Training Interactive Videodisc Designers

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Abstract. This article describes a model for training instructional designers who will work as members of a videodisc development team. The model develops and integrates a complex set of skills that range from planning and design to programming and production. Its purpose is to train designers who can envision the many facets of disc development—designers who can converse intelligently, creatively, and efficiently with other specialists. The model is implemented, over a 15-week period, through a sequence of intense and highly coordinated activities. These build rapidly from relatively simple tasks that omit many aspects of disc development to a complex collaborative undertaking that includes, in simplified form, all of the major elements involved in creating a disc from scratch.

Introduction

There may be a shortage of videodisc designers on the horizon. Miller and Sayers (1985) forecast that by 1990, the installed base of videodisc players used in education and training could exceed 124,000. They project that about 65% of all videodiscs will be educational or instructional. Several hundred companies now design. and produce videodiscs.

A rough estimate of the future demand for instructional videodisc designers can be derived as follows: Assume that total production expenditures will exceed $1.5 billion (Miller & Sayers, 1985) and that 15% of these costs are for instructional design; if 80% of design costs are allocated to salaries and benefits for instructional designers (at an average of $40,000 per designer, including benefits), the number of designers required would exceed 4,000.

We may already face a shortage of trained disc designers. Industry experience is currently limited to a small cadre of self-taught experts who paid their dues as pioneers. Thus, disc design is an expensive trial-and-error process in many organizations. It is characterized by conceptual backing and filling; it is not particularly efficient; it does not exploit the real power of the technology; and the industry produces only a small trickle of quality products.

The long, pioneering phase of interactive video is coming to an end. During this innovative period, designers acquired their knowledge primarily by participating in various research and design projects and small-scale commercial projects. Training was informal, dominated by collegial exchanges and mentorships. Using the technology in an orderly and efficient manner now requires a more systematic and formal approach.

How can we train good disc designers? What skills should they possess? To put these questions differently, what would a formal training program look like? This article describes a model for training instructional designers who will work on videodisc development teams—a model that could be adapted to a variety of educational and industrial organizations.

Based on a course offered by the San Diego State University Educational Technology Program as part of its master's degree curriculum, the model has been developed over a four-year period. The model is not designed to train production specialists or computer programmers. Rather, it aims is to train students who can function as instructional designers on a videodisc development team.

General Description of the Model

DeBloois (1982) argues that computer-based interactive video instruction (CBIVI) is not merely a combination of previously existing media delivery systems, but a new medium with unique properties. DeBloois also contends that effective use of interactive video technology requires a radical reconceptualization of the way we design and produce instructional products. Therefore, competent design of interactive video instruction requires a new synthesis of diverse skills.

CBIVI development requires efficient coordination of many specialists. An instructional designer is only one member of a team that may include project managers, subject-matter experts, writers, actors, directors, video production specialists, video editors, computer programmers, and representatives of disc mastering facilities.

This model is not intended to teach students to be fully competent in any of the other specialties. Yet it allows students to become aware of the problems faced by other team members, even as they master skills specifically associated with design. It assumes that competence in designing discs requires the ability to converse with other team members and to assist them with their roles when necessary. The model represents these competencies as seven skill strands. They are:

- Instructional design
- Project management
- Interpersonal skills
- Storyboarding and flowcharting
- Computer programming
- Video production
- CBIVI systems knowledge.

