Interactive Digital Video Authoring and Prototyping

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INTERACTIVE DIGITAL VIDEO AUTHORING AND PROTOTYPING

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EXECUTIVE SUMMARY

What We Have Done During the Past Seven Months

This joint research project between Virginia Tech and NCR was initiated in May 1989. During the seven months since then, we have accomplished several major goals, outlined below. Each of these is further discussed in the accompanying documents.

- ***Produced a design for two different DVI applications and completed the (painful) development cycle for the first application***

The first application, the DVI Product Theater, shows a CD-ROM player and TV monitor surrounded by compact discs. The user selects a compact disc with the mouse, drags the disc into the disc player, and then can watch a small segment of full motion video from the DVI Product Theater. The user can use the mouse to try several special effects on the full motion video.

The second application, an Architecture Images Database, has just passed the design stage. Numerous slides from an extensive architecture library have been captured and, when this application is complete, can be searched and retrieved by the user. A HyperCard prototype now operates in coordination with an Architecture Videodisc.

- ***Acquired and integrated the DVI hardware and software development platform and experimented with numerous aspects of this environment***

We began our project using Dell equipment, but converted to the Pro750 in the summer. Similarly, we began with version 1 of the software and, in the fall, converted to several new versions of the software. These conversions caused considerable delays in our application development. After the hardware and software were integrated and running, we used ELV, PLV, still video capture (at various levels of quality, with comparisons), special effects (on stills and motion video), and tried out the Lumena paint package.

- ***Used related facilities***

We made use of the Intel compression services, for both full and quarter screen video. Some of the compressed material (for the Product Theater) was returned to us fairly rapidly; we are still awaiting delivery of some of the other material. We also used the services of the Virginia Tech video production department, and Architecture's Targa system.

- ***Collected information on numerous areas of DVI work***

In order to determine the kinds of DVI applications under development, we conducted individual personal interviews with more than a dozen DVI developers (in person and/or by phone). These interviews were invaluable in acquainting us with other DVI developers and their problems, as well as giving visibility for our project here. We feel that we now have a good network of colleagues working in this area. In addition, we collected literature and software for more than a dozen "authoring" tools and organized a library of DVI-related materials, including more than 10 hours of videotapes and numerous books and articles.

- ***Built and trained a powerful, multi-disciplinary DVI development team, carefully promoting our complementary skills***

**Co-Principal Investigators:*

Edward A. Fox - information storage and retrieval
Deborah Hix - human-computer interaction
Edward E. Schwartz - instructional development

**Postdoctoral Research Associate:*

Antonio Siochi - human-computer interaction; programming

**Graduate Research Assistants:*

Prabhakar Koushik - chief programmer for DVI application
Don Inman - audio-visual production

**Graduate Students:*

Arun Narasimhan - prototype architecture database
Amjad Daoud - CD-ROM files and data structures

**Undergraduate:*

Steve Lidard - interviews with DVI developers

- ***Established communication links and visibility for our team with numerous other DVI groups***

Since we were just beginning to work in the DVI area, this was a primary consideration. The interviews with DVI developers, as mentioned, were key in accomplishing communication and visibility. In addition, Hix, Siochi, Schwartz, and Koushik attended the SALT Conference in Washington, DC in August 1989 and made numerous new contacts. We are participating in a new DVI Bulletin Board service established by Horizons Technology in San Diego. Fox has made numerous site visits to groups doing DVI development including Intel Princeton Operation, Bank Street College, the MIT Media Lab, the Software Engineering Institute, Videodisc Publishing Inc., and Children's Television Workshop. He has made several presentations or given tutorials, including CHI '89, the ASIS Mid-Year meeting, SIGIR '89, an ACM Washington Chapter Professional Development Seminar, a Miami University of Ohio Seminar, the IIA Seminar "The Second Generation of CD-ROM", and the 7th Intelligence Community Artificial Intelligence/Advanced Computing Symposium. We have also produced a one page "PR" sheet (attached) that gives highlights of our project. Fox edited the July 1989 Communications of the ACM, a special issue on interactive technologies, as well as a videotape supplement, prepared a paper for the OnLine 89 proceedings (with A. Daoud) and for the National Online Meeting, and had several meetings with Capitol Video personnel to discuss CD-I. Fox is on the program committee for the International Conference on Multimedia Information Systems (Singapore, January, 1991), the 13th International Conference on R & D in Information Retrieval (Brussels, September 1990), and the Fifth Annual AI Systems in Government Conference (Washington, May, 1990).

