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ANALYSIS, DESIGN, AND IMPLEMENTATION OF A WEB-BASED TRAINING SYSTEM FOR MULTI-CRITERIA DECISION SUPPORT, INTEGRATING HYPERTEXT, MULTIMEDIA-BASED CASE STUDIES AND TRAINING SOFTWARE

by

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September, 1997

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ABSTRACT

The objective of this thesis is to propose a new learning medium, which takes advantage of the latest developments in computer based training (CBT) and the World Wide Web as an innovative mode for delivering education. The key research focus of this thesis is the design of the framework to best combine hypertext technology, computer-based training functionality and interactive multimedia to enhance learning effectiveness. This thesis develops a prototype of a multimedia training module based on a case study for the ELECTRE 1 model of Cooperative Multiple Criteria Group Decision Making. The written thesis reports on the process of building the prototype and the lessons learned. The actual product may be viewed at [**http://www.cimnet.nps.navy.com/coop**].

TABLE OF CONTENTS

I. INTRODUCTION 1

A. AREA OF RESEARCH 1

B. RESEARCH QUESTIONS 1

C. BENEFITS OF STUDY 1

D. METHODOLOGY 2

E. RESEARCH OUTPUT 2

F. ORGANIZATION OF THE STUDY 3

II. LITERATURE REVIEW 5

A. HISTORICAL PERSPECTIVE OF CBT 5

B. CURRENT TRENDS IN CBT DELIVERY 9

1. Determining the Feasibility of CBT Use 9

2. Cost Issues 15

3. Hypertext-based Instruction 18

4. Multimedia as a Training Tool 20

5. Internet-based Training (IBT) and Web-based Training (WBT) 22

6. Motion Video 24

C. INSTRUCTIONAL DESIGN ISSUES 25

D. AUTHORING TOOLS 27

III. METHODOLOGY 31

A. ANALYSIS 31

1. Determine Training Technique 31

2. Determine Training Objectives 32

B. DESIGN 32

1. Script Design 32

2. System Considerations 33

3. Media Selection 34

4. Audio Considerations 36

5. Software Considerations 37

C. DEVELOPMENT 38

1. Animation Creation 39

2. Audio Creation 41

3. Movie Layout 42

D. IMPLEMENTATION 44

1. Web Page Implementation 45

2. Movie Internet Preparation 46

E. EVALUATION 47

IV. OPERATION OF THE GROUP DECISION SUPPORT SYSTEM TRAINING MODULE 49

A. INTRODUCTION 49

B. INTERNET-BASED TRAINING APPLICATION 49

C. PROCEDURES FOR ACCESSING AND RUNNING THE IBT 53

D. INTERNET BROWSER REQUIREMENTS 57

V. SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH 61

A. SUMMARY OF RESEARCH 61

B. LESSONS LEARNED 62

C. RECOMMENDATIONS FOR FUTURE RESEARCH 63

APPENDIX A. ELECTRE PRESENTATION SCRIPT 65

APPENDIX B. LINGO SAMPLES - MACROMEDIA'S PROGRAMMING SCRIPT LANGUAGE 81

APPENDIX C. Co-oP TRAINING SURVEY 83

LIST OF REFERENCES 91

INITIAL DISTRIBUTION LIST 95

LIST OF FIGURES

Figure 2.1 Major Phases of ISD 26

Figure 2.2 Hypermedia Design Model 27

Figure 3.1 Sample Screen 44

Figure 4.1 Introduction/Course Objectives 51

Figure 4.2 Menu of Part II 52

Figure 4.3 Introduction 54

Figure 4.4 Navigation 55

Figure 4.5 Play Part II 56

Figure 4.6 Exam 57

LIST OF TABLES

Table 2.1 CBT Benefits Checklist 12

Table 2.2 Current CBT Development Costs 16

Table 2.3 Current CBT Delivery Costs 17

Table 2.4 Current CBT Budget Matrix 17

Table 2.5 Cost Estimate for Interactive Courseware (ICW) 18

Table 2.6 Training Taught via CBT 22

Table 2.7 Latest CBT Authoring Tool Comparison 29

Table 4.1 Download Times 59

I. INTRODUCTION

A. AREA OF RESEARCH

The purpose of this thesis is to propose a new learning medium that takes advantage of the latest developments in computer-based training (CBT) and the World Wide Web (WWW) as an innovative mode for delivering education. The research focus is the design of a general framework for developing integrated Web-based CBT tools that combine hypertext technology, computer-based training functionalities and interactive multimedia to enhance learning effectiveness.