Prerequisite Skills

Before taking the interactive video course, students should have completed

SKILL STRAND	DESIGN	MANAGEMENT			DEVELOPMENT		
		Interpersonal Skills	Project Management	Flowcharts, Storyboards	CBIV Capabilities	Computer Programming	Video Production
EXIT COMPETENCIES	Apply theories and principles of human learning and instructional systems design to selection of and development of CBIV systems. Develop instructional strategies appropriate to CBIV.	Communicate effectively with clients and other specialists about ideas, plans, tasks, responsibilities. Lead and motivate. Adjust personal strengths and limitations to those of other team members.	Allocate time and resources to project tasks. Monitor and control project activities. Understand roles and functions of other specialists. Manage personal time.	Transform instructional strategies into algorithms. Represent algorithms in flowchart form using standard conventions. Represent instructional messages in storyboard form.	Know strengths and limitations of available CBIV systems for the delivery of instructional products. Know how CBIV systems can be used to control and represent instructional messages.	Use a language or authoring system to transform instructional algorithms and messages (represented by flowcharts and storyboards) into appropriate computer displays and programs.	Transform instructional messages represented on storyboards into appropriate audiovisual displays. Manage logistics of studio shoots and post-production activity. Edit video footage.
Project 1 Develop a simple Level 2 program	Critique examples of commercially available discs for instructional effectiveness. Design a display to elicit response from a viewer.	Individual project. Work informally with a partner to proof each other's flowcharts and to check manual entry of code into player's onboard computer. Minimal supervision from instructors.	Two-week duration. Single deadline. No formal management structure.	Use standard flowchart conventions to represent a Level 2 program.	Understand procedures for entering Level 2 programs into onboard microprocessor. Understand how disc control capabilities are represented in Level 2 program dumps.	Convert flowchart into Level 2 code. Enter code into videodisc player's on-board microprocessor. Debug and run program.	Dub sample run-through of Level 2 program onto videotape.
Project 2 Interactivate existing linear video	Analyze linear video on commercially available disc. Evaluate existing instructional strategies. Design new instructional components to improve instructional effectiveness.	Two-person teams work on different modules; one person strong in programming, the other strong in instructional design. Two student managers coordinate team efforts to ensure consistent designs.	Four-week duration. Use simple Gannt chart.	Develop flowcharts to represent instructional algorithms. Then create detailed message designs in storyboard form (no new video or audio). Validate, cross-reference flowcharts, storyboards.	Know how capabilities of external computer can be integrated with those of Level 3 players. Understand how commands for controlling disc are embedded in computer programs.	Transform flowcharts and storyboards into Level 3 computer program using subroutines and shells. Construct computer text and graphic displays which can be overlayed on videodisc images.	Analyze cinematic structure of existing linear video (shots, camera angle, scenes, narration, music, etc.)
Project 3 Create an interactive videodisc from scratch	Develop instruction to teach procedures and trouble-shooting. Analyze task, establish objectives, design instructional strategies. Conduct formative evaluation.	Four separate teams, each with specialized roles: designer, programmer, video producer. Six coordinators manage team efforts. Interaction with numerous groups and individuals.	Six week duration with multiple deadlines. Use PERT charts for tasking, budgeting, and monitoring progress.	Develop flowcharts to represent instructional algorithms. Create detailed message designs in storyboard form, specifying original video and audio components.	Understand basics of disc mastering process. Understand basic requirements for acceptance of video material by videodisc mastering plant.	Write specialized subroutines for controlling disc player and for overlaying computer text and graphics on video source. Configure and position overlays in concert with video producers.	Direct a two-camera iso-production emphasizing voice-over narration rather than live sound. Configure and position overlays in concert with programmers.

Figure 1. Model for Training Interactive Videodisc Designers.

This model develops and integrates seven skill strands. As students progress through the three projects, the skills represented by each strand become more complex and the strands become more interdependent.

a minimum of two semesters of computer applications, two semesters of instructional design, one semester of video production, and a semester of basic audiovisual production. In addition, some students will have taken courses in project management, case studies in instructional design, computer simulation and games, educational research and evaluation techniques. For most students in the program the interactive video course is a culminating experience because it requires them to integrate all the skills they have acquired in previous coursework.

The model is designed to train students to function as instructional designers on a videodisc development team.

Competencies

Here are some of the competencies which the model attempts to teach:

Algorithm Design

Developing disc control programs requires that designers represent instructional strategies as algorithms. Optimal use of CBIVI capabilities presupposes modular designs (DeBloois, 1982); instructional messages are linked in different patterns depending on the needs and requirements of the individual learner. Efficient construction of algorithms requires that designers lay out the flow of an algorithm as a sequence of instructional strategy components. Furthermore, designers must conceptualize the *function* of each component message within the strategy.

Message Design

Capacity for user interaction is the most widely acknowledged feature of interactive video systems, but the salience of this feature belies other extremely important capabilities. CBIVI systems encompass a variety of representational capabilities. Sophisticated systems permit independent control of at least seven subsystems: computer-generated text and graphics, video, audio tracks 1 and 2, keyboard input, and specialized input devices such as a touchscreen or mouse. Computer text can be added or subtracted from a video display, and audio track 1 can be alternated with audio track 2.

Seven independent subsystems for representing information to learners results in $7! = 5040$ possible combinations or configurations of delivery channels. Therefore, competent designers should be able to create instructional messages that are constructed as layers of independent components represented by the various subsystems.

Flowcharting and Storyboarding

The complexity of CBIVI requires that designers represent algorithms as flowcharts which they can cross-reference with storyboards, which in turn serve primarily to represent message detail. Flowcharts and storyboards are not only tools for the individual designers, but also serve as a vehicle for communication with other team members. Designers must, therefore, adhere to (and create when necessary) flowcharting conventions that can do the following: represent the logic of instructional algorithms, designate media subsystems, and describe the instructional functions of message components.

Project Management

As Glasgow and Edmondson (1985) note, "The success or failure of an ISD (instructional systems design) project often depends on the actions of the people managing it. Any manager who embarks upon an ISD effort to develop interactive videodisc training better have highly-developed management skills to bring off a successful product (p. 23)." Project management techniques help ensure efficient development. It is not uncommon for disc designers to develop specifications that substantially exceed available project resources. In addition, optimal scheduling of CBIVI projects involves parallel development activities undertaken by separate teams. Thus, the model provides training in the use of Gannt and PERT charts to allocate project resources and to monitor and control progress.

