be divided into nine segments that cover the operating functions of the Sony BVU-150 video tape recorder. Here the program begins recording data that describe the users' navigation and presentation choices.

Figure 1. Introduction to the BVU-150

VTR Introduction. In this very brief introduction to the BVU-150 videotape recorder (VTR), the workshop instructor describes the unit in terms of advanced features, such as high resolution recording and a built-in time code generator (see Figure 1).

Loading a battery. The instructor identifies the type of battery used by the VTR, and shows the trainee where the battery compartment is located on the deck.

Powering up. Here the trainee is directed to turn the deck power on (see Figure 2). The trainee learns that the tape counter serves as a power-on indicator, and is then led through the steps of checking the charge on the battery using the VU meter for audio channel one.

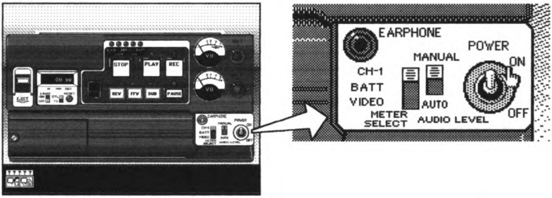

Figure 2. Powering Up

Loading a tape. The trainee locates and presses the EJECT button to open the tape transport door, and is shown a demonstration of how to properly label a tape before inserting it into the deck for recording.

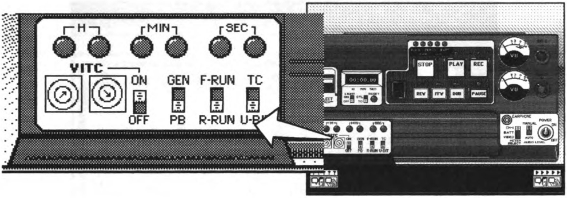

Figure 3. The Time Code Panel

<u>Time code generator</u>. The trainee switches the tape counter into time code display, and the instructor introduces the control panel used for setting the time code generator (see Figure 3). The instructor gives a very brief explanation of four switches that set parameters for recording time code; the trainee sets these switches, and sets the starting hours, minutes and seconds for the time code.

<u>Connecting cables</u>. The trainee is directed to the VTR connector panel, located on the side of the deck opposite the battery compartment (Figure 4). Here the instructor leads the trainee through the necessary cable connections: a lavalier (or "tie-tac") microphone is connected to an audio cable, and then to audio channel two; the output of the time code generator is patched into audio channel one with an adapter cable; and the camera cable is connected. Proper line/mic input levels are set with the appropriate switches, and the switch for Dolby noise reduction is turned off.

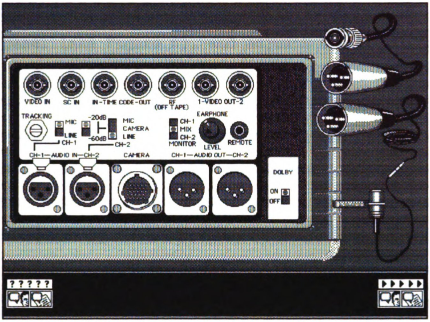

Figure 4. Connecting Cables.

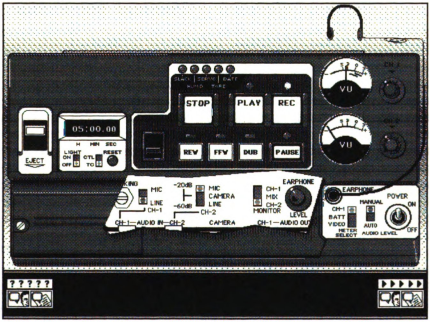

Figure 5. Setting Audio Levels.

Setting audio levels. The trainee returns to the VTR control panel (see Figure 5), and adjusts the audio level of the time code signal in channel one; checks the audio level for the mic in channel two; and uses the VU meter for channel one to check the video signal from the camera. Here the trainee also learns to adjust the gain and the output (ch1,ch2 or MIX) for earphone monitoring.

Recording. The trainee uses the PLAY, REC, and PAUSE buttons to record room noise and the color bar reference signal from the camera; a scene slate; and the interview.

Tape alerts. The instructor demonstrates the warning lights that flash and the alert tone that sounds when the tape is nearing the end and when the battery is low on power. Also demonstrated is the battery-saving mode when the deck is in pause with a low battery.

Program Structure

The basic structure of FKW is linear, since the student is guided on a fixed path through a standard procedure made up of a series of specific steps. The program also has characteristics of single-frame structure (Apple Computer, 1989), in that new information is presented to the learner without (metaphorically) moving to a new location in the program.

In keeping with the vocabulary of hypermedia, each unit of information within the program will be referred to as a *node*. In FKW, a node of information is typically composed of several smaller parts: one or more sentences of verbal information relating to a single fact; a static or animated visual which illustrates or complements that verbal information; and a specific program response to user manipulation of virtual controls. From the user's standpoint, a node consists of everything that lies between two navigation decisions.

The prototype version of the program contains forty-seven nodes of information. Thirty-one of the forty-seven nodes require the user to perform some specific action as a part of the procedure for preparing the VTR to record. Within one of these *action nodes*, the user is directed to perform some action on-screen. When the correct action is performed, additional information may be presented, or the node may be complete.

Figure 6 depicts an action node in its most basic form. When the user sends a navigation command to CONTINUE, the node begins with a sentence display that provides tutorial information -- in this case, the proper setting for the audio level in channel one. This tutorial information is immediately followed by a procedural instruction -- a sentence that directs the user to turn a certain dial on the control panel. The result of the user's action is a new setting on the simulated VU meter. With the correct setting, the node is complete, and the user has reached another navigation point. Here the user chooses to REPEAT this node or to CONTINUE to the next.

visual	audio
navigate	
VU meter reads at maximum	"The timecode signal is way too hot. It should be between -5 db and -3 db."
	"Adjust the level for audio channel One to put the timecode signal midway between -5 and -3."
action: dial CH 1 counterclockwise	
needle adjusts to -4	sfx: dial
navigate	
	"While you're still at the meter for channel One, check to see that the deck is getting a good VIDEO signal from the camera.

Node Begins
Tutorial Information
Procedural Instruction
User Action & Result
Node Ends

Figure 6. An Action Node.

User Control

To keep the user involved in the presentation of information, and to increase transfer of learning, FKW is designed for a high level of interactivity. The user interacts with the program in three ways: at regular intervals, the user is required to perform some action; and after each node of information is presented, the user sends a navigation command to REPEAT or to CONTINUE. The user also controls whether information is presented as Speech Only or as Speech & Text.

Action

In "Field Kit Workshop," the user must perform a variety of actions throughout the program. For the most part, all of the physical actions that a VTR operator must perform with the real piece of equipment must be performed by the trainee within the simulation. Using a mouse to point, click and drag, the trainee flips switches, pushes buttons, connects cables, and turns dials.

Navigation

Navigating in FKW is limited to moving forward in the program, or repeating recent information. The CONTINUE command in FKW simply advances the user to the next node, since, as a linear program, there are no branching options. There are, however, two ways that the program can respond to a command to REPEAT. How the program repeats depends on whether the program is paused at an action point or at a navigation point.

Figure 7 shows the script of the sample action node again, with navigation and action points highlighted. In all action nodes, after the procedural information is delivered, the program pauses for the user to complete the action as directed. This is called an *action point*. In the event that the user doesn't hear what the next step is, doesn't understand it, or forgets it, at an action point the user can send a repeat command. When the user repeats at an action point, the program repeats only the procedural instruction -- in this case, the instruction to adjust the level of the audio signal in channel one. This REPEAT gives the user only the specific information that is critical for completing the node. When a node has been completed, the user finds himself or herself paused again, this time at a navigation point. Now if the user selects REPEAT, the program returns to the beginning of the recently completed node, and proceeds from there. In this way the user reviews the tutorial information, and performs the required action a second time.

visual	audio	
navigate		► Navigation Point
VU meter reads at maximum	"The timecode signal is way too hot. It should be between -5 db and -3 db."	
	"Adjust the level for audio channel One to put the timecode signal midway between -5 and-3."	
action: dial CH 1 counterclockwise		► Action Point
needle adjusts to -4	sfx: dial	
navigate		► Navigation Point
	"While you're still at the meter for channel One, check to see that the deck is getting a good VIDEO signal from the camera.	

Figure 7. Action and Navigation Points Highlighted

Presentation

In the design of the prototype version of the program, the user makes a choice of Speech Only presentation or Speech & Text presentation each time a navigation decision is made. This means that the user is choosing from one of four options: (1) REPEAT, Speech Only; (2) REPEAT, Speech & Text; (3) CONTINUE, Speech Only; or (4) CONTINUE, Speech & Text. Figure 8 illustrates the control panels that offer the user these four choices. Each of the two control panels on the bottom of the screen has icons representing the Speech Only option, and the Speech & Text option. Clicking on the narrator icon within the REPEAT panel repeats information as Speech Only. Clinking on the "balloon and page" icon within the CONTINUE panel advances the user to the next node, with information presented as Speech & Text.

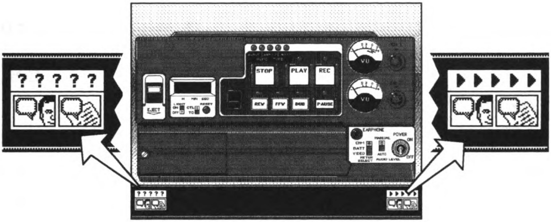

Figure 8. Navigation Panels in the Control Bar.

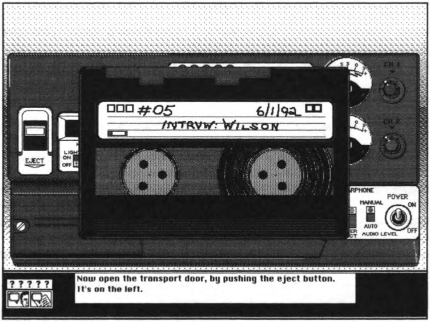

Figure 9. The Text Window in the Control Bar

When the Speech & Text option for presentation is selected, a "Text Window" appears in the center of the control bar. The text window contains the exact text as spoken by the narrator (see Figure 9).

Speech

Applying speech effectively in the program, "Field Kit Workshop," meant considering a wide range of characteristics of delivery, including scripting, recording quality, and rate of speech.

The program script for the "instructor" had to be written to be spoken rather than read. Syntax and diction were crafted to achieve a conversational tone. This generally meant breaking long sentences into shorter ones, using connecting words, and avoiding formal-sounding words and phrases. The program "instructor" uses the pronouns *you* and *I* to maintain the natural, conversational feel of the program.

The instructor's narration was recorded using a studio-grade microphone, a Sennheiser MD 421 U-5. This microphone was selected for its ability to capture lower frequencies that lend warmth to the recorded voice. All voice recordings were sampled at a rate of 11 kHz. A higher sampling rate of 22 kHz would have been preferred, but there was simply not enough disc storage space available. As it was, slightly over twelve minutes of voice recordings for the program required 8.4 MB of storage.