B. RESEARCH QUESTIONS

- What are the design considerations and implementation strategies for combining hypertext, multimedia case studies and group decision support (GDSS) software?
- What is the ideal structure of a web based training tool?
- What is the best way to implement a multimedia case study?
- How can DSS software be used in an interactive training tool?
- What are the difficulties associated with creating a web based tool as opposed to a stand-alone application?

C. BENEFITS OF STUDY

There is a need for continuous education and training; most specifically training in real-time for effective information usage. This study contributes to meeting this need through creation of a framework that can be used to analyze, design, implement and evaluate a web-based training presentation.

D. METHODOLOGY

To identify the required elements for designing and developing a web-based training program that integrates hypertext, multimedia case studies and group decision support system (GDSS) software, we conducted a survey and analysis of CBT development issues. We also performed a comparison of CBT authoring tools to determine which tool provided the best features and capabilities for creating training programs and deploying them on the web.

To demonstrate the feasibility of implementing an integrated training program on the Internet, we used the ELECTRE 1 Model from *Co-oP* to develop a training prototype using Macromedia Director 6 presentation and authoring software. *Co-oP* is a Group Decision Support System for Cooperative Multiple Criteria Group Decision Making, created by Dr. Tung X. Bui of the Naval Postgraduate School, Monterey, California.

In order to capture vital user feedback for the enhancement of the prototype, we created an on-line evaluation form using NetObjects Fusion 2.0 and Microsoft Access 97.

E. RESEARCH OUTPUT

A working prototype of a Web-based CBT was created with Macromedia Director 6.0. The product is available for viewing at [**http://www.cimnet.nps.navy.mil/coop**].

The software training module is provided "as is." All guarantees either expressed or implied are disclaimed as to the software and its quality, performance, or fitness for any particular purpose.

F. ORGANIZATION OF THE STUDY

Chapter II is a literature review of CBT. A brief history of CBT is presented. Current trends in CBT delivery such as multimedia, authoring tools and Internet/WWW platform deployment are discussed.

Systems analysis and design procedures employed in developing the training module are discussed in Chapter III. The framework for the development methodology is derived from the Instructional Systems Development (ISD) model discussed in Chapter II. Design considerations and trade-off issues are also discussed.

Chapter IV discusses the operating procedures and system functionality for the training module. This chapter includes a description of:

- minimum system requirements for accessing and viewing the training module
- ideal system features for optimizing the training module's access and viewing
- approximate download times for various connection rates

Chapter V concludes the study by summarizing the research, discussing lessons learned and providing recommendations for future research.

II. LITERATURE REVIEW

A. HISTORICAL PERSPECTIVE OF CBT

Despite having gained significant popularity in recent years, CBT has been around for several decades. Maul and Spotts (1993) trace CBT's origins back to the 1920s with Pressey's invention of a teaching machine that could "produce measurable amounts of learning in students." Much of the credit for the instructional principles behind CBT courseware is attributed to B.F. Skinner (Hassett and Duke, 1986). In the 1950's Skinner developed a teaching machine which according to Hassett and Dukes:

> ...presented instruction and questions on a paper tape which the student moved to see a new sentences at a time. The user wrote answers on a second tape, then uncovered a hidden portion of the teaching tape to see whether the answer was correct.