Interpersonal Communication Skills

Successful orchestration of team activities requires that designers be able to communicate with other team members about plans, roles and functions. They must be able to do the following: give and accept criticism, adjust to and negotiate differences with others, adapt to strengths and limitations of others, and assume leadership roles when necessary. The model does not attempt to teach the kind of interpersonal wisdom that requires years of learning; yet it provides numerous opportunities to experience the differences in interest, skill and perception that result from specialization. More importantly, it gives students a chance to refine previously acquired interpersonal skills with instructor guidance in the context of specific problems that typify CBIVI development.

CBIVI Capabilities

The development of interactive video technology has been tumultuous and is only now making strides towards standardization of equipment and software. The model provides for exposure to a range of equipment and emphasises potentials and limitations for delivery of instruction. Course content focuses on how CBIVI can be used to control and represent instructional messages.

Computer Programming

Students use BASIC to transform instructional algorithms (represented by flowcharts and storyboards) into computer displays and a program that controls videodisc functions. Students who take this course are already familiar with BASIC. However, since the projects focus on instructional design, programming is not emphasized. Instead, students use subroutines developed by the instructors and draw on a library of program shells created by former students. Students who are especially well versed in BASIC develop new or unusual programs when necessary.

Video Production

All students taking the course have had at least one semester of television production; the course usually contains one or two students who possess undergraduate degrees in telecommunications. Introductory projects rely exclusively on existing videodisc material. Only the final project requires original video production. Options for this project are deliberately constrained to reduce complexity and save time.

Projects

Course activities revolve around three major projects of increasing difficulty. As the students progress through the projects, the skills represented by each strand become more complex; the strands also become more interdependent.

In the first project, individual students develop a simple Level 2 program that controls playback of an existing commercial disc. For the second project, students work in pairs to develop software for an external computer linked to a disc player. These programs incorporate computer-generated text and graphics but rely on an existing commercial disc for video content. For the third project, the entire class produces a complete videodisc from start to finish.

Project I

Project I does not deal with instructional design issues; the focus is on controlling the disc player and on systematic documentation. Students are introduced to videodisc capabilities, videodisc programming logic, and flowcharting conventions. Students use standardized template symbols to identify motion sequences, still frames, step frames, and decisions made by the learner or the control program. They also use a standardized system for numbering video or computer segments. Flowcharting conventions are adapted from those developed by Sony Corporation and Pioneer Video, Inc., for Level 2 program dumps.

Designing a Control Program

Before the project begins, students review the differences between Level 1 and Level 2 systems (see authors note) and they critique the effectiveness of representative instructional discs. With this background, each student designs a program to demonstrate important functions of a videodisc player: still frame, step forward, search, alternate use of audio tracks 1 and 2, user input and branching. Each student selects a short section of an existing disc and develops a simple flowchart to represent the control program. The student then converts the flowchart into a series of Level 2 commands that are laid out on codesheets. Working informally with a partner, each student verifies the logic of the code and enters it into the videodisc player's onboard computer using a remote control unit. The program is debugged and a sample run through is recorded on a VHS videotape.

Deliverables

Project I provides an introduction to the capabilities of disc players; students are advised to focus on the player's capabilities and to de-emphasize message design issues. However, they are required to design a hypothetical single still frame that would request user input and to use this information to execute a simple program-branch. Deliverables for Project I include: a flowchart with appropriate designators, a program codesheet, and a sample run through. Criteria used to evaluate Project I include: use of all the player's capabilities, accuracy of the flowchart, and match between flowchart and code.

Project II

The second project extends knowledge acquired by students in previous instructional design courses to videodisc systems. The goal is to "interactivate" a short linear segment of video instruction using the capabilities of a Level 3 videodisc system.

Designers must be able to negotiate differences with others and assume leadership roles when necessary.

Interactivation

Allen (1986) defines interactivation as "a process in which linear, fixed-pace media (including audiotapes, videotapes, and films) are transformed so as to allow the selection, pacing and sequencing of messages to be based on the responses of the learner" (p. 102). Project II allows students to extend their instructional design skills to interactive video without requiring that they develop original video footage.

Students work in teams of two. The original video material consists of excerpts from a commercially produced video disc on 35-mm photography, *The Creative Camera* (Holzmann & Benz, 1981). This disc uses the constant angular velocity (CAV) format. In theory, CAV discs support true interactive designs. However, the organization of *The Creative Camera* is linear. The information is also extremely dense; it is not uncommon for a one-minute segment to present two or three new concepts or a complex procedure. Audio track 1 contains introductory narration, while audio track 2 presents advanced information for more experienced photographers. The high information density of this videodisc makes it especially appropriate for an interactivation exercise.