Rate of speech in words per minute (wpm) is a characteristic of narration that can affect intelligibility. Marics and Williges refer to studies that examined rates of speech, in which conversational speech is typically found to be at a rate of around 180 wpm, with compressed natural speech being understandable at 280 wpm (Marics & Williges, 1988). For FKW, it was decided that 200 wpm would be the target rate of speech for the narrator; close to the conversational rate of speech, to maintain the conversational feel, but a little faster for the sake of keeping the program pace up.

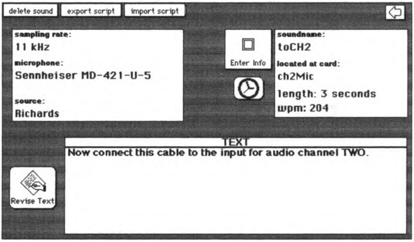

Figure 10. A Sound Card

By using HyperCard's built-in audio sampling software, it was possible to monitor the rate of speech during the recording process. A HyperCard stack separate from the FKW program stack was created for the purpose of storing and cataloging the individual recordings of the narration. Each card of this stack describes one sampled sound -- usually one or two sentences of narration. The card consists of a data field which displays the text of that particular sound file, and additional fields which describe other characteristics of the sound (see Figure 10).

Immediately after a sound is recorded and saved to the disc, HyperCard plays back the sound, and automatically calculates the wpm based on the number of words contained in the data field and the length of time required for playback. If the rate of speech does not fall within the preferred range, that particular sound has to be recorded again.

This process of recording narration resulted in an average rate of speech of 205 wpm over the course of the program.

Speech as Negative Feedback

At any given action point in the program, there is only one correct response that the trainee can make. When the user makes an incorrect response -- flipping the wrong switch, or connecting a cable to the wrong place -- the user must be given feedback to indicate that the attempted response is not correct. FKW provides two types of "negative feedback" in these instances: one, the attempted action can't be completed (the wrong switch doesn't respond, or the cable will not connect to the connector); and two, the program uses speech to tell the trainee that the action is incorrect.

Given that speech is used throughout the program, it seemed natural to use the instructor's voice to provide negative feedback. Each time the user attempts an incorrect action in FKW, the instructor's voice delivers one of four messages, selected at random: "No," "Sorry," "Try Again," or "Sorry, Try Again." The variety of responses and the random element help to maintain the conversational feel of the program.

The Audio Environment

In addition to speech, the audio environment was inhabited by sound effects and music. The designer did not want to use artificial, computer-generated sounds, because it was felt that these types of sound tend to call attention to the fact that the delivery system is a computer. It was felt that the use of natural sounds for both sound effects and music would contribute toward making the delivery system invisible to the user.

Sound Effects

Sound effects served several important functions within the program. They added important content to what was being taught; provided the user with command feedback; and enhanced the realism of the simulation.

Certain sounds produced by the VTR in operation needed to be included in the program as specific content items that the trainee would have to be familiar with. Two examples are the warning tone that sounds when the battery power is low or the tape is just about to end; and the sound of the SMPTE time code signal -- a signal that can be very disconcerting to a tape operator who has never heard it before.

Other sounds produced by the deck provided a natural way to follow the hypermedia design convention of providing the user with "command feedback." A common example of audio as command feedback is a beep that sounds whenever the user clicks a pointer on a screen object. This audio feedback lets the user know that he or she is getting through to the computer. In FKW, one typical user command is a click with the pointer on a screen image of a switch. The natural audio feedback from flipping a switch is a mechanical "click" sound -- so the natural source for audio cues as command feedback was the video tape recorder itself.

More than twenty sounds produced by the Sony VTR in operation were recorded to be used as sound effects within the program. The click of a switch, the spring of the tape eject mechanism, the distinctive sound of the tape being threaded around the tape head -- these and other sounds provide the tape operator in the field with important information about the status of the VTR. This audio information can't be presented in an equipment manual, and much of it is too subtle to be communicated in a demonstration setting with a small group. By incorporating these sounds into the hypermedia simulation as realistic detail, the trainee receives a more complete experience than other training methods can provide.

The equipment sounds were recorded at the maximum sampling rate of 22 kHz to maintain a high rate of realism.

Slightly over one minute of VTR sounds occupied almost 2 MB of disc storage space.

Music

Music serves the same functions in hypermedia as it does in non-interactive multimedia, such as film and television -- it sets a mood, creates a setting, draws attention to important information, and supports scene transitions. Few electronic media programs can succeed without music, and yet music that is poorly done can annoy the audience and reduce the appeal of any program.

Developing music for FKW meant choosing appropriate instrument voices and determining the various functions music would play to support the design of the program. It also meant creating a scheme that would provide enough music to take the user through more than thirty minutes of program -- without devoting a huge chunk of disc space to storing sound files for an elaborate sound track, and without boring the user to distraction with excessive repetition of simple themes and annoying cues.

The design philosophy of making the computer an invisible agent of instruction led to a decision to use acoustic instrument sounds rather than electronic sounds. Electronic, synthesized sounds are typically associated with computers. It was felt that electronic sounds, by association, would draw attention to the computer as the medium of delivery; and it was hoped that by using samples of acoustic instruments, the "natural" feel of the program might be maintained.

The theme and incidental music for FKW was provided by a single instrument, an acoustic bass, played in an improvisational jazz style. Additional music was provided by a basic drum set made up of kick drum, snare, tom-toms, hi-hat and cymbals.

The acoustic bass theme and incidental music accompanied scene transitions within the program, and were used to "bracket" narration in introductory and review segments of the program. Occasionally a short phrase was used in conjunction with an animated, on-screen "pointer" to help draw attention to some visual detail in illustration or animation. Any of a variety of drumbeats announced the appearance of the CONTINUE control panel, and with it the need for the user to make a navigation decision to either continue or repeat.

Assigning different instruments to different functions followed the "Design for Function" principle, and integrated the music into the program design: the acoustic bass theme was used to support content, and the drumbeat accents were used to aid the user in navigation. And since the screen design also split content from navigation, another way to put it is that the bass theme accompanied whatever happened in the main body of the screen, while the drumbeat accents drew the user's attention to what was happening in the "control bar" portion of the screen.

Integration of music into the program was accomplished with a minimum demand on disc storage space. Sound requires a lot of space -- when this prototype version of the program was completed, the narration, recorded at 11 kHz, required over 8 MB; the sound effects of the video tape recorder, recorded at 22 kHz, took almost 3 MB of storage space.

To economize on disc space, all music was generated using less than a dozen sound samples, played back according to routines scripted in HyperCard's programming language, Hypertalk. The total disc storage space required for the sounds that were used, recorded at 22 kHz, is less than 300 K.

The acoustic bass theme and incidental music is generated within the program from a one-note sample of an acoustic bass. Twelve brief passages of music using the acoustic bass sample were composed in Hypertalk. The passages are of varying length and complexity, but all have the same light jazz feel.

Individual passages, or specific combinations of passages, are called from within the program when needed for short musical cues. For scene transitions, the longer program theme is generated from the same twelve passages, supplemented by eight single notes of a blues scale. Two specific passages are always called first as the theme introduction. Then the acoustic bass "improvises" for whatever duration has been specified. At random, the program repeatedly plays from twenty possibilities: one of eight quarter notes of the blues scale, or one of the twelve composed passages. At the end of the specified duration, the tonic note of the scale is played to put a consistent ending to the theme.

Figure 11 shows a simplified version of a Hypertalk script to illustrate how a random, improvisational element was incorporated into the theme music for "Field Kit Workshop."

```
on Theme X
  phrase 1
  phrase 2
  repeat X times
    put random(20) into Y
    phrase Y
  end repeat
  play bass
end Theme

on phrase Y
  if Y =   1 then play bass D3q (below middle C)
  if Y =   2 then play bass E3q (below middle C)
  ...
  if Y =   8 then play bass Dq
  if Y =   9 then play bass Ds. D#s A#s Ds D#s De
  if Y =   10 then play bass Gs. As Fs As A#s Cs C#s Ds
  ...
  if Y =   20 then play bass Fs Cs Fs
end phrase
```

Figure 11. Improvising on Bass in "Field Kit Workshop."

Another touch was added to conform to the conventional practice of fading music in and out rather than beginning and ending at full volume. The sample of the single bass note was modified to create a second sample, identical to the first except that it plays at half the volume of the original. When the program theme plays, it actually plays the first introductory passage, and the final tonic note, using this reduced-volume sample. The result is a fade-in and fade-out of the music theme wherever it appears in the program.

The programming commands that play the notes are processed much faster than the sounds can be played, so the passages play in natural, rapid succession. And because HyperCard can play sound while processing other commands, animated visual sequences can proceed while the music plays. The result is a smooth, natural-sounding solo instrument that can literally play indefinitely, with little chance of ever repeating itself, and yet have a consistent feel, recurring motifs, and improvisation to keep the music fresh.

It was important that the drumbeats also incorporate a random element, just as the acoustic bass did. A drumbeat plays each time the user needs to make a continue or repeat decision -- more than 45 times throughout the program. Any one musical cue heard 45 times over a thirty minute run of the program would be sure to annoy the user long before the program was finished. Because the only function of the drumbeat is to announce the presence of the CONTINUE panel, a variety of drumbeats could be used.

A single note was recorded of each of six drum sounds: kick drum, snare, tom, hi-hat open and hi-hat closed, and cymbal crash. Using these sounds, six different drumbeats were composed. The length of each drumbeat was approximately the same for all, but there was a good deal of variation in terms of the rhythm and the specific drum sounds used for each.

As the user completes a segment within the program, one of the six drumbeats is selected at random and played, and the CONTINUE panel appears, signaling the user to make a decision to CONTINUE or REPEAT. The sound, rhythm and tempo of the drumbeats provides a nice contrast to the admittedly low-key mood set by the acoustic bass.

Visual Elements

Graphics

Just as in sketching, painting and the medium of video, the images that the computer screen can produce are naturally limited to two dimensions: the horizontal and the vertical. To create lifelike images, the artist in these visual media must employ a variety of techniques to add the third dimension -- depth.

Graphic elements of the program were designed for a high degree of realism, to achieve maximum transfer of learning (Alessi & Trollip, 1991). Most graphics originated as line drawings, scanned into the computer from the equipment manufacturer's operating manual. Using the paint tools in HyperCard, and other graphic software, these line drawings were enhanced to create realistic, monochrome images. In most cases, the finished graphics appear approximately actual size.

Objects were enhanced with highlights and shading to help create the illusion of depth. Each screen used a background characterized by a gradation from light to dark; most foreground objects cast a shadow on this background, further supporting the illusion of depth.

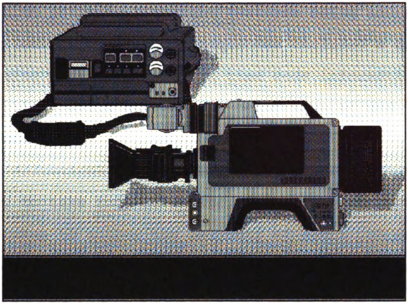

Figure 12. Shadow and Contrast for Depth and Clarity

Care was also taken to use contrast to ensure that the images presented the important components of the equipment clearly.