Easton (1997) defines CBT as "the use of computers and multimedia technology for training in a way that promotes student interest and motivation." Much of the literature reviewed contained numerous acronyms describing the use of computers in education and training. Other CBT related terminology described by Bixler and Bergman (1997) includes the following:

- CAI – Computer-Assisted Instruction, and CBI – Computer-Based Instruction; delivering instruction through the medium of a computer; these are alternative terms for computer-based training

- CAL – Computer-Assisted Learning; using a computer as an adjunct tool to aid in a traditional learning situation, like classroom training. The computer is a device to assist the instructor during the training process; like a blackboard or handouts

- CAT – Computer-Assisted Testing. Assessing an individual through the medium of a computer. Individuals take the test at the computer, and the computer records and scores the test. CAT is imbedded in most computer-based training

- CMI – Computer-Managed Instruction. The computer is used to register students, assign training schedules, generate and score tests, and produce reports on student progress and utilization of training resources (Kearsley, 1983)

Fletcher and Rockway (1986) date the history of computer based instruction (CBI) as beginning in the mid-1950's. Much of the initial CBI research and development was either performed by or supported by the military. The Air Force is credited with being the first military service to begin developing CBI (Fletcher & Rockway, 1986). The Air Force's Semi-Automatic Ground Environment (SAGE), was the first "computer-based, on-the-job training system" (Fletcher & Rockway, 1986).

The Navy is regarded as the slowest military service to begin participation in CBT research and development (Fletcher & Rockway, 1986). Despite its slow entry into the CBT field, the Navy is recognized for its success at the U.S. Naval Academy, which was "among the first institutions of higher learning to offer an entire course by computer" (Fletcher & Rockway, 1986).

The most widely recognized CBT initiative involving Department of Defense agencies, was the Programmed Logic for Automatic Teaching Operations (PLATO) Project. The initial development period for the PLATO Project occurred from

approximately 1959 to 1965. During this period, researchers received funding support from the Army, Navy and Air Force. Fletcher and Rockway (1986) describe the initial product, PLATO I, as "a single-station computer-based teaching machine using the ILLIAC (with 1K 40-bit words of primary memory, a 10,000-word drum, and an add time of 75 microseconds) as the central processor." The PLATO project successfully provided the first programming environment for computer-based training.

Nicholson (1997) credits the evolution of the microcomputer in the late 1970's as the springboard for the principle of developing programs to provide electronic training which supplements or replaces standard training manuals. Programs developed during this time were consistent with one of two fundamental layouts—linear programs and branching programs (Nicholson, 1997). The linear program involved "a sequence of very small learning steps punctuated by a test question." This method provided immediate feedback to the student as to whether the question had been answered correctly. One of the most widely recognized linear programs is "Exploring the IBM Personal Computer". The program was distributed as an introductory disk, which was shipped with each new IBM personal computer (Hassett and Dukes, 1986). In branching programs, students were provided with one of several instruction paths to help lead them to correctly answering questions. The program would not allow the learner to continue to the next step of the program without the answer given being correct.

Modern technological advances have resulted in the creation of media-rich training programs, which combines text, graphics, animation, video and digital sound. Multimedia enables CBT courseware developers to "create a complete multi-sensory

learning program, allowing students to interact with the material, and to learn according to their own needs, pace and learning styles." (Easton, 1997) These multi-sensory systems aid in the greater retention of new knowledge according to Bixler and Bergman (1997), who observed that "on average, people remember: 10% of what they read; 20% of what they hear; 30% of what they see; and 50% of what they hear and see."

CBT program designs incorporate one or a combination of the following techniques (Bixler & Bergman, 1997; Kearsley 1983):

- Tutorial – useful for teaching factual information, simple discrimination, rules and simple application of rules
- Drill and Practice – used after initial instruction to aid in mastery of new skills or information taught
- Training Games – used as a supplement to other instruction. Training games provide users with motivating opportunities to practice new skills or information taught
- Simulation – used primarily to practice skills in situations where real-world application is too expensive or dangerous
- Problem Solving – helps student develop skills in logic, problem solving, and following directions, and is generally used to augment higher order thinking skills
- Demonstration/Presentation – best used to support the introduction of new information