Lessons We Have Learned During the Past Seven Months

- Currently, DVI application development is very slow and very difficult.
- Current DVI hardware and software still need much work, to improve their integration, functionality, usability, and RELIABILITY.
- Development is at the mercy of Intel efforts. Thus, the lack of support of networking while DVI applications are operable has precluded planned design and testing of integrating the CODER system with our DVI applications.
- Tools to support speedy DVI application development are virtually non-existent, and will be difficult to build so that the power of DVI can be harnessed without programming.
- DVI development requires a broad variety of skills, some of which are not typically present in traditional software developers.
- DVI project management must be done very adaptively.
- DVI systems and applications should be commercializable, perhaps by 4Q 1990. This does not mean that planning for and design of DVI-based systems should not be underway right now. With continued tool and methodology development and research, NCR can be well-prepared to be on the leading edge of DVI technology when it is ready for commercial development.
- Consumer acceptance of innovative multimedia systems will probably require TV quality full motion video and FM quality stereo, movie quality special effects, and effective human-computer interaction.
- DVI will be ahead of CD-I, for professional use.
- DVI has an enthusiastic following; developers will build upon Intel's low level support, and are anxious to produce a range of products.
- DVI's greatest deficiency is lack of a development environment and trained developers.
- ***Main Point***: DVI has great potential as a multimedia technology, but it needs much more development support in order for applications to be produced in an efficient, cost-effective manner. With proper resources, we feel that the VPI&SU team can make a significant contribution toward building a suitable development environment.

SYNOPSIS: Deliverables Produced and Their Purpose

- ***Developers' Survey:***

Our project is exploring the future of DVI application development, both commercially and technologically. Through our own DVI development effort, we have learned much about the current state of the technology, its strengths and weaknesses, and its potential for commercial success. However, in order to further advance our assessment of the technology, we conducted a survey of developers at 10 other DVI sites.

The survey focused on five main topics pertinent to DVI application development:

- what was done,
- how it was done,
- problems encountered,
- development tools, and
- general impressions.

Most of the interviewees were application developers, but some were managers or project leaders. The kinds of projects being developed included point of information (POI), proof of concept, and commercial ventures.

The purpose of the survey was three-fold:

- to establish a communications link between us and other DVI development sites,
- to learn first hand from the experiences of other development efforts, including the problems encountered and the methodology involved, and
- to provide input for our taxonomy and our tools requirements documents.

In general, analysis of the surveys resulted in many of the "Lessons We Have Learned" items above.

- ***Applications Survey:***

The family of optical storage technologies that began with the Laser Videodisc (LV) now includes the Compact Audio Disc (CD), Compact Disc Read Only Memory (CD-ROM), and the emerging media of Digital Video Interactive (DVI) and Compact Disc Interactive (CDI). Our investigation shows that IVD will continue to receive the majority of attention in development and production for the near future, simply because it is presently the only instructional multimedia delivery system that has a proven record. It is clear, however, that IVD is merely a transitional technology due to its partial reliance on an analog system in a rapidly changing, computer-based environment. The promise of DVI in particular creates, from a production standpoint alone, capabilities within one system that currently requires in IVD several separate, specialized, and expensive production sequences to achieve a similar outcome.

Another area in which IVD cannot match the potential of DVI is in the manipulation, and thus control, of the final product; IVD information is stored as a fixed analog recording on the videodisc, while DVI information is in digital form and capable of being modified in its delivery for each instructional event. The most revolutionary aspect of DVI that neither IVD or CDI can offer is in the user's ability to dynamically control the information that he or she is seeing. DVI

technology provides the user with the highest level of interactivity possible, digital information that can be altered in any way, in real time, as the user sees fit.

CDI is also a digital format, but it is currently designed as a closed architecture which will not allow the flexibility offered by DVI technology. Therefore, DVI, unquestionably, has the most potential for future instructional applications. At the present time, however, DVI is faced with some time of maturation before it can be competitive as an instructional delivery system. Some of the areas in which DVI will need to grow involve increased storage capacity, faster information transfer rates from the compact disc, increased quality and speed of video compression techniques, and improved authoring and programming environment.