While the images gave an impression of realism and detail, often accuracy was compromised in the name of clarity and simplification. Scale was occasionally slightly distorted to accommodate labeling of components. Rather than trying to use shading to represent colors, shading of various surfaces in the monochrome images was typically applied to create contrasts that enhanced image clarity (see Figure 12).

Animation

Animations were used regularly to help illustrate information presented in the program. The simplest form of animation was a small pointer that appeared on the screen, moving from point to point to highlight features being addressed by the narration. More elaborate sequences included a demonstration of using pushbuttons to set time code information, and a sequence illustrating a videotape being labeled and loaded into the deck.

Most animations in FKW are presented simultaneously with narration, to take full advantage of dual-channel processing. Care was taken to author the delivery of narration and presentation of animation so that there could be no loss of synchronization between the two.

Color

Color is used sparingly in "Field Kit Workshop." Where color is used, it is used either because effective presentation of specific content demands the use of color, or it is because color is being used as an attention-getting device in an otherwise monochrome environment.

As dictated by content, color is used in the expanded detail of the VU meter for audio channel one. This meter uses color to help the VTR operator distinguish between three different scales used to read the meter in three different modes. To illustrate the procedure for recording the "color bars" reference signal, a video monitor is presented in color.

As an attention-getting device, the animated pointer that appears throughout the program is colored green to stand out against the monochrome images to which it points. The navigation panels, important for user control of the program, also incorporate color: red for REPEAT and green for CONTINUE.

Degree of Realism

Many of the design features described above combine to create a program that, as a simulation of a sophisticated piece of electronic equipment, has a high degree of realism. The simulation of the deck in record mode is complete with flickering VU meters, a flashing record indicator light, a time code display that advances by the second, and the voice of the person who is being interviewed. But a high degree of realism does not necessarily improve learning. Studies indicate that novice learners benefit more from simulations with low fidelity, or realism, while advanced learners benefit more from simulations with high fidelity (Alessi & Trollip, 1991).

FKW is designed to take advantage of the transfer of learning benefits that can result from a realistic simulation. But FKW also strikes a compromise between reality and simplicity for the sake of the learner who is new to location video production.

The one-on-one instructional scenario has a low degree of realism relative to actual field production experience. The lack of time constraints, the continual guidance from the instructor, and the flexibility to pause and seek additional information, are all elements that would not be present in an actual production setting.

Some operating procedures of the VTR are given simple treatment -- no details are provided, for example, in the brief description of how to load a battery. Some operating features, such as the DUB switch and the KEY INHIBIT switch, are ignored in this first introduction, to avoid cluttering the presentation of more critical information.

HyperCard as Development Tool

The process of developing "Field Kit Workshop" was complex, and was facilitated in large part by the author's development of support materials for production. The creation of a separate file, or stack, to catalog sounds as described above is just one example of how the flexibility of the HyperCard authoring environment helped facilitate the development of FKW. Some other tools and methods that were developed during the creation of this program are worth a brief mention here.

An "authoring palette" was created that served as an aid to navigation and helped facilitate the storing and cataloging of speech files. Navigation commands from the authoring palette make it possible for the developer to navigate throughout the program without triggering automatic functions that exist at some locations. The palette also includes links that make it possible for the developer to jump to key locations within the program, and to other stacks that provide support for the main program stack. Any navigation from the authoring palette opens a message window that serves to identify the developer's current location within the program.

The authoring palette also contains commands that create the text fields necessary for each node of the program, and that link the text within the program to the appropriate "Sound Card" of a sound stack where the sampled speech is actually recorded and stored. This link between the text as it appears within the Text Window during the run of the program, and the sound card where the sampled sound is described and recorded, makes it relatively easy to revise the text of the program script during development.

A music stack was created to help in the composition of the twelve passages that make up the program theme and incidental music. One card of the stack simulates a piano keyboard. When a series of notes is played on the keyboard, a HyperCard "button" is automatically created that contains the programming script to play the notes back. The button with the new passage is then moved to a card that contains other passage buttons. If the passage created with the new button is compatible when played with the others, it's script can be added to the program theme.

These and other, less elaborate, aids to development were critical to the creation of "Field Kit Workshop." Most are general enough in application that they could be put to use in the development of future programs that have a basic underlying design similar to that of FKW.

EVALUATION DESIGN

Evaluation of the program was designed to explore how students use and respond to speech display as a mode of presentation in hypermedia. One aim of the evaluation was to gauge user response to and acceptance of speech as a means of delivery in the FKW program. A second aim was to gather information about decisions users make when given a choice between presentation modes. This information would be used to plan the design of a complete and final version of the "Field Kit Workshop" simulation.

Evaluation of "Field Kit Workshop" was essentially formative, intended to determine if delivery of verbal content by speech was appropriate to the specific needs of this program in terms of effectiveness and user acceptance. Questions explored included: Do students take advantage of the option to repeat speech displays? Do students desire on-screen text displays as a complement to speech displays? Can it be demonstrated that a program such as "Field Kit Workshop" can be designed to effectively deliver verbal information through the medium of speech?

Sample

The program was tested with a non-probability sample comprised of students who responded to posted notices and in-class requests for study participants. All participants were either currently enrolled in or had completed basic video or audio production coursework. A total of thirteen volunteer subjects took part in the study. The small sample size was appropriate to the nature of the study as formative evaluation.

Instruments

One instrument of measurement was a record of presentation choices made within the program by each student. Each user command to CONTINUE or REPEAT was recorded, along with information identifying the location in the program, and the selected presentation mode of "Speech Only" or "Speech & Text." In addition to itemizing the user choices, the data record for each user included the program running time, and totals for the four choice options of CONTINUE, Speech Only; CONTINUE, Speech & Text; REPEAT, Speech Only; and REPEAT Speech & Text.

As a second measurement instrument, each student completed a questionnaire designed to assess user response to speech displays and components of the program related to speech displays. The questionnaire included questions which addressed:

previous experience with hypermedia and with speech in hypermedia;

general reaction to the use of speech in the test program;

presentation preferences (speech vs. text) for verbal information/instruction in the test program;

overall reaction to the program "Field Kit Workshop."

The questionnaire can be found in the Appendices (Appendix B).

Procedures

Development and testing of the program was conducted on an Apple Mac IIsi computer with high resolution 13-inch monitor, 5 MB RAM and 40 MB internal hard drive. A small external amplifier and speaker were used for sound rather than the system's built-in speaker. The external amplifier allowed each user to easily set the program volume for his or her own comfort.

Thirteen individual sessions were conducted with the program over a period of four days. Three of these sessions, conducted on the first day of testing, were used to debug the program, and did not directly contribute data to this study. Based on these test runs of the program, some revisions were made to program delivery and navigation, and serious problems with the method of recording user activity were resolved. The ten sessions conducted after these revisions were made contributed the data for this study.

All sessions were conducted on the same computer, in the same environment. The large group office where the study was conducted provided a "real-world" setting: one other individual used the room for purposes unrelated to the study, and an air conditioning system provided a low level of steady ambient noise.

Upon arrival for testing, a participant was provided with a questionnaire and a manila envelope, and took his or her place at the computer. The researcher showed the participant the volume control, and, if necessary, provided a brief demonstration of using a mouse as input device to point, click and drag. The participant was then directed to begin. Introductory modules within the program itself provided information needed to use the program and to com-plete the questionnaire.

Because the program was still in a developmental stage, and not entirely free from bugs, the researcher remained in the vicinity during each session to troubleshoot any problems with the hardware or software. No direct observations of user behavior were made or recorded as a part of this study. It became obvious once the study was under way that direct observation of behavior would have provided additional data very useful as a component of formative evaluation; unfortunately, approval of this project by an oversight committee was based on a guarantee of participant anonymity which could not be maintained if participant behavior was directly observed.

Immediately after using the program, each participant filled out the questionnaire. The completed questionnaire was placed in the manila envelope, and then in a box where it was shuffled in with other respondents' questionnaires to maintain anonymity.

RESULTS

CHARACTERISTICS OF PARTICIPANTS

Half of the ten participants reported that they had never used a hypermedia program before. Of the five who had previous experience with hypermedia, four had used at least one program that presented information through the medium of speech.

On a scale from 1 to 5, 70% of the participants reported a level of experience with audio or video production equipment in general of either 4 or 5. A range of experience with video field production equipment specifically was more evenly distributed, with 40% reporting 1 or 2, 20% reporting 3, and 40% reporting 4 or 5 (see Figure 13).

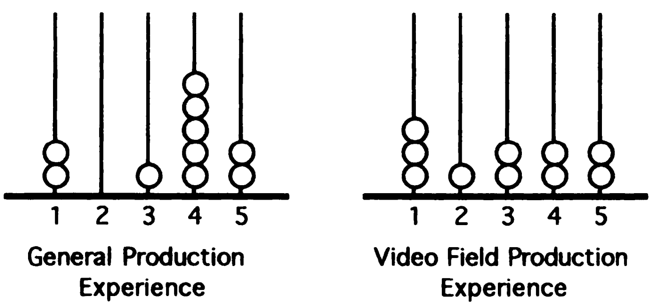

Figure 13. Reported Levels of Experience

Half of the participants had used the piece of equipment that was the subject of the program at least once.

SPEECH ONLY VS. SPEECH & TEXT

The preferred mode of presentation was Speech Only: seven of ten participants selected Speech Only more than 90% of the time. Only two of these participants reported having previously used hypermedia to receive information, instruction or training.

Three of the seven participants who demonstrated a preference for Speech Only presentation did vary somewhat the mode of presentation over the course of the program. One participant used Text & Speech for the first two nodes, and then switched to Speech Only for the entire remainder of the program. One used Speech Only throughout the program, and then switched to Text & Speech for the last two nodes. One student used Speech Only throughout the program, with one exception. In one node the user repeated a procedural instruction once as Speech Only, then switched to Speech & Text for a second repeat. After this second repeat, the user completed the requested task and returned to Speech Only mode to continue the program.

Among the three participants who demonstrated a preference for Speech & Text presentation, there was no variation from that mode. These three participants all reported having previously used hypermedia to receive information, instruction or training at least once; and all of these users had used the Sony BVU-150, the subject of the program, at least once.

The average level of agreement with the statement that speech "seemed **natural**, and was an effective way to receive instructions and information," was 4.0, on a scale from 1 to 5 where 1 = "disagree" and 5 = "agree." 50% of the participants responded with the mode of 5, and 80% responded either 4 or 5. One participant responded 1, and one responded 2 (see Figure 14).