B. CURRENT TRENDS IN CBT DELIVERY

1. Determining the Feasibility of CBT Use

Kearsley (1983) stated, "almost all CBT applications are driven by the need to improve the efficiency or effectiveness of a particular training system or situation." This assertion continues to hold true across the wide spectrum of training and educational organizations. In an era of military and corporate downsizing, training specialists are continually searching for more efficient ways to spend limited training dollars. Allen (1996) originally highlighted challenges that he believed would have a major impact on training and instruction in the early 1980's. These challenges include the following:

- The high cost of energy
- Generally inefficient use of instructors due to student overload
- Changing social trends
- The high cost of training in multiple locations
- Too wide a range of learner abilities and expectations
- The increasing cost of downtime required by traditional methods
- Increased turn-over and worker/student mobility
- The inability of traditional training modes to present instruction consistently across learner groups
- General information overload

Many of these same challenges are being encountered by training and education organizations today. These are some of the issues that form the basis for exploring CBT

as a training option (Allan 1993; Rand, 1996; Gallagher & Olbeter, 1997). Montague (1984) studied the use of CBT systems for training in the U.S. Navy and identified the following reasons for using CBT, although they are not unique to the U.S. Navy:

- Provide students direct contact with tasks to be learned via simulations
- Reduce the variability of instruction
- Improve security and quality of achievement testing
- Reduce requirements for presence of instructors
- Make training available at anytime to match student availability
- Provide training at remote site where instructors are unavailable
- Reduce training time
- Convenience
- Reduce travel requirements and per diem expenses for training
- Reduce development time for teaching materials and revisions

These recurring themes seem to provide adequate rationale for implementing CBT. However, CBT may not be an appropriate solution for some training situations. Extreme care and consideration must be exercised when determining when, where and how to use CBT. Due to the potentially high investment cost of CBT, organizations must perform assessments to determine: (1) the feasibility of incorporating CBT into their training strategy; (2) the type of CBT courseware that best fits their training needs and (3) the return on investment or cost-benefit analysis of CBT. Kearsley (1983), proposed a "CBT Benefits Checklist" (Table 2.1), to aid in assessing a training situation and the

potential benefit to be derived from applying CBT technology. The checklist is not designed to be a conclusive evaluation tool. A majority of "yes" answers should be viewed as a situation where CBT may successfully address the organization's training needs and warrants further investigation. A majority of "no" answers is indicative of a situation where CBT would most likely not fit the organization's training needs and alternative methods should be considered.

CBT BENEFITS CHECKLIST

		Yes	No
1.	Increased Control		
	Are existing materials poorly used?	[ ]	[ ]
	Are existing training programs taught inconsistently?	[ ]	[ ]
	Is standardization of training important?	[ ]	[ ]
	Is detailed tracking of learning needed?	[ ]	[ ]
2.	Reduced Resource Requirements		
	Is decentralized (field-based) training possible?	[ ]	[ ]
	Is higher student throughput desired?	[ ]	[ ]
	Is a higher student-to-instructor ration desired?	[ ]	[ ]
	Is expensive equipment needed for training?	[ ]	[ ]
3.	Individualization		
	Is there considerable variation in student backgrounds?	[ ]	[ ]
	Is there considerable variation in student abilities?	[ ]	[ ]
	Is there likely to be considerable student variation in terms of learning progress?	[ ]	[ ]
	Does the instruction have to stand alone (e.g., self-study)?	[ ]	[ ]
4.	Timeliness and Availability		
	Is it necessary to provide training to many students as quickly as possible?	[ ]	[ ]
	Is it desirable to provide training "on demand" i.e., whenever and wherever a student needs it?	[ ]	[ ]
	Is there a problem with students forgetting due to premature training?	[ ]	[ ]
	Is there a problem with a shortage of qualified instructors?	[ ]	[ ]
5.	Reduced Training Time		
	Would time savings in training be worthwhile?	[ ]	[ ]
	Can the training system and organization be changed to capitalize on time savings?	[ ]	[ ]

(Continued on next page)