Project II requires extensive collaborative use of the tools and conventions introduced in Project I. Students employ a 15-step model for interactivating the videodisc (Allen, 1986). The model contains three stages: (a) specifying outcomes, (b) analyzing and designing instructional strategies, and (c) producing new components.

Analysis of Existing Video

Stage One requires students to determine the instructional goals and objectives of the video and to specify additional objectives if necessary. In Stage Two, they subject the continuous structure of the linear video to a detailed four-phase analysis.

Students log four separate phases or structures against an absolute time scale, measured in seconds and in disc frame numbers. They analyze video cinematic structure as a set of components (e.g., scenes, shots and camera angles). They analyze audio cinematic structure in terms of music, narration, dialogue, and field sounds, etc. The other two phases of the analysis are concerned with the instructional function of audiovisual representations. Video and audio channels are each assumed to carry a sequence of more or less discrete instructional messages; each message is seen as a component in an overall instructional strategy. Merrill's (1983) component display theory (CDT) provides a set of descriptors for identifying these components and for describing their relationship. As modified by one of the authors (Allen) for use in the four-phase analysis, CDT provides about 40 descriptors ranging from "motivator" and "expository generality" to "directions" and "learning strategy."

The four-phase analysis helps students to catalogue existing pictorial and audio representations, to determine the structure and function of the existing instructional strategies, and to locate points where the continuous structure of the tape can be interrupted without damaging cinematic continuity. The four-phase analysis also provides students with a basis for deciding how additional components might enhance the existing instruction or adapt it to new purposes. The students must consider the extent and nature of the learners' interaction with the program; when to use still frame and when to use motion; what additional graphics are appropriate; and what kind of feedback and remediation could or should be added.

Algorithm Development

Once the four-phase analysis is complete, students develop a flowchart that incorporates existing video as part of an instructional algorithm. Flowcharts for Project II are more complex than those in Project I since they include computer-generated text and graphics. Flowchart symbols representing instructional components include a brief content description and a CDT descriptor that explains the function of the component within the instructional algorithm/strategy (see Figure 2).

Flowcharts serve as instruments for communication among team members. They permit preliminary evaluation of instructional strategies and verification of program logic during informal reviews within the team as well as with other teams.

Message Design

The next step is to develop the instructional messages in more complete detail. A storyboard frame is developed for each message contained in the algorithm. A standardized storyboard form (see Figure 3) includes space for describing video, audio, and computer displays; for indicating programming branches; and for specifying subroutines. Frames are cross-referenced to corresponding flowchart symbols. Since Project II relies on existing video, un-

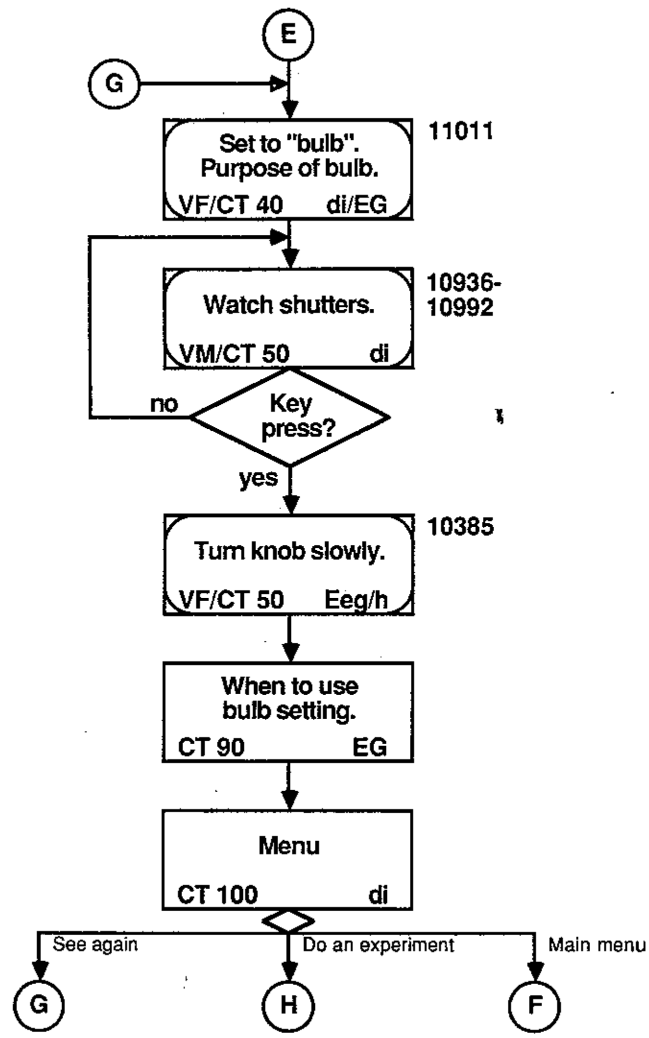

Figure 2. Portion of a flowchart used to interactivate an existing linear video presentation on 35-mm photography.