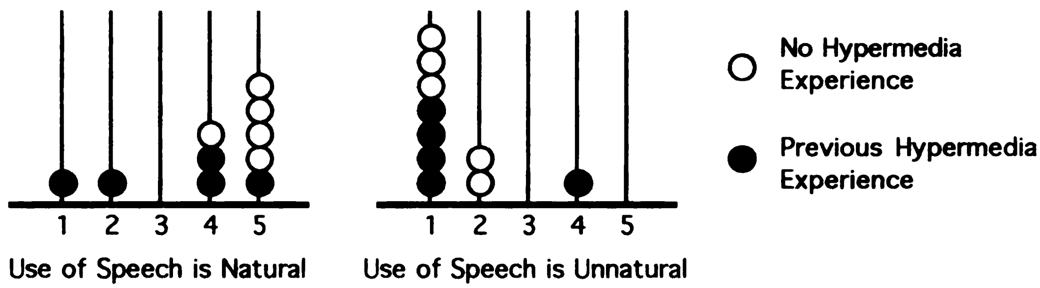

Figure 14. Use of Speech is Natural

In response to the question, "How much did the **use of speech** enhance your level of enjoyment of the program?" with 1 being "none," and 5 being "very much," the mean was 4.1, with 80% of the respondents giving ratings of either 4 or 5.

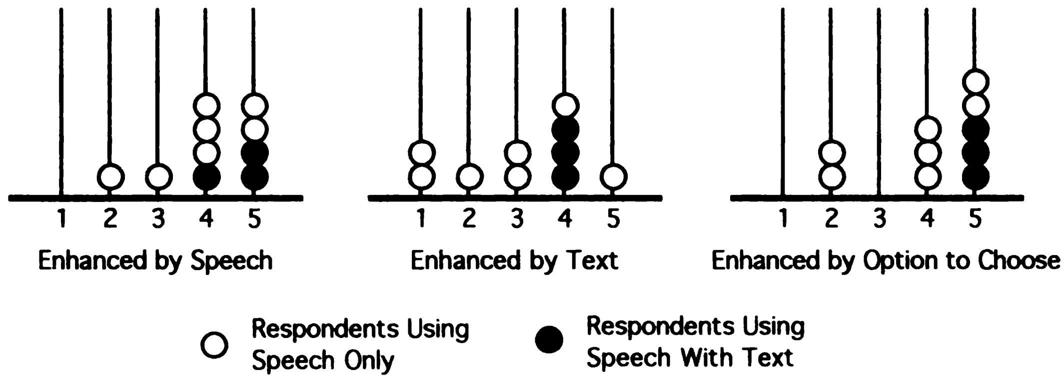

Figure 15. Responses to Use of Speech

80% of the respondents gave a rating of 4 when asked how easy it was to understand spoken instructions, with 1 being "very difficult" and 5 being "very easy." The mean was 4.0; 3 was the lowest rating received. The mean for ease of understanding written instructions was higher, at 4.4 (see Figure 16).

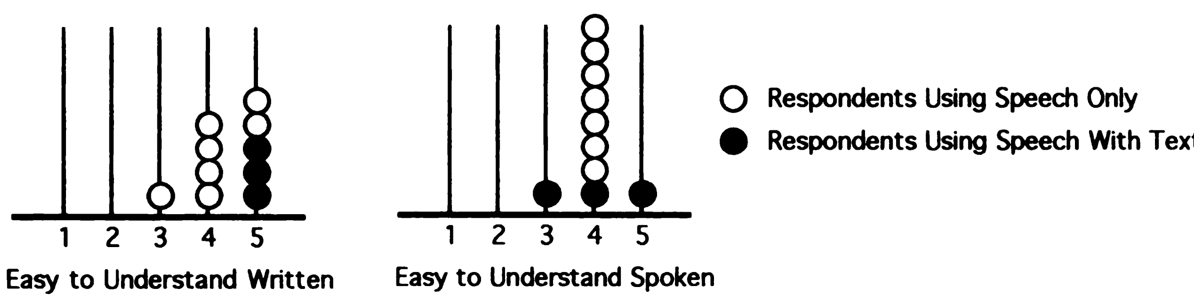

Figure 16. Understanding Speech and Text

There was greater agreement that the program would be improved if the "instructor" spoke more rapidly than there was that the program would be improved if the "instructor" spoke more slowly, although both suggestions received very low ratings: 1.6 was the mean for slower rate of speech, and 2.2 was the mean for faster rate of speech (where 1 = "disagree" and 5 = "agree"). The statement that the program would be improved if there were a variety of speakers throughout the program also received a low level of agreement, with a mean of 2.0.

Participants were presented five statements that described possible ways to use the Text Window within the program, and were asked to indicate any that described their own use. In keeping with the recorded data, 60% indicated that they "did not use the text window;" two participants (20%) indicated the statement that "Displaying the TEXT WINDOW helped me avoid having to use the REPEAT feature;" one indicated the statement that "With the TEXT WINDOW displayed, I sometimes missed details presented in visual images and animated sequences;" one indicated the statement, "Although I often displayed the TEXT WINDOW, I only referred to it occasionally;" and one indicated the statement, "Even with SPEECH, I depended mostly on the TEXT WINDOW for information."

In the course of the program, the user encountered a minimum of 47 prompts to continue or repeat (more if the user repeated). The mean number of repeats in Speech Only mode was 1.2; the mean number of repeats in Speech & Text mode was .3. The mean number of total repeats per participant was 1.5.

USING AND LEARNING

On a scale from 1 = "very difficult" to 5 = "very easy", the rating for overall ease of use had a mean of 4.6, with 60% of the responses being 5. Other use-related items on this scale included ease of operating controls, with a mean of 4.4; and ease of moving forward or backward through the program, with a mean of 4.3. (see Figure 17).

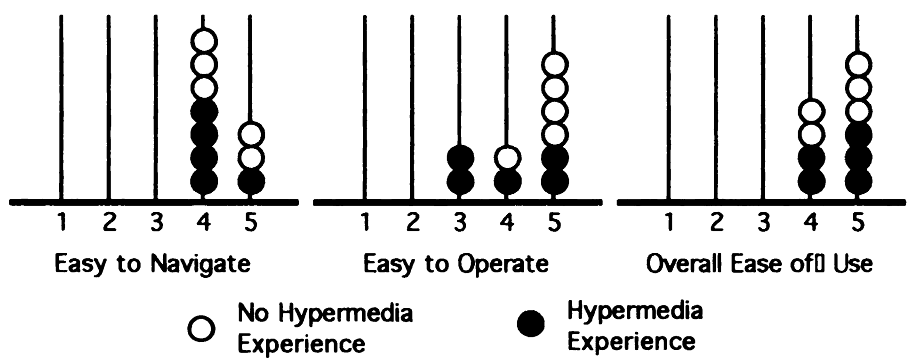

Figure 17. Ease of Use

When asked how easy it was to learn from the program, 50% of the participants assigned the highest rating of 5, with a mean of 4.4. All respondents reported that they had learned something new about the video tape recorder (VTR) in at least one of twelve listed content areas. The average number of content areas in which something was learned was 3.1. Among those who had previous experience with this particular VTR, the mean was 2.0; among those with no previous experience with the VTR, the mean was 4.2.

Asked "How confident are you that you have a **basic** understanding of how to operate the Sony BVU-150 video tape recorder," on a scale of 1 = "not confident" to 5 = "very confident," the mean for all responses was 4.3. Among participants who had used the VTR before, the mean was 4.6; among those who had not, the mean was 4.0.

When the participants were asked how much benefit they might receive from using the program a second time (on a scale from 1 = "none" to 5 = "very much"), the mean for all responses was 2.6. Against the same scale, when asked how much benefit would be received from having the program readily available for repeated use, the mean was higher, at 3.5 (see Figure 18).

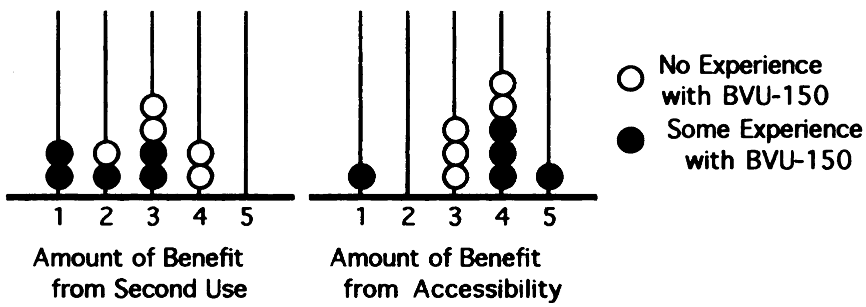

Figure 18. Expected Level of Benefit from Repeated Use

Participants were asked their preferred means of receiving a first introduction to a new piece of production equipment. In three separate items, 100% indicated a preference for using a hypermedia program over reading the equipment manufacturer's Operating Manual; 90% preferred using a hypermedia program over viewing a videotaped demonstration of the equipment; and 90% preferred using a hypermedia program over attending a small-group demonstration session (no hands-on) conducted by an experienced operator.

An overall level for enjoying the program was rated on a scale from 1 = "none" to 5 = "very much." 50% of the respondents gave the program the highest rating of 5; the mean was 4.3. Asked to rate, on the same scale, specific features that may have enhanced the level of enjoyment, the response mean for "realistic sound effects" was 4.3; for "use of speech" was 4.1; and for "use of music" was 3.2. The rating for the "option to choose" Speech Only or Speech & Text had a mean of 4.1; and for "use of text," the mean was 3.1. The rating for the "quality of the visuals" in enhancing the level of enjoyment had a mean of 4.3 (see Figure 19).

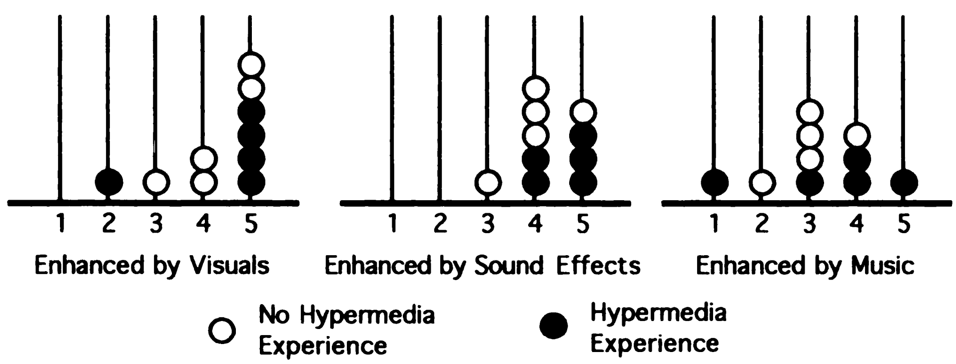

Figure 19. Other Enhancing Features

All respondents agreed with a statement that programs similar to the one tested should be developed for introducing students to the operation of other audio and video production equipment. On a scale with 1 = disagree and 5 = agree, all ratings were either 4 or 5; the mean was 4.3.

Seven sample screens from the program were rated by participants for complexity, on a scale from 1 = "not complex" to 5 = "very complex;" and for attractiveness, on a scale from 1 = "not attractive" to 5 = "very attractive." The means for these ratings are described in Table 1.

TABLE 1. Screens Ranked by Complexity, from Least to Most

	screen descriptor	complexity	attractiveness
1	Field Kit Introduction	1.6	3.6
2	Video Tape Recorder (VTR)	1.9	3.5
2	VTR with Monitor (slate)	1.9	3.6
2	VTR with Video Meter Overlay	1.9	3.4
3	VTR with Time Code Generator	2.4	3.6
4	VTR with Connector Panel Overlay	3.0	3.5
5	VTR Connector Panel	3.6	3.4

DISCUSSION

THE PARTICIPANTS

Given the small sample size, it was fortunate for this study that participants represented a range of experience with hypermedia and with video field production. The nearly even split of experienced and not experienced, across both categories, makes it possible to examine the data in ways not fully anticipated in the initial design.