		Yes	No
6.	Improved Job Performance		
	Is the quality of job performance a critical training concern?	[ ]	[ ]
	Are there job performance problems that improved training can address?	[ ]	[ ]
7.	Convenience		
	Do employees already use a computer system for their jobs?	[ ]	[ ]
	Could CBT be integrated into existing jobs or equipment?	[ ]	[ ]
8.	Change Agent		
	Is there a need for new training approaches or methods?	[ ]	[ ]
	Could CBT lead to improved personal or organizational productivity?	[ ]	[ ]
9.	Increased Learning Satisfaction		
	Is the attrition or failure rate high?	[ ]	[ ]
	Is there a problem with student motivation?	[ ]	[ ]
10.	Reduced Development Time		
	Is the large-scale development of training materials and program involved?	[ ]	[ ]
	Is immediate revision/update of training material important?	[ ]	[ ]
	Is instruction developed in terms of a competency-based framework?	[ ]	[ ]

Table 2.1 CBT Benefits Checklist (Kearsley, 1983)

The purpose of a feasibility study is to investigate and assess the degree of risk associated with using CBT. According to Kearsley (1983), there are four major types of feasibility that need to be examined:

- Instructional – deals with the suitability of CBT for achieving the instructional objectives of the training
- Organizational – focuses on social, policy or political issues that may affect the use of CBT
- Technical – availability of CBT features or capabilities needed
- Economic – concerns the affordability of CBT costs involved

Kearsley further contends that a CBT application should be successful in all four areas in order to be successful.

Adams (1993) offers a "decision aid" to help determine whether to use CBT in a corporate environment. The goal is to provide an evaluator with "a structured way to look at issues involving the learners and the corporate climate." Adams also advises that the aid should not be viewed as a substitute for detailed cost-benefits analysis. The decision aid should be used as a supplement to a cost-benefit analysis.

Much attention has been given to measuring the return on investment (ROI) for information technology acquisitions in both the public and private sector. In assessing the return on investment of CBT, Allen (1996) examines the potential results of CBT from two main factors: cost savings and performance improvement. Allen develops a cost savings model for CBT by illustrating savings in the following areas:

- Wages spent on training and opportunity costs
- Travel and entertainment costs for learners
- Travel and entertainment costs for trainers
- Development costs
- Delivery system costs

In summarizing the research regarding CBT's impact on worker performance, Allen (1996) concluded that "people learn better with multimedia training; they remember what they learn more accurately and longer, and they are better able to use what they learn to improve their performance."

2. Cost Issues

CBT programs generally come in one of three types: (1) off-the-shelf; (2) customizable programs; and (3) programs built from scratch and fully customized to company specifications (Bixler & Bergman 1997). Off-the-shelf training is the cheapest and least flexible type of CBT because the content is fixed and cannot be changed. Off-the-shelf CBT is considered appropriate for training situations where the skills to be taught are relatively generic. Customizable CBT allows for the addition of organization specific content and is best suited for teaching skills that are relatively unique. Customized training is the most expensive type of CBT to develop and implement. As a result, this type of CBT is recommended for situations where the skills to be taught are unique, there is no existing CBT to teach the skills and there is a requirement to train a large number of people.

A variety of approaches have been used for estimating the cost of purchasing or developing CBT. Bixler and Bergman (1997) use a combination of development and delivery costs. These costs are dependent upon the customizability of the CBT program and the instructional format of the training. Tables 2.2 - 2.4 illustrate the development costs, delivery costs and budget matrix derived by Bixler and Bergman.