Flowchart symbols contain a designator (lower left corner) that denotes the form in which a message will be represented, e.g., VM=video motion, VF=video freeze, CT=computer text, etc. (Each flowchart designator is cross-referenced to a storyboard form. See Figure 3.) Notation modified from Merrill (1983) describes the instructional function of the message, e.g., EG=Expository generality, Eeg=Expository instance, Eeg/h=Expository instance with help, di=Directions. Flowchart symbols also contain a brief description of content. A rectangle with squared corners specifies that messages will be generated by computer; a rectangle with rounded corners indicates that source of message will be videodisc. Combined use of both forms specifies that computer text and/or graphics will be superimposed over video source. Based on a student project by J. Duffield and M. Weiner.

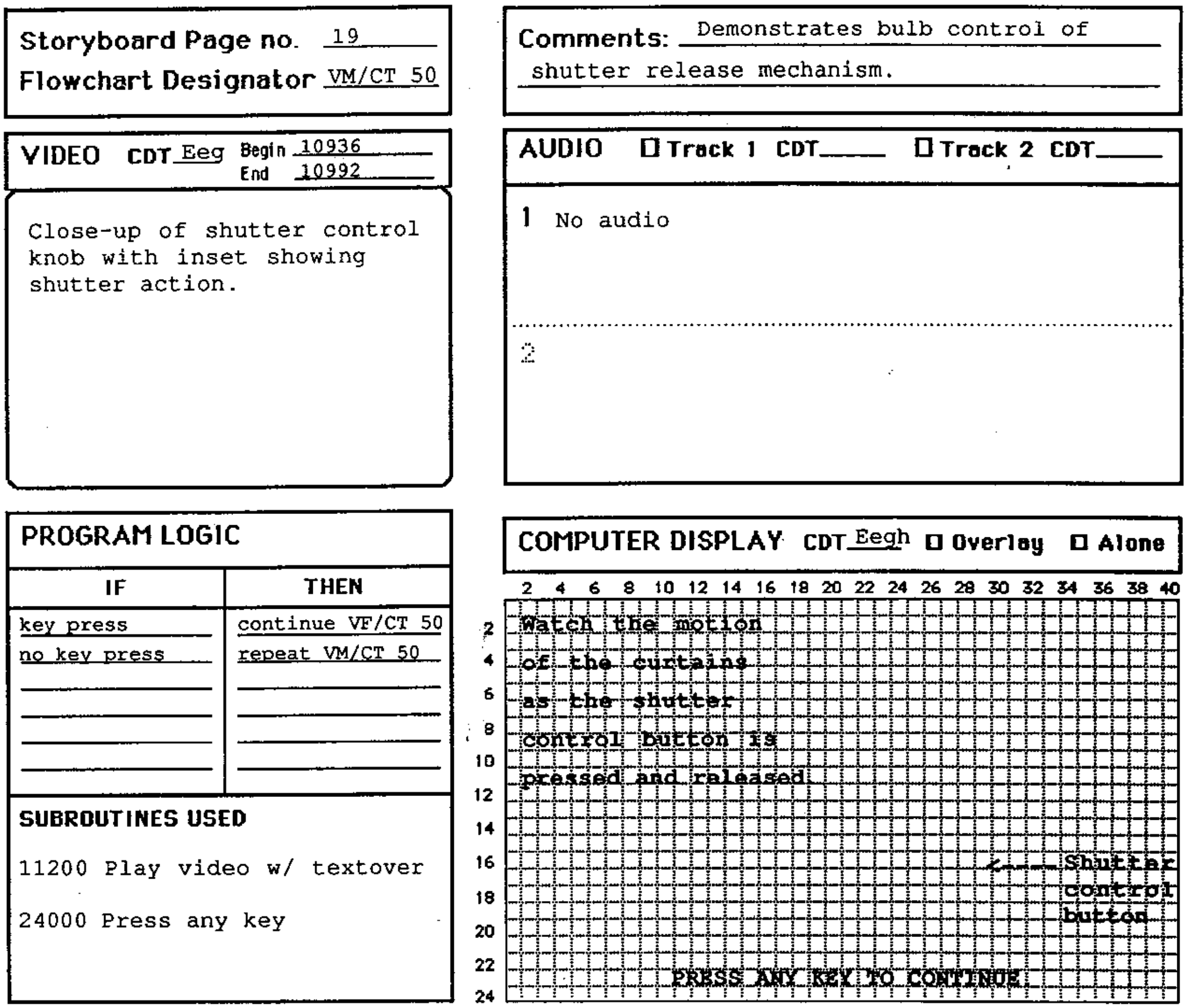

Figure 3. Storyboard form.