It should be noted that participants reported a higher rate of previous exposure to speech in hypermedia than was expected, given that speech in hypermedia is not common. This high exposure is likely due to the fact that the sample was drawn from a population of students at a university that is active in developing and implementing hypermedia, and where there is a focus among developers on integrating sound into hypermedia programming.

SPEECH IN "FIELD KIT WORKSHOP"

The main purpose of this study as formative evaluation was to gather feedback to support the use of speech alone as a means of delivery for this particular program; a second aim was to gain insight into design factors that may have an impact on the effectiveness of speech display.

User Acceptance

The participants in this project did accept speech as a means of delivery. A strong majority chose the Speech Only mode of presentation, and even those who used the program with text support responded favorably to questionnaire items which addressed the use of speech.

The high rate of approval by participants suggests that a complete version of the program, "Field Kit Workshop," in which speech is the default and perhaps only mode of presentation for verbal information, could be designed to be effective, and would be accepted by the majority of those who would use the program. Nevertheless, enough participants took advantage of the option for text support to suggest that a text display option should be maintained.

When the data regarding use and acceptance of speech displays is viewed in terms of the users' previous exposure to hypermedia, an interesting trend is observed. As noted above, all of those who consistently selected Speech with Text as the mode of presentation reported having previous exposure to hypermedia; and the statement that speech seemed a natural way to receive information received it's lowest rates of agreement from two users who had previously used hypermedia.

As noted in the review of literature, computer-based instruction has traditionally delivered verbal information as text. While the data in this study is not conclusive, there is a suggestion that experienced hypermedia users have a positive bias toward the use of text, as a result of their past experience with computer-based delivery.

Speech, Understanding, and Content

It was beyond the scope of this study to provide a direct measure of the effectiveness of speech as a mode of delivery. Still, most users reported that speech was easy to understand; and the very low figures for repeats within the program support the notion that information was understood by all users, with or without text.

The low number of repeats, however, may have been the result of a low level of motivation to learn the material. Participants in the study would not necessarily be expected to ever use the piece of equipment that was the subject of the program, and so motivation to learn the material may have been low. The fact that only two of the fifteen repeats were repeats of entire nodes, while the remainder were repeats of only the procedural instructions, would seem to bear this out. Some users may have been unclear about tutorial information and simply not bothered to repeat it, but the program was structured such that procedural instructions had to be understood before the user could continue.

Of the fifteen repeats that did occur, five were within one particular node within the program. The procedural instruction in this action node calls for the user to complete two actions in succession. This design is inconsistent with the rest of the program, in which each procedural instruction requires only one action.

Within this node, several participants believed that they had encountered a bug in the program when completion of the first action brought no response. These participants sought assistance from the researcher, and were directed to use the REPEAT panel in order to review the instruction. Users did so, and then completed the second action to continue with the program.

Data that describe the number of repeats within this node are not good data because some users were told to repeat. But how these users repeated -- with Speech Only, or with Speech & Text -- is still useful data. When users repeated, did they choose a different presentation mode than they did for forward navigation through the program? If users who demonstrated a preference for Speech Only chose to REPEAT in Speech & Text mode, it would seem to indicate that these users thought the addition of text would improve the likelihood of understanding the instruction the second time. In fact, one user repeated the instruction one time as Speech Only, and then a second time as Text & Speech, before successfully completing the action.

The poor design of this node actually helped produce other useful data relating to whether users changed modes for repeats. What was demonstrated was a strong tendency for users to use their preferred mode of presentation for REPEATS as well as for forward navigation.

While the repeat function was not heavily used, it did seem to serve the purpose of clarifying information for the user. Out of fifteen repeats, only twice did any user repeat the same chunk of speech twice. For all other instances, one repeat was sufficient to enable the user to proceed with the program.

Speech Characteristics

The low level of agreement with suggestions to increase or decrease the rate of speech seems to indicate that the decision to target 200 wpm as the average rate of speech for the program was a good one. And, while the designer had at one time considered using more than one voice through the course of the program, users did not feel that such an approach would add anything to the program.

Speech and Visual Content

The questionnaire asked participants to rate several representative screen images for level of complexity. The researcher had hoped to see if a relationship might exist between the complexity of the visual image and user repeats of information. One-third of the repeats occurred as a result of one poorly designed node, as described above. It is worth noting that the screen image at this node received the highest rating for complexity; but, as has been pointed out, several users were directed to repeat at this point when they became confused by inconsistent design, and so this data can not be used to describe a relationship between image complexity and user repeats. It may even be that the image received a high complexity rating because the users recalled being confused at that particular point in the program. No pattern relating to image complexity could be discerned among the repeats that occurred at other locations in the program.

THE PROGRAM

Program Acceptance

Speech was accepted as a medium within a program in which many other related and complementary components also received high approval ratings by users. The quality of the visuals and the use of realistic sound effects were also very well received. The use of music received a somewhat neutral response.

Overall, "Field Kit Workshop" received overwhelming approval as a training tool. After using FKW, most participants in the study indicated hypermedia as a preferred means for receiving initial equipment training, and all felt that programs similar to FKW should be developed for training students in the operation of other production equipment.

Program Effectiveness

The only measure of the effectiveness of the program overall was the participants' own reporting. It came as no surprise that inexperienced participants reported learning more about the video tape recorder than experienced users did; it was somewhat of a surprise that all users reported learning something about the VTR -- even those who indicated a high level of experience with the Sony BVU-150.

SUMMARY

As outlined above, it was felt that a useful evaluation of speech in hypermedia could only be accomplished within a program that was well-designed overall. The high ratings this program received across all measures indicate that the project was successful in placing speech within an appropriate vehicle for examination.

This study found that speech will be accepted by users within a program that is well-designed overall, and in which the design takes into account the special strengths and weaknesses of speech as a medium for delivery.

It also found that users were generally satisfied with a speaking rate of approximately 200 words per minute. The high ratings for understandability of speech also suggest that a sampling rate of 11 kHz may be sufficient for recording speech, if care is taken in considering other recording factors, such as microphone selection.

RECOMMENDATIONS

THE FINAL DESIGN

The results of the evaluation supported the notion that speech could be used effectively to present information in this particular simulation. The final version of "Field Kit Workshop" will incorporate revisions in several areas to take full advantage of speech as a primary source for verbal information.

Because thirty percent of the users elected to receive text support for that narration, and eighty percent reported that the option to choose the mode of presentation enhanced their enjoyment of the program, the Speech & Text option will be maintained in the final design. But the way in which the option is offered will be revised.

In the prototype version of FKW, the user was required to make the decision of "Speech Only" or "Speech & Text" in conjunction with every navigation command to move forward or repeat. This was a design aimed at generating data for this study, and was not designed for the users' convenience. In the final version, the option to present text along with speech will be maintained, but the choice of mode will be made independently of navigation decisions. A separate "presentation mode" panel will be added to the control bar portion of the screen. The user will be free to choose Speech Only or Speech & Text at any point in the program, but is not repeatedly "forced" to do so as the prototype design required.

It had been felt in the design of the prototype that building options for presentation and options for navigation into the same panels would turn the simple task of navigating forward or backward into a complicated and cumbersome one. By removing the presentation mode options from the Repeat and Continue panels, the navigation devices -- in particular, the Repeat function -- can be more fully developed.

In the prototype version of the program, when the program is paused at an action point, the REPEAT function only plays back the procedural instruction for that action. The tutorial information cannot be repeated until the user completes the node. In the final version of the FKW, the user who is paused at an action point will be able to REPEAT either the procedural instruction alone, or can repeat back to the beginning of the node to receive the tutorial information as well as the procedural instruction. The final design for the REPEAT panel is illustrated in Figure 20.

Paused at an Action Point, the user can repeat back to the beginning of the node, or just back to the procedural instruction. There is no option to continue at an Action Point.

Paused at a Navigation Point, the user can repeat back to the beginning of the recently completed node, or can continue to the next.

Figure 20. Redesigned Repeats

Some speech samples need to be broken up into smaller units in order to fully implement the tutorial information vs. procedural instruction structure that makes the repeat option possible. For example, in the tested version of the program, these two sentences are recorded as one sampled sound: "But the Vertical Interval Time Code, or VITC, creates some playback problems on our edit systems. So turn the VITC switch off." The two sentences need to be split into separate samples, so that when the user asks for a repeat of only the procedural instruction, only the second sentence will be spoken: "So turn the VITC switch off."

A majority of the users indicated they would make additional use of "Field Kit Workshop" if it were readily available. The strictly linear and sequential navigation of the prototype reduces the usefulness of the program if it is to be used as a reference to specific information. To make the program more useful for repeat users, a menu will be added at the bottom of the control panel to allow the user to jump to certain topics.

FURTHER STUDY

There is clearly much that needs to be learned about the application of speech in hypermedia programming in general -- even considering only the use of speech as applied in "Field Kit Workshop," there are many questions that this small study did not treat.

Is text necessary at all in FKW? The decision was made to include text as a display option in the final version of "Field Kit Workshop," because almost one-third of the users selected the text option and most users appreciated having the choice. But further study, aimed at measuring the relative effectiveness of Speech Only vs. Speech with Text, may find that Speech Only presentation results in more effective learning under the conditions present in FKW.

In FKW, the most important information is in the active display area of the screen, and not in the text. Through images and sound, the student learns what the deck looks like, where certain controls are, and how the machine responds. The student who reads the text at the bottom of the screen may miss details of animated visual displays. Text seems to have an authority which people find hard to resist -- as one person who tried the program in an early stage of its development said, "With the text there, I just *have* to look at it."

A next step in examining speech presentation as it is applied in "Field Kit Workshop" might be to design an experiment to answer questions of relative effectiveness of speech with or without text. Do users respond more quickly to procedural instructions when text is not present? When the instructor gives a procedural instruction -- "Turn the Power Switch on," for example -- does the user who is not reading text respond more quickly and accurately? If not having to read the text means that the user has a head start scanning the screen for the power switch, then this user should be able to act more quickly.

It may also be that users can learn more detailed information without text display than with. FKW regularly uses animated sequences to illustrate certain procedures and characteristics of the deck, because animation is the most direct way to present the information. If the user is reading the text description that accompanies the animation, then that user may be missing the primary source of information -- the animated sequence. An experiment designed to test recall of animated sequences, comparing Speech Only and Speech with Text groups, may demonstrate that text can interfere with learning in these situations.

Also worth pursuing is the possibility that experienced hypermedia users are slower than first-time users when it comes to accepting speech as the sole source for verbal information. Incorporating speech as a regular component in the hypermedia mix could help make hypermedia accessible to a broader range of users -- but if the established base of users are slow to accept speech, and if developers are slow to implement it, then hypermedia may be unnecessarily slow in developing to its full potential as a powerful tool of learning.