DEVELOPMENT COSTS			
	Off-the-shelf	Customizable	Customized
Computer Program/software	$100 - $300	$100 - $5,000	$100 - $2,000
Customization or Development	–	$1,280	$30,720 - $46,080
Selection & installation	$640	$640	$640
TOTAL	$740 - $940	$2,020 - $6,920	$31,460 – $48,720

Table 2.2 Current CBT Development Costs (Bixler & Bergman, 1997)

DELIVERY COSTS			
	Independent Study	On-site Classes	Off-site Classes
Instruction	–	$768	$600 - $20,000
Instructional Support	$1,280	$768	$512
Selection & Enrollment	–	–	$640
TOTAL	$1,280	$1,536	$1,752 - $21,152

Table 2.3 Current CBT Delivery Costs (Bixler & Bergman, 1997)

BUDGET MATRIX				
Development Costs		Delivery Costs		
		Independent Study	On-Site Classes	Off-Site Classes
		$1,280	$1,536	$1,752 – $21,152
Off-the-shelf	$740 – $940	$2,020 – $2,220	$2,276 – $2,476	–
Customizable	$2,020 – $6,920	$3,300 – $8,200	$3,556 – $8,456	–
Customized	$31,460 – $48,720	$32,740 – $50,000	$32,996 – $50,256	–

Table 2.4 Current CBT Budget Matrix (Bixler & Bergman, 1997)

Military instruction and training requirements tend to be unique therefore most CBT programs used within the military must be customized. Cost figures for military skills related CBT were obtained from the Chief of Naval Operations Office of Training Technology (OTT), paper on Interactive Courseware (ICW). Costs are estimated according to the category of ICW presentation. The following table provides a summary of ICW presentation categories and estimated average cost per hour of instruction. (OTT, 1996)

Category Number	Type of Presentation	Estimated Avg. Cost Per Hour of Instruction
1A	Baseline: video with minor text	$1,901
1B	Baseline: graphics with minor text	$2,170
2	Medium simulation	$3,768
3	High level simulation	$7,183

Table 2.5 Cost Estimate for Interactive Courseware (ICW) (OTT, 1996)

3. Hypertext-based Instruction

In researching instructional methodologies and adult learning, Montague and Knirk (1997) determined that hypertext-based instruction is appropriate for conveying complex content. Traditional instructional methods tend to be linear in form and more suitable for well-structured subject matter. Hypertext provides for a non-sequential, random access method of obtaining information. (Montague & Knirk, 1997)

The structure of hypertext, namely nodes and links, presents a unique architecture for the development of instructional materials. Balsubramanian (1994) defined nodes as

"concepts" and links as "relationships." Nodes can contain text, graphics, video, audio, animation and images. Links are responsible for establishing connectivity between nodes; thereby connecting related concepts. The basic features of a hypertext system are (Balasubramanian, 1994):

- A Graphical User Interface, with the help of browsers and overview diagrams, helps the user to navigate through large amounts of information by activating links and reading the contents of nodes
- An authoring system with tools to create and manage nodes (of multiple media) and links
- Traditional information retrieval (IR) mechanisms such as keyword searches, author searches etc.
- A hypermedia engine to manage information about nodes and links
- A storage system which can be a file system or a knowledge base or a relational database management system or an object-oriented database management system

Implementing a hypertext system on the World Wide Web creates an instructional environment where content can be developed, modified and maintained in a timely manner. These features are particularly attractive when there is a need to distribute current and rapidly changing information and instruction (Hites & Ewing, 1997). The cross-platform capability of the web guarantees users are able to access materials with a variety of systems and browsers.

4. Multimedia as a Training Tool

According to the *1996 Computer-Based Training Report* (Kemske, 1996), 73% of 1,024 survey respondents estimated multimedia was used to some degree in their organization's courseware. Respondents were also asked to compare multimedia to traditional CBT based on five criteria:

- knowledge outcomes
- performance outcomes
- overall return on investment
- retention
- instruction completion time

The most significant findings occurred in the area of knowledge outcomes, where 79% of the respondents felt multimedia was better than traditional CBT.

In a 1996 survey of 146 *Fortune* 1,000 companies by TRAINING and OmniTech Consulting Group of Chicago, multimedia as a training delivery system accounted for an estimated 16% of the total training hours delivered to employees (Training, 1996). For the purposes of the survey, the investigators defined multi-media based training (MBT) as "...an interactive learning experience incorporating the use of either CD-ROM or World Wide Web technology (via the Internet or, more often, an internal company "intranet" using the WWW protocols)."