This device is used to specify detailed message design. The form is divided into sections for video, audio, and computer text/graphics since a given message may involve a combination of representations. A component display theory (Merrill, 1983) descriptor accompanies each representation. The form is cross-referenced to the flowchart through its own designator (upper left) and through conditional branching statements contained under "Program Logic."

modified video segments and audio content are transferred to storyboards.

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Project Management

A coordinating instructional designer monitors the early phases of development to ensure consistency in screen formatting. A coordinating programmer conducts a parallel effort to ensure that variables and subroutines are used consistently by separate teams. The coordinating programmer also works with the instructors as necessary to develop new subroutines and program shells. When team efforts are completed, the coordinating programmer links each program to a main menu and record keeping system. Teams and coordinators use a simple Gannt chart to monitor progress and to ensure adherence to deadlines.

In the final phase of Project II, students develop computer code to control the disc player and to drive text and graphic displays. Working with a library of shells and subroutines developed by the instructors and other students, they write and debug programs in BASIC.

Deliverables

Deliverables for Project II include the following: goals and objectives for the interactivated video, a four-phase analysis of the videodisc segment, a narrative description of the instructional strategy, flowcharts and storyboards, computer code, and computer diskette.

The entire class critiques each team's final product. The lessons developed in

Project II from *The Creative Camera* videodisc are used to teach students basic 35-mm camera skills in an introductory audiovisual course. A menu allows learners to select different modules. The program keeps a record of each student's performance.

Project III

In the third project, videodisc development is a team effort. No individual student is expected to have the expertise or the time to accomplish this project alone. Just as all seven skill strands (see Figure 1) overlap and intertwine in earlier projects, so do the responsibilities of the team members overlap and intertwine in the third project.

Scope

Projects I and II build a framework for creating and communicating CBIVI designs. They introduce students to a systematic development process. They also establish—through small teams and class critiques—a collegial environment in which CDT notation, flowcharts, storyboards and other tools become vehicles for resolving conflicts. Project III is far more complex and demanding than its predecessors. It involves a team of over twenty people and requires development of a complete Level 3 disc from start to finish in eight weeks.

The instructors determine the general concept for the production, which is usually centered on procedural skills. They solicit informal support from a local company or agency in the form of subject-matter expertise and equipment. Past projects have resulted in discs to teach simple medical procedures to Navy medical corpsmen and food preparation techniques to restaurant workers.

Management

The class is divided into four module-development teams. Each module deals with a different aspect of procedural content: (a) parts, functions, and principles of operation; (b) demonstration of the procedure; (c) remediation of common errors; and (d) guided practice. Module team members assume roles as instructional designers, computer programmers, or video producers. Team efforts are managed by coordinating designers, coordinating programmers, and coordinating video producers.

MacProject (Willrett & Young, 1984), a computer-based project planning tool, is used to coordinate the project. Project III is broken into about 30 separate sub-

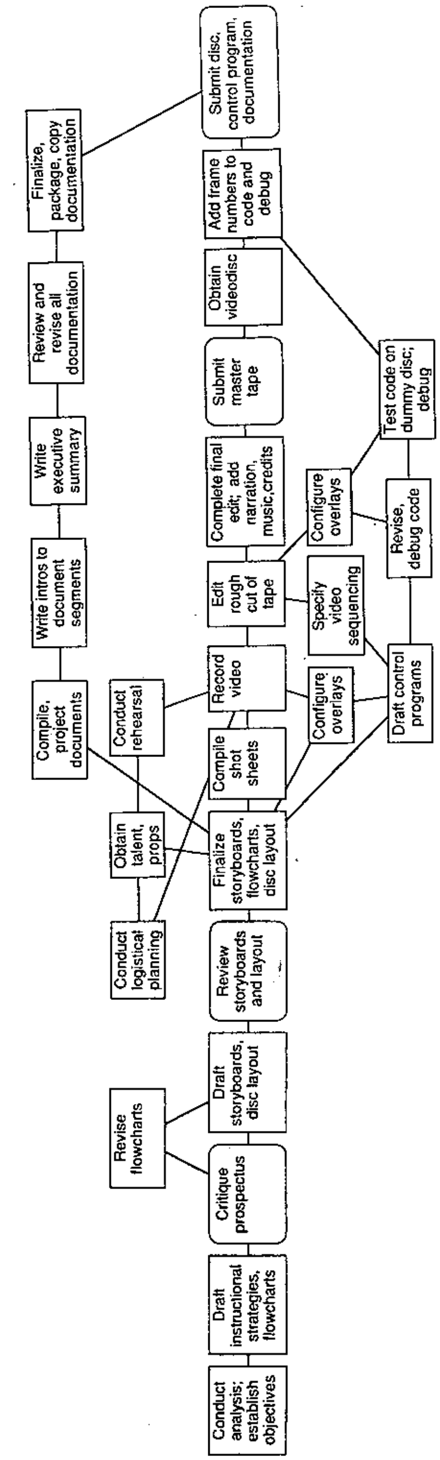

Figure 4. PERT (Program Evaluation and Review Technique) chart for Project III.