APPLYING HYPERMEDIA AND SPEECH IN PRODUCTION INSTRUCTION

The hypermedia program, "Field Kit Workshop," is not intended as an example of how an educator might develop hypermedia materials for teaching a specific course within a typical institution of higher education. As a detailed simulation of one specific, technically sophisticated piece of equipment, the program stands as an example of how a manufacturer might develop materials that can be used to provide training support for its products. For the educator thinking about developing hypermedia programming to complement classroom or lab activities, FKW does provide an example of the effective use of digitized speech to support the presentation of visual material.

In the field of video production, hypermedia programming has great potential for teaching basic concepts of the discipline; concepts such as shot composition, lighting techniques, and shot sequencing. Teaching these areas by any method requires extensive use of visual material -- often there are concepts of physics that need to be illustrated, and there are always examples of good and bad video to be shown. New hypermedia programs that are developed for teaching in the field of video production -- and other areas where the principle content of the instruction is visual -- should use speech to present verbal information. If your picture is worth a thousand words -- why clutter it up with a couple dozen more?

APPENDIX A

APPENDIX A

PROGRAM SCRIPT FOR "FIELD KIT WORKSHOP"

program location	screen image	audio	name of sound
BG: equipment menu			
CD 1: CardOne	Camera & Deck with text overlay: "Field Kit Workshop"	Theme	
	add text: "Click once anywhere to begin"		
navigate			
CD 2: program Open			
CD _: program Open2	Camera, with text: "Ikegami ITC 730"	"This program will introduce you to the Ikegami ITC 730 video camera..."	ProgramIntro1
CD _: program Open3	VTR, with text: "Sony BVU-150"	"...and the SONY BVU-150 portable video tape recorder."	ProgramIntro2
CD 2: program Open	Camera & Deck with text overlay: "Field Kit Workshop"	"When you're done, you won't be an expert -- but you should have a working knowledge of a professional-grade field production kit."	purpose
CD 6: ReadConsent	Questionnaire laid over Camera & Deck image	"Please read the cover page of the questionnaire before you begin. After you've read the page, click on the box in the lower right corner to continue."	readQuest
navigate			
CD 7: readConsent2	"Please read the cover of the Questionnaire now."		
CD 8: Log In	"XXXX"		
	"4925"	"Here's the random number you need for your questionnaire."	LogIN1
		"Write this number on the questionnaire, place the questionnaire in the envelope, and then click on the box below to get started. "	LogIn2
	add text: "First, write this on your questionnaire:"	Theme	
	add text: "Then, put your questionnaire in the envelope."	Theme	

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
	add text: "Finally, click on this box to start ->"	Theme	
navigate			
BG: stack tutorial			
CD 11: practiceIntro		"Before we get to the equipment, you have to learn how to flip switches, turn dials, and connect cables."	controlIntro1
CD 12: switchPractice		"You can flip a switch by clicking where you want it to go."	toFlip
		"If you click anywhere in this rectangle -- on the switch or by the label -- the switch will turn on. Try it."	ClickArea Try It
action: switch ON			
	switch ON	sfx: click	*click
		"Now switch it back off."	turnOff
action: switch OFF			
	switch OFF	sfx: click	*click
		"Some switches will have three positions, like the one below. Set it to position B."	3Positions
action: switch B			
		"Now and then through the program, I'll flip a switch for you."	fingerIntro
CD 13: practiceDials		"For a dial, hold the mouse down on the right side to turn it clockwise..."	clockwise
		"...and on the left side to turn it counterclockwise."	counterclockwise
		"Turn this dial all the way up -- clockwise."	turnItUp
action: dial clockwise			
		"You'll find the filter wheel when you get to the camera. Click on the bottom half of the wheel to set it to the A position."	setFilter
action: wheel A			
CD 14: practiceCables		"To connect a cable, position the mouse over the cable connector.	selectConnector2
		Push the mouse button down, and hold it down."	
		"Drag the cable connection symbol to where you want to make your connection, and release the mousebutton."	dragConnector2
		"Try it.	tryIt
action: connect cable			
CD 15: inputConnected			
CD 16: outputConnected		"Now connect the other one."	connectOther

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
action: connect cable			
CD 18: text&Speech		"The last thing to show you before we start is the control bar at the bottom of the screen."	controlBar1
		"Whenever you hear a drumbeat..."	controlBar2a
		"...two control panels appear in the bottom corners of the screen."	controlBar2b
	"Use this panel to REPEAT"	"Use the panel with the Red Question Marks, on the left, to REPEAT the most recent segment..."	aboutRepeat
	"Use this panel to CONTINUE"	"...or use the panel with the Green Arrows, on the right, to CONTINUE forward through the program."	aboutContinue
	"present info as SPEECH or as SPEECH with TEXT"	"From here on, you can also choose whether you want information presented as SPEECH ONLY, like we've been doing so far, or as SPEECH WITH TEXT."	s&tIntro
		"If you click in the first box, the new or repeated information is delivered as SPEECH ONLY."	aboutSPonly
		"If you click in the second box, this window for text appears in the control bar. and the new or repeated information is delivered as SPEECH WITH TEXT."	aboutS&T
		"Now, use the REPEAT panel if you want me to go through that again, or use the CONTINUE PANEL to begin the workshop."	clickToGo
navigate			
CD 19: endTutorial	dissolve to camera/deck image	Theme	
navigate			
BG: VTRGuide	dissolve to VTR image		
navigate			
CD 20: VTRintro	"SONY BVU-150"	"The portable video tape recorder is the Sony BVU-150."	BVU Intro1
	"••Super Performance (SP) Recording "•• Timecode Generator"	"It features high resolution, SP recording, and a built-in time code generator."	BVU Intro2
	"Cost New $5600.00"	"The current cost of a new BVU-150 is well over five thousand dollars."	BVU Intro3
navigate			
CD 21: VTRorganizer	"needs illustration of interview set up"	"This part of the program will help you get the portable tape deck ready for recording an interview."	VTRorganizer

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 22: aboutTimeCode		"We'll cover most operating features of the BVU-150, with special attention paid to using the built-in timecode generator."	tcIntro
		"If you need some background on what timecode is, click on the help button."	tcHelp
	navigate		
CD 23: VTRintro2	dissolve to deck, screen right	"The first step in getting the deck ready is to load a battery."	LoadBatt
CD 25: VTRbattery1	dissolve in battery, screen left	"The BVU-150 uses a Pro-Pac 90."	ProPac90
CD 26: VTRbattery2	animate: battery into deck	"It loads on the left side of the deck."	LoadLeft
	navigate		
CD 33: vtrHome	orienting transition to control panel	Theme Music	
BG: VTR			
	navigate		
CD 38: VTRPowerUp		"Turn the power on. The switch is in the lower right corner."	VTRPowerOn
	action: power ON		
CD 39: VTRPowerUp2	•Tape counter displays "00:00"	"If the tape counter appears, you know your power is on."	PowerIndicator
	navigate		
CD 40: BattCharg1		"Now check the charge on your battery. There's a switch labeled "Meter Select." Put it in the BATTERY position."	BattCharge
	action: meter BATT		
CD 41: BattCheck	•VU meter position changes •VU meter detail expands to center screen	"Now instead of showing you an audio level, the VU meter for audio channel one shows you how much charge is on the battery."	VUbatt1
		"A battery that's just about out of power would read like this..."	VUbatt2a
	needle shifts lower; then returns to best position	"with the needle at the bottom of the green scale. But this battery is fine."	vuBatt2b
CD 42: resetMeter		"Go ahead and put the METER SELECT switch back in the CH 1 position."	backCH1
	action: meter CH1		
	lose detail; needle to - position		
	navigate		
CD 43: LoadTape1	add tape cassette to screen	"Now you need to load a tape."	LoadTape1
CD 44: tape	animation: tape being labeled	"Always label your tapes with the date, a number, and the subject."	LabelTape1-4
CD 45: tapeLabel			
CD 46: beginLoad		"Now open the transport door, by pushing the eject button. It's on the left."	pushEject
CD 50: DoorClosing	animation: tape being loaded, door closing		

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 51: tapeLoaded			
navigate			
CD 52: switchDisplay		"Next, you need to set the timecode information for this tape. Right now the tape counter is displaying control track information. "	setTimeCode
		"Flip the switch next to the reset button to the TimeCode (TC) position."	switchDisplay
action: switch TC			
	counter display shows: "00:00:00"	"Notice that the display now shows six digits: for hours, minutes and seconds."	TCDisplay
		"It doesn't show the individual frame numbers of the timecode. But they will be on the tape."	noFrames
navigate			
CD 53: CD id 27084	time code generator panel door opens	"Below the counter is a panel that controls the timecode generator."	TCControl
navigate			
CD 54: TCUbit		"Make sure the switch in the lower right of this panel is set to the TC, or TimeCode, position."	TCcode
action: switch TC			
	switch to TC	sfx: click	*click
navigate			
CD 55: setTCrun	animation: demonstration of counter in free-run mode	"If you put the RUN switch into Free-Run, the timecode will generate continuously, even when you are not recording."	FRun
		"We want the time code to advance only when recording -- what's called Record-Run. Set the RUN switch in the Record-Run position."	RRun
action: switch F-RUN			
	counter stops advancing	sfx: click	
navigate			
CD 56: setTCgen		"If you want to read timecode from a pre-recorded tape, the next switch needs to be in the Playback position."	tcPB
		"But we're recording, so we need to Generate timecode. Put the playback-or-generate switch in the GEN position."	tcGEN
action: switch GEN			
	switch to GEM	sfx: click	
navigate			

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 57: setTimeCode3		"In addition to recording timecode to an audio channel, the BVU-150 can record timecode in the Vertical Interval of the video signal."	aboutVITC
		"But Vertical Interval Time Code, or VITC, creates some playback problems on our edit systems. So turn the VITC switch OFF."	VITCoff
action: switch VITC			
	switch to OFF	sfx: click	
navigate			
CD 58: setTimeCode	animation: demonstration of setting time code hours and minutes	"When you start recording, timecode will be generated beginning with the number that you set here."	timeCodeStart
CD 59: setTimeCode2		"The hours digits of the timecode should always match the tape number. The tape that you loaded was labeled number five. "	HoursDigits1
		"So, set the hours digits to Zero, Five. Leave minutes and seconds at zero."	HoursDigits2
action: set HOURS,MINUTES			
	display set to 05:00:00	sfx: pushbutton	
navigate			
CD 60: RvwPowerUp		"You checked the charge on your battery, loaded a tape, and set the time code generator. Now you need to connect the audio and video cables."	RvwPowerUp
BG: VTRGuide			
CD 33: VTRhome			
navigate			
CD 34: VTRright	VTR moves to left of screen	"On the right side of the deck is a connector panel."	ConnectPanel
CD 35: VTRside	VTR rotates to show right side	Theme	
CD 36: VTRnaked	porta-pac case is removed		
BG: patch panel	zoom in to patch panel, full screen		
CD 85: patch panel intro			
navigate			
CD 85: patch panel intro		"This panel has input and output connectors for audio and video signals."	input intro1
CD 86: ppIntro2		"You'll need a tie-tac mic, with cable, for the person being interviewed..."	input intro 2
CD 87: MicDemo		"And you'll need a BNC to XLR adaptor cable to send a timecode signal into channel One."	input intro3
navigate			