- ***Digital Multimedia Taxonomy:***

The purpose of developing a digital multimedia taxonomy was to define and organize all components of a multimedia application in order to:

- provide a foundation for producing multimedia development tools,
- provide a framework for evaluating existing development tools,
- serve as a basis for comparing DVI vs. non-DVI multimedia applications, and
- establish common terminology across many different development roles.

Our project at Virginia Tech is a unique combination of theoretical and practical work. This taxonomy represents some of the first theoretical work to be done in this new area of DVI technology. The taxonomy is oriented toward the end-user's perceptible (e.g., visible, audible) interaction with a multimedia application.

Multimedia applications are not very different from any other software system. All software systems have at least the following 4 main components:

1. *Data type* - kinds of objects the user manipulates
2. *Operations* - types of manipulations allowed (e.g., for each data type)
3. *Control structure* - organization of data types and operations
4. *Hardware* - equipment that supports the first three components

Instances of each of these components observed *in DVI applications* have been developed.

- ***Development Tools Survey:***

We conducted a survey of about a dozen development tools — or "authoring" tools, as they are often called — to determine what is currently available and to use that information to help develop the requirements for a multimedia development environment. These fall into two general classes:

- languages and
- systems.

A language is a specialized programming language with built-in constructs to support development of (multimedia) applications. A system is a more complete development environment that may contain, for example, direct manipulation tools for developing graphical portions of the application or for animating sequences without programming. Examples of each class are InfoWindow Pilot and IconAuthor, respectively. In general, the tools support development of applications running interactive video discs. There are capabilities for playing certain video segments or stills from the video disc, based on user inputs. There is often support for grading and other instructional tasks.

Rather than producing a detailed arbitrary listing of various capabilities of the tools, we used the theoretical structure provided by our taxonomy as a basis for analyzing those tools. This procedure has two benefits:

- The current tools are analyzed with respect to support for general multimedia applications. This should reveal whether or not the current tools are suitable for such applications.
- Capabilities that tools have which are not reflected in the taxonomy may be useful for improving the taxonomy.

• *Requirements for a Multimedia Development Environment:*

Multimedia applications are, at an abstract level, the same as traditional interactive applications involving only text and graphics. Thus at this level, the requirements for a multimedia application development environment, i.e., *a system of integrated development tools*, are the same as those for the traditional applications. However, the increased number and complexity of multimedia components (e.g., video, audio, stills), and their combinations impose additional requirements, such as operations specific to those components, and greater attention to managing that complexity. Both types of requirements are addressed by describing three types of requirements for a multimedia development environment:

- general,
- functional, and
- usability.

• *DVI Applications:*

The purpose of our application development is to explore and demonstrate capabilities of DVI technology. The first of our two prototype applications is designed to test the ability of the current DVI hardware and software to:

- display still images,
- play video segments in conjunction with user interaction via the mouse,
- video special effects, and
- time-out after certain periods of user inactivity.

It also provided a test case for us to learn about DVI development. This application — its design and implementation — represented a major part of our efforts on this project. As a test case for DVI development, we uncovered numerous limitations and problems with both the software and hardware.

This application, which we call the "DVI Product Theater" is a self-running "demo" that also allows user interaction. When first started, a short video segment , called the attract video, plays continuously until the user clicks the mouse button. As implied by its name, the purpose of this segment is to attract people to the demo and invite them to try it out. When the mouse is clicked, the application stops playing the attract video and shows a still image consisting of a digitized image of a TV monitor and a CD-ROM player in the lower middle portion of the display screen, surrounded on both sides by six digitized images of compact discs, three on each side. Each disc represents a video segment containing information about various NCR products or Virginia Tech.

In order to study DVI issues and capabilities relating to information storage and retrieval in large databases, we are designing a second DVI application using images available to us from the Center

for Theory and History of Architecture in the College of Architecture at Virginia Tech. Concurrently we are investigating other DVI issues such as scaling, image enhancement, and resolution.

A prototype of a DVI application is being developed in which the images — both stills and motion sequences — from the videodisc are being converted to the DVI format. The user will then interact with them in real time. The first 28 images from the Introduction in the book "A Visual Text: History Of Architecture — Catalogue For Videodisc" are being used initially. As preparation for this prototype, a HyperCard demonstration has been developed wherein a Macintosh Plus computer controls the Architecture videodisc.