To further refine the survey results, respondents were grouped into three classifications based on the level of multimedia use within their organization. The

classification groups were light users, moderate users, and heavy users. Results for each classification are as follows:

- Light users – are companies that deliver less than10 percent of total training hours via multimedia. Light users comprise 36 percent of all survey respondents
- Moderate users – deliver 10 percent to 25 percent of total training hours via multimedia. They comprise 42 percent of respondents
- Heavy users – comprising 17 percent of respondents, deliver more than 25 percent of all training hours via multimedia
- The remaining 5 percent of respondents declined to estimate a figure

In addition, the results indicated that software/basic computer skills remains the most frequently taught subject via CBT. Table 2.6 provides a breakdown of other training topics taught (Training, 1996).

SUBJECT	PERCENTAGE OF RESPONDENTS
Software/Basic Computer Skills	42
Technical Training	25
Management Training	25
Safety/Regulatory Compliance	20
Product/Industry Training	19
Interpersonal Skill Training	17
Job Responsibility Training (Basic, noncomputer-related)	15
Customer Service Training	13
Sales/Marketing Training	13
Corporate Culture Training	13
Advanced Computer Training	11

Table 2.6 Training Topics Taught via CBT (Training, 1996)

5. Internet-based Training (IBT) and Web-based Training (WBT)

The Internet is becoming an increasingly popular alternative for delivering training (Appleton, 1997; McManus 1995; McGarvey, 1996; Schneider, 1994). Training delivered over the web provides for easy distribution of knowledge and resources regionally, globally, or within an enterprise. McManus (1995) provides a description of the Internet as a delivery system that also adequately describes the World Wide Web.

> The Internet can deliver video, but not as quickly as videotape, television or CD-ROM. It can carry real time personal interaction, but not as well as telephone or video conferencing. It can display textual information, but not as usefully as a book or magazine. Why then should the Internet ever be used. The Net has two real advantages over other media. It combines advantages of other media so that it conveys video and sound better than a book, is more interactive than a videotape and, unlike CD-ROM, it can link people from around the world cheaply. The second advantage, and one that is often overlooked when discussing the Internet as a delivery system, is that it can also be a content provider. The Internet is, arguably, the largest and most diverse information resource in the world today. It is possible to incorporate a wealth of information available on the Net in your design. ...This sort of immediate access to information and resources can not be found with any other medium. (McManus, 1995)

In comparing WBT to traditional implementations of CBT, Kilby (1994) outlines the following advantages and disadvantages of WBT:

Advantages:

- Easy delivery of training to users
- Instant multi-platform capabilities (Windows, Mac, Unix)
- Easy updating of content
- Shift from costly programming to interface and content design
- Quicker turnaround of finished product
- Requires less technical support
- Billing options by user ID, number of accesses, date/time of access
- Access is controllable
- Options for installations on private networks for security or greater bandwidth
- Options to link with other training systems

- Multitasking capability suitable for electronic performance support systems (EPSS)
- Vast, untapped market for training

Disadvantages:

- Limited formatting of content in current browsers
- Bandwidth/browser limitations may restrict instructional methodologies
- Limited bandwidth means slower performance for sound, video, and intense graphics
- Someone must provide server access, control usage, bill users

Most of the disadvantages of WBT are attributable to techonolgical limitations. As new advancements in browser capabilities and solutions to bandwidth limitation problems are discovered, WBT's popularity as a training alternative, will increase.

6. Motion Video

The use of video in CBT programs and on the Web is becoming more common. However, video requires enormous storage space and processing power (Joralmon, 1997). One frame of video requires approximately one megabyte of storage space. Full video uses 30 frames of video per second (Joralmon, 1997). The Moving Picture Experts Group (MPEG) standard developed by the International Standards Organization and the International Electrotechnical Commission, is becoming a common compression standard for CBT and Web applications (Joralmon, 1997). The three MPEG standards compress video into files that are smaller and more suitable for use with current computer

resources. Specifically, "MPEG-1 standard compresses video into files with playback data rates supported by current