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 88: camDemo			
CD 89: patch panel begin		"First, connect the tie-tac mic to the audio cable."	MictoCable
action: connect cable			
	cable connected to MIC	sfx: click	
navigate			
CD 90: ch2Mic		"Now connect this cable to the input for audio channel TWO."	toCH2
action: connect cable			
	cable connected to input	sfx: click	
navigate			
CD 91: ch2level		"Each channel has a switch to set the level of the input."	inputSwitches
		"Set the input level for channel two to MIC."	setInput
action: switch INPUT			
	switch to MIC	sfx: click	
navigate			
CD 92: ch1cable		"Now you have to patch the output of the timecode generator into channel One."	timecode1
		"The BVU-150 normally records timecode to a special third audio channel, called the address track."	timecode2
		"The decks at our editing stations can't read from this address track -- but they can read time code from audio channel one. "	timecode3
		"So you have to patch the output of the Time Code generator into audio channel one."	timecode4
		"Connect the adaptor cable from Time Code out to audio Channel One."	tcConnect
action: connect cable			
	BNC connected to TC OUT	sfx: click	
action: connect cable			
	XLR connected to ch 1 IN	sfx: click	
navigate			
CD 95: ch1connected		"Set the input level for channel 1 to LINE."	lineLevel
action: switch INPUT			
	switch to LINE	sfx: click	
navigate			
CD 96: DolbyOff		"A reminder -- audio recorded with Dolby noise reduction MUST be played back with Dolby. The playback decks in our edit suite DON'T HAVE Dolby."	DolbyWarning
		"So, make sure the Dolby switch is off."	DolbyOff

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
		.action: switch DOLBY	
	switch to OFF	sfx: click	
		navigate	
CD 97: addCam		"Now connect the camera cable."	ConnectCam
		action: connect cable	
	camera cable connected	sfx: click	
		navigate	
CD 98: CamCable		"The camera cable supplies video to the deck. It can also carry audio from a camera-mounted mic into audio channel two..."	CamPosition1
		" -- if the input switch is in the CAMERA position."	camPosition2
		"This switch only affects the CAMERA audio. If you are sending a camera-mounted MIC into audio channel two, you have to set this switch to match the output level of the camera audio."	camPosition3
		"But we need channel two for the Tie-Tac MIC. So switch the input back to MIC."	camPosition4
		action: switch INPUT	
	switch to MIC	sfx: click	
		navigate	
CD 99: RVWconnectors		"We're finished here for the moment. The microphone is in channel two,"	rvwMIC1
		"with the input level set to MIC..."	rvwMIC2
		"The output of the timecode generator is patched into channel 1, "	rvwTCline1
		"with the input level set to LINE..."	rvwTCline2
		"the dolby switch is off..."	rvwDolbyOff
		"and the camera cable is connected."	rvwCamera
		navigate	
CD 33: VTRhome	orienting transition back to control panel		
		navigate	
CD 61: setTCLevel		"Now you need to set the audio levels, starting with the timecode signal that you're sending into Audio Channel One."	setTClevel
		"Push in the RECORD button to open up the channels into the deck."	pushRecord
		action: push REC	
	ch 1 VU jumps up to maximum		
		navigate	

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 62: setTClevel2		"The timecode signal is way too hot. It should be between -5 db and -3 db."	tcHOT
		"Adjust the level for audio channel One to put the timecode signal midway between -5 and -3."	adjustTC
action: dial CH 1			
	needle adjusts to -4	sfx: dial	
navigate			
CD 63: checkVideo		"While you're still at the meter for channel One, check to see that the deck is getting a good VIDEO signal from the camera.	checkVideo
		"With the RECORD button still pushed in, put the METER SELECT switch in the VIDEO position."	meterVideo
action: switch METER			
	show expanded detail: VU meter with needle in mid of blue		
navigate			
CD 64: meterVideo		"The blue scale shows the strength of the video signal. With the needle here in the middle, you're getting a good signal."	goodVideo
	expanded detail: needle drops to lowest position	"If the needle falls off the scale like this, you're not getting any video into the deck. If the cable is connected, and the camera is fine, you may have a damaged camera cable."	badVideo
		"Go ahead and put the Meter Select switch back in the Channel 1 position."	backCH1
action: switch METER			
	lose detail; meter returns to audio monitoring		
navigate			
CD 65: setMIClevel		"Next, get a level on the mic in channel 2. You'll need an earphone or headphones."	getCH2Level
CD 66: addHeadphones		"Plug the Mini connector for your headphones into the earphone jack."	plugJack
action: connect cable			
CD 67: phonesConnected	headphone miniplug in jack	sfx: click	
		"What you're hearing is the timecode in channel One. Let's look at part of the connector panel from the side, and make some adjustments."	addConnectPanel

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
CD 68: adjustPanel		"The MONITOR switch and the EARPHONE LEVEL dial control what you hear through your headphones."	phoneControl
		"Put the MONITOR switch in the CH-2 position."	putCH2
action: switch MONITOR			
	switch to CH-2	sfx: click sfx: timecode sound stops	
navigate			
		"Now let's get a level on the mic. Your director will ask the person being interviewed to say a few words."	getLevel2
		"The level for Channel Two looks good -- peaking around zero db -- but your headphone level is faint."	goodLevel
		"Turn the EARPHONE LEVEL all the way up.	turnItUp
action: dial EAR LEVEL			
	dial TURNS to MAX	sfx: dial	
		"Let's hear it again."	hearAgain
		sfx: interview soundbite	
CD 69: ch2Levels		"The MONITOR switch and the EARPHONE LEVEL dial DO NOT affect what is being recorded."	noEffect
		"They only affect what you hear through your headphones."	affectAmonitor
navigate			
CD 70: rvwSetLevels		"Now you're ready to begin recording. You've got a good video signal..."	revLevels1
		"and good levels on the timecode in channel ONE and the MIC in channel TWO."	revLevels2
navigate			
CD 71: beginRecording		"So you can see what you're recording, we'll give you a portable monitor."	addMonitor
		"You won't always have a monitor when you're working in the field."	monitorWarning
navigate			
CD 72: recordBars		"You should always record at least 30 seconds of Color Bars at the head of a tape."	RecColorBars
		"And when you're recording an interview, it's also important to use this same thirty seconds to record "room noise" through the MIC in channel two."	recNoise
		"Your videographer will set the camera to generate color bars."	genBars

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
		"Now, with the RECORD button still in, press PLAY. The deck will automatically go into PAUSE."	standby–Command
action: push PLAY			
CD 73: ColorBars2		"Now press the PAUSE button to roll the tape."	RollCommand
action: press PAUSE			
		"There are three things you always have to look at when you roll tape."	3Things
		"First, check the counter to be sure tape is rolling."	tapeRolling
		"Second, be sure the RECORD indicator light is flashing to show that you are in RECORD and not PLAY mode."	checkREClite
		"And third, check your audio levels. The timecode in channel One is good."	rolling3a
		"and the flicker of the needle in Channel Two shows the room noise."	rolling3b
		"I'll pause the tape for you when you have 30 seconds of Bars."	pauseAt30
navigate			
CD 74: slate tape		"After recording bars, your videographer will probably want to record a slate to help the editor identify the scene later."	recSlate
		"When the deck is standing by in PLAY/RECORD/PAUSE, the videographer can roll tape from a pause button on the camera."	recSlate2
		"The videographer will count off about ten seconds of slate, and then pause the tape."	recSlate3
navigate			
CD 75: setLevel		"We'll stay in PAUSE here for a moment while the videographer gets the first shot ready."	pauseTilReady
		"Never STOP the tape unless the videographer tells you to. "	noStop
		"When you STOP tape, you create a break in the recorded material that can complicate things for the editor later on."	breakCTL
navigate			
CD 76: setLevel2		"Now everything's ready for the interview. The videographer will roll tape from the camera."	beginIntrvw
	pointer at tape counter	"Remember to check the counter..."	reminderA
	pointer at REC indicator light	"...the record indicator..."	reminderB
	pointer at VU meters	"...and your audio levels."	reminderC

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
		"The interview may be fascinating, put your attention has to be focused on this control panel and on the quality of the audio through your headphones."	reminder2
		navigate	
CD 77: rvwRecording		"That covers the basics for recording. There are a few other things to mention."	otherThings
	pointer at tape counter counter resets from 05: 00:30 to 05:19:53	"Let's jump ahead to near the end of this twenty-minute tape, still recording the interview with Dr. Wilson."	tapeEnd
		"With about two minutes of recording time left on a tape, a warning light starts to flash and your earphone will start to beep."	flashBeep
	TAPE END light flashes	sfx: alert tone	
	TAPE END light flashes	"Don't panic. The beeping in your headset is not being recorded."	noBeep
	TAPE END light flashes	sfx: alert tone	
	TAPE END light flashes	"And two minutes is usually plenty of time to finish up the shot."	nuffTime
	TAPE END light flashes pointer at tape counter	"The counter reading that says you have already shot about twenty minutes of tape is correct. Most tapes are about two minutes longer than it says on the label."	extra2
		navigate	
CD 78: lowBattery		"Let's pause here, and demonstrate another thing you need to be warned about."	battSaver1
	animation: finger pushes PAUSE button	sfx: tape pausing	
	pause button flashing	"When the charge on your battery drops to a certain point, the deck goes into a battery-saving mode whenever you pause the tape."	battSaver2
	VU meters repeatedly bounce from bottom to -3 db in time sync with PAUSE indicator	"The deck basically shuts down and opens up in time with the blinking of the pause light. As soon as you roll tape, everything returns to normal."	battSaver3
	animation: finger releases PAUSE	sfx: pause release and tape rolling	battSaver3
		navigate	
CD 79: BatteryAlert		"It may be awhile before your battery gives out completely. Just before it does, you'll get the beeping in your headphone and another flashing light."	battAlert1

Program Script for "Field Kit Workshop" (continued)

program location	screen image	audio	name of sound
	BATT light flashes	sfx: alert tone	
		"At this point you probably have less than a minute of battery power left."	battAlert2
navigate			
CD 80: beginEnd		"Despite this little demonstration, your battery is still in good shape."	tapeEnd1
	animation: finger switches METER SELECT to BATT VU Meter displays battery level finger switches METER SELECT back to CH 1.	sfx: click sfx: click	
		"But you have reached the end of the tape."	tapeEnd2
	animation: counter reaches 05:22:00, stops PLAY, REC, PAUSE lights off TAPE END light ON steady	sfx: stop tape	
navigate			
CD 81: noRewind	VTR control panel , status ON but stopped	"When you do reach the end of the tape, DON'T rewind it. There are three good reasons not to."	noRewind
	text overlay: "Tape Wear"	"First, on this deck REWIND is actually a high-speed search mode that can really abuse your tape if you rewind for the full length of the tape."	rewReason1
	text overlay: add "Battery Drain"	"Second, rewinding takes a lot of battery power. Save it.	rewReason2
	text overlay: add "Risk of Re-Recording"	"The third and best reason not to rewind the tape is to make sure that you don't accidentally record over it some time later during the shoot."	rewReason3
		"Push the Eject button."	ejectTape
action: push EJECT			
	button slides up and springs back	sfx: click	
	transport door opens	sfx: door opening	
navigate			
CD 82: resetTCcounter	VTR control panel with transport door open	"Push RESET to set the timecode generator back to zero."	resetTC
action: push RESET			
	display resets to 00:00:00:00	sfx: pushbutton	
CD 83: setforNext		"and set the hours digits to ZERO, SIX, for the next tape."	setNext
action: set HOURS			
	display set to 06:00:00	sfx: pushbutton	
END			

APPENDIX B

APPENDIX B

QUESTIONNAIRE FOR "FIELD KIT WORKSHOP"

The questionnaire on the following six pages was used to assess user response to speech, music and sound effects as applied in the hypermedia program, "Field Kit Workshop."