This analysis is generated by *MacProject* (Willert and Young, 1984) and consists of 29 tasks conducted over an eight-week period.

tasks (see Figure 4). These subtasks are often collaborative efforts involving as many as six individuals. Students spend about 50 hours on the project; distribution of workloads during the eight-week period depends on the role assumed by the individual. Certain tasks on the critical path, such as video editing, may generate peak loads of 20 hours in one week.

Analysis

The initial phases of Project III focus on analysis of the instructional problem. Working with a subject-matter expert, the coordinating instructional designers perform a task analysis of the procedure. They also analyze the target population's age, educational background, subject-matter knowledge, attitudes, and motivation. They then base instructional goals and objectives on this information.

Design

Coordinating designers and module designers develop instructional strategies and represent strategies as algorithms. The algorithms are evaluated by the entire class. This is a critical step in terms of disc development and student experience. Designers often develop specifications that exceed the resources and capabilities of programmers and producers. A rigorous critique at this stage ensures that all "specialists" have a chance to express reservations and doubts about the soundness and feasibility of the designs. Properly managed class discussions serve not only to negotiate differences, but to build consensus.

Once the flowcharts have been revised, the instructional designers develop detailed storyboards. They then write simple, conversational-style scripts for the video segments. Coordinating instructional designers, producers, and programmers then meet with module designers and instructors to review the storyboards. Coordinating designers, programmers, and producers make final revisions and freeze the design.

Production and Programming

The coordinating producers, in conjunction with the instructors, now begin planning the logistics of the video shoot. They organize actors, scenery and props, and schedule rehearsal time. Module producers develop shot sheets, and coordinate their efforts to eliminate duplicate shots.

Meanwhile, programmers begin drafting the computer code. Since flowcharts and storyboards provide detailed specifications, programming is relatively independent of other project activities. With the help of the instructors, coordinating programmers develop specialized subroutines for controlling the disc player and for superimposing computer text and graphics onto videodisc images. Copies of the subroutines are supplied to each module programmer. Team programmers meet to help revise and debug each others' code. Programs are tested and debugged using a "dummy disc." Any standard optical laser disc can serve this function. The primary concern is to ensure that the program generates computer text and graphics as specified and that it controls the disc player properly.

Post-production

The coordinating programmers review the completed computer code and determine the precise order in which video segments must be laid out on the finished videodisc. (Unlike conventional linear videotapes, the sequencing of segments must be optimized to reduce access time during frame searches.) They relay the tape-sequencing specifications to the coordinating producers for use during editing sessions. The coordinating producers and programmers also work together to configure computer text and graphic overlays. This is a joint effort since it involves positioning of actors and props during the video shoot as well as placement of computer-generated screen displays.

Module producers are responsible for videotaping, editing, and post-production. Production techniques are deliberately constrained; shooting is usually completed in a single day. The procedure is shot as a table-top demonstration. Voice-over narration is used in lieu of live sound whenever possible and two cameras shoot all scenes simultaneously. The tape is edited in conformity with storyboards and specifications of coordinating programmers. Music and narration are dubbed and the final tape is sent to a disc mastering facility for conversion to disc.

Disc Production

The final phase of the project awaits production of the videodisc. Since the disc is not intended for commercial distribution, low-cost production technologies are used. One option is a 30-minute/54,000 frame DRAW (Direct Read After Write) disc available from several disc-oriented post-production services. A single copy costs about $300. DRAW discs have a limited life span, are not as durable as commercial discs, and the video image quality is poor.

A second option, the Lasermaster, is available from Laservideo Inc. of Chicago. This proprietary process is suitable for small runs. As with DRAW technology, each disc is mastered separately in real time. However, the Lasermaster process yields a durable disc with an indefinitely long life span, and high video image quality. The cost for one 15 minute/25,000 frame disc is about $600.

Program Completion

When the disc is received, frame numbers for all critical segments are logged on flowcharts and storyboard forms. Frame numbers are then inserted into the control program code by module programmers, who replace frame numbers used with the dummy disc. Module programmers test the separate module programs again and adjust the configuration of any text or graphic overlays to the actual videodisc images. They then link the separate module programs to a master menu/record keeping system and test the entire program again.

Documentation

One incentive for the high level of involvement and commitment required by Project III is the value that it adds to a student's portfolio. Students are encouraged to make videotape copies of a sample run through of the final CBIVI program. Project documentation is also important as portfolio material. Students use this documentation in their portfolios because it gives future

> Although this model was designed for a specific audience, a number of its features will be useful to others engaged in training designers of CBIV products.

employers a summary of their CBIVI design experience. It is also used by students as a reference on future projects.

Two students assigned the role of writers compile and polish storyboards and flowcharts, write introductions for the documentation, and compose the executive summary. Coordinators meet with the writers to review and revise the project documentation and to ensure that it corresponds with the completed master videotape and computer code. At this point the documentation is finalized for printing.

Deliverables

Project III deliverables include an executive summary of the project, an analysis of the subject matter and the target audience, instructional objectives, narrative descriptions of proposed instructional strategies and lessons, flowcharts and storyboards, computer code, videodisc, and computer diskette.

Evaluation is based on the quality of instructional strategies, accuracy of flowcharts and storyboards, clarity and layout of text and graphics, and, use of interactive capabilities. The production quality of the video, audio and graphics as well as the accuracy of the computer code is also assessed. Assessment of individual student performance is based on the quality of the product as evaluated by the instructors and peer evaluations of individual contributions.

Discussion

This model describes a complex set of integrated skills that range from planning and design to programming and production. The model is implemented through a sequence of intense and highly coordinated activities. These build rapidly from relatively simple tasks that omit many aspects of disc development to a complex undertaking that includes, in simplified form, all of the major elements involved in creating a disc from start to finish. The projects described here incorporate specialized protocols for planning, designing, communicating, and managing in a highly collaborative framework.

How generalizable is this model? The answer is unclear. The model is closely articulated with other courses in a master's degree program. Students in this program are typically mature individuals in their late twenties or thirties. Most are highly committed to the program. By the time they take the course on which this model is based, they have completed most of their degree requirements. Many are actively pursuing new employment. In short, this course was designed for a specific group of students with a specific academic background. In spite of this, we suspect that a number of features of the model will be useful to others who are engaged in similar efforts to train future designers of CBIVI products.

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Equipment Notes

We have taught the course on which this model is based for four years. Equipment capabilities and course content have been interdependent and have evolved together. For the first two years, we used an interactive videotape system consisting of an Apple II+ computer, a Whitney interface card, and a Panasonic solinoid-operated VHS tape system. A menu-and-prompt-driven authoring system supplied with the Whitney card was used to generate Applesoft BASIC code for the CBIVI programs. The Whitney authoring system was cumbersome, simplistic, and full of bugs. In the second year, we substituted Apple Superpilot and had much better results.

For the third and fourth years, we purchased a new system consisting of an Apple IIe, a Pioneer LD-V1000 player, and VMI interface; we used a Microkeyer graphics card to superimpose text and graphic overlays. Costs for the total system were about $4000. In our experience, the Microkeyer card was not well supported by its manufacturer. Since Superpilot did not allow sufficient room for Microkeyer drivers, students wrote their code in BASIC.

During the third year, our videodisc was mastered by Spectraimage, Inc. of Burbank, CA for a cost of $300 using DRAW (Direct Read After Write) technology. Video was recorded on half-inch VHS tape using light industrial equipment and then transferred to 3/4-inch tape during editing. DRAW discs are currently suitable only for temporary ("check disc") use. While the disc was functional, it had a high signal-to-noise ratio. It began to degrade even further after about nine months.

During the fourth year, we significantly improved the quality of our video production, relying on assistance from our university's television station, and its Telecommunications and Film Department. We also sought and received help from a local corporation which lent us its studio. We used an inexpensive, high-quality mastering process offered by Laservideo, Inc. of Chicago ($600 for a 25,000 frame, 8" disc) with excellent results.

We are planning to switch again to a new interactive video system next year and anticipate using it for at least two or three years. It will link a Macintosh Plus to a Pioneer LD-V6000 player via a straightforward RS-232 cable. We have recently negotiated a site license with Edudisc, Inc., of Nashville for use of its CBIVI software products including its authoring system, *Mentor;* a videodisc clip editing utility, called *MacVideo,* and an image management system, *Portfolio.*

Author Notes

Teaming Tomatoes, this years' class project, won a silver "Cindy" award for excellence in Level 3 video disc design from the Association of Visual Communicators.

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tors about the complexities of developing computer-based interactive video projects.

[1]A Level 1 system allows a viewer to determine the pace of information delivery. The user can freeze the action, step frame by frame in forward or reverse, scan the disc, or procede in slow motion. Level 2 players possess an onboard, programmable microcomputer. This allows a videodisc to be programmed to respond to a user's input. Level 3 systems link a videodisc player with an external computer, allowing complex branching patterns and computer text and graphics overlays.