Items 5, 35, 38, 48 and 56 where crossed out on copies of the questionnaire provided to study participants because these items address content not included in the tested version of "Field Kit Workshop."

"FIELD KIT WORKSHOP"
a hypermedia study

This research project is designed to study the ways people use and can learn from hypermedia programming that combines detailed visual images with an audio environment of speech, sound effects and music.

As a participant in the project, you will be asked to use an experimental version of the hypermedia program, "Field Kit Workshop." The self-paced program provides an introduction to equipment used in on-location, professional video production, and takes 30 to 40 minutes to complete.

Choices you make within the program that relate to pacing and presentation of information will be automatically recorded to provide data for the study.

After using the program, you will be asked to complete a questionnaire (attached). The total time commitment for using the program and completing the questionnaire is not expected to be more than 1 hour.

Thank you very much for participating in this research project. It is hoped that this project will contribute to the development of improved teaching and training materials for use in the field of Media Arts and other areas. If you have any questions relating to your participation in the study, contact Bill Richards, 355-8009.

You indicate your voluntary agreement to participate as an anonymous subject in this study by completing and returning this questionnaire.

You are free to choose not to participate at any point, and can stop responding to questions at any time.

To assure confidentiality, as you begin the program "FIELD KIT WORKSHOP," you will be randomly assigned a number that will be used to link your questionnaire responses to your computer session.

PLEASE RECORD THAT NUMBER HERE:

___ ___ ___ ___

NEXT, RETURN THIS QUESTIONNAIRE TO THE ENVELOPE, AND CONTINUE USING THE PROGRAM, "FIELD KIT WORKSHOP."

AFTER YOU HAVE STOPPED USING THE PROGRAM, "FIELD KIT WORKSHOP," COMPLETE THE QUESTIONNAIRE AND RETURN IT IN THE ENVELOPE

Questionnaire (continued)

The program, "Field Kit Workshop," is an example of a hypermedia program. Hypermedia programs are basically defined by two characteristics:

the user of the program controls the presentation of information;

information can be presented through a wide variety of media, including text, pictures, video, animation, sound, or any combination of these.

1. Not including the program, "Field Kit Workshop," how many times have you used a hypermedia program to receive information, training or instruction? ______ times
2. Not including the program, "Field Kit Workshop," how many times have you used a hypermedia program which presented information through the medium of speech? .... ______ times
3. How experienced do you consider yourself in the operation of audio or video production equipment in general .... not experienced 1 2 3 4 5 very experienced
4. How experienced do you consider yourself in the operation of video field production equipment...... not experienced 1 2 3 4 5 very experienced
5. Have you ever used the model of camera (Ikegami ITC 730) demonstrated by this program? .... __YES __NO If yes, about how many times? ______
6. Have you ever used the model of Video Tape Recorder (Sony BVU-150) demonstrated by this program? .... __YES __NO If yes, about how many times? ______

Rate how strongly you agree or disagree with the statements made in questions 7 through 13, below.

7. The use of sound in this program seemed **natural**, and supported the visual and verbal information being presented. .... disagree 1 2 3 4 5 agree
8. The use of sound in this program seemed **unnatural**, and distracted me from the visual and verbal information being presented. .... disagree 1 2 3 4 5 agree
9. Overall, the use of **speech** in this program seemed **natural**, and was an effective way to receive instructions and information...... disagree 1 2 3 4 5 agree
10. Overall, the use of **speech** in this program seemed **unnatural**, and made it difficult to receive instructions and information. .... disagree 1 2 3 4 5 agree
11. This program would be improved if the "instructor" spoke more slowly. .... disagree 1 2 3 4 5 agree
12. This program would be improved if the "instructor" spoke more rapidly. .... disagree 1 2 3 4 5 agree
13. This program would be improved if there were a variety of speakers throughout the program. .... disagree 1 2 3 4 5 agree

Questionnaire (continued)

14. Put a check next to any item(s) below that describe the way you responded to the presence of text and speech in the program, "Field Kit Workshop." You can check more than one.

- __ Although I often displayed the TEXT WINDOW, I only referred to it occasionally.
- __ Even with SPEECH, I depended mostly on the TEXTWINDOW for information
- __ Displaying the TEXT WINDOW helped me avoid having to use the REPEAT feature.
- __ With the TEXT WINDOW displayed, I sometimes missed details presented in visual images and animated sequences.
- __ I did not use the TEXT WINDOW.

15. The times when you asked for a repeat of a segment, how often was it because you had **forgotten** part of what had been spoken? .... never 1 2 3 4 5 always

16. The times when you asked for a repeat of a segment, how often was it because you **did not understand** part of what had been spoken? .... never 1 2 3 4 5 always

17. The times when you asked for a repeat of a segment, how often was it because you wanted to review the **visual information** presented? .... never 1 2 3 4 5 always

18. Overall, how easy was it to learn from this program? .... very difficult 1 2 3 4 5 very easy

19. How easy was it to move forward or backward through the information presented in this program? .... very difficult 1 2 3 4 5 very easy

20. How easy was it to operate controls, like switches and dials? very difficult 1 2 3 4 5 very easy

21. How easy was it to understand written instructions? .... very difficult 1 2 3 4 5 very easy

22. How easy was it to understand spoken instructions? .... very difficult 1 2 3 4 5 very easy

23. Give an OVERALL rating for how easy this program was to use. .... very difficult 1 2 3 4 5 very easy

24. How much did you enjoy using this program? .... none 1 2 3 4 5 very much

25. How much did the quality of the **visuals** enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

26. How much did the use of **realistic sound effects** enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

27. How much did the **use of speech** enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

28. How much did the **use of text** enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

29. How much did the **use of music** enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

30. How much did the **option to choose** Speech, or Text & Speech enhance your level of enjoyment of the program? .... none 1 2 3 4 5 very much

Questionnaire (continued)

4

31. Which of the following methods of instruction/training would you prefer in receiving your **first introduction** to a new piece of production equipment.

    A. Attend a small-group demonstration session (no hands-on) conducted by an experienced operator.

    B. Use a hypermedia program that demonstrates the equipment

32. Which of the following methods of instruction/training would you prefer in receiving your **first introduction** to a new piece of production equipment.

    A. Read equipment manufacturer's Operating Manual.

    B. Use a hypermedia program that demonstrates the equipment

33. Which of the following methods of instruction/training would you prefer in receiving your **first introduction** to a new piece of production equipment.

    A. View a videotaped demonstration of the equipment

    B. Use a hypermedia program that demonstrates the equipment

34. After using the program, "Field Kit Workshop," how confident are you that you have a **basic** understanding of how to operate the Sony BVU-150 videotape recorder (VTR)? .... not confident 1 2 3 4 5 very confident

35. After using the program, "Field Kit Workshop," how confident are you that you have a **basic** understanding of how to operate the Ikegami camera ? .... not confident 1 2 3 4 5 very confident

36. How strongly do you agree or disagree with this statement: Programs similar to "Field Kit Workshop" should be developed for introducing students to the operation of other audio and video production equipment. .... disagree 1 2 3 4 5 agree

Questionnaire (continued)

37. Put a check mark by each content area where you feel you learned something new about using a professional-grade Video Tape Recorder:

- __ Using VU Meter to check battery charge and video signal
- __ Loading and labeling a videotape
- __ Setting the timecode generator
- __ Recording timecode
- __ setting MIC/LINE audio input levels
- __ Dolby Noise Reduction
- __ setting gain levels for Audio channels (VU meters)
- __ Monitoring audio with headsets
- __ Operating the transport controls (PLAY, REC, FFW, etc.)
- __ Alert lights and tone
- __ Responibilities during recording
- __ Other (specify) ______________________________
____

38. Put a check mark by each content area where you feel you learned something new about using a professional-grade Video Camera:

- __ Using battery power
- __ Standby vs. Operate modes
- __ white-balancing the camera
- __ Filter wheel selection
- __ operating the electronic zoom lens
- __ zooming the lens manually
- __ focusing the lens
- __ Other (specify) ______________________________
____

39. How much benefit do you think you would receive from using the program, "Field Kit Workshop," a second time? .... none 1 2 3 4 5 very much

40. How much benefit do you think you would receive from having the program, "Field Kit Workshop," readily available for repeated use? .... none 1 2 3 4 5 very much

Questionnaire (continued)

The attached pages show screen images from the program, "Field Kit Workshop." Rank them below according to **how complex** you felt each was **as it appeared in the program**

41.	Figure A: Field Kit Introduction	not complex	1	2	3	4	5	very complex
42.	Figure B: VIDEO TAPE RECORDER (VTR)	not complex	1	2	3	4	5	very complex
43.	Figure C: VTR with Connector Panel Overlay	not complex	1	2	3	4	5	very complex
44.	Figure D: VTR with Monitor (slate)	not complex	1	2	3	4	5	very complex
45.	Figure E: VTR with Time Code Generator	not complex	1	2	3	4	5	very complex
46.	Figure F: VTR with Video Meter Overlay	not complex	1	2	3	4	5	very complex
47.	Figure G: VTR Connector Panel	not complex	1	2	3	4	5	very complex
48.	Figure H: Camera Operation	not complex	1	2	3	4	5	very complex

Referring to the same pages, rank these images according to **how attractive** you felt each was **as it appeared in the program**.

49.	Figure A: Field Kit Introduction	not attractive	1	2	3	4	5	very attractive
50.	Figure B: VIDEO TAPE RECORDER (VTR)	not attractive	1	2	3	4	5	very attractive
51.	Figure C: VTR with Connector Panel Overlay	not attractive	1	2	3	4	5	very attractive
52.	Figure D: VTR with Monitor (slate)	not attractive	1	2	3	4	5	very attractive
53.	Figure E: VTR with Time Code Generator	not attractive	1	2	3	4	5	very attractive
54.	Figure F: VTR with Video Meter Overlay	not attractive	1	2	3	4	5	very attractive
55.	Figure G: VTR Connector Panel	not attractive	1	2	3	4	5	very attractive
56.	Figure H: Camera Operation	not attractive	1	2	3	4	5	very attractive

If you have any comments on this program that you'd like to pass along, write them here:

When you have finished, return this questionnaire to the envelope, and put the envelope in the box.

Thanks for your help with this project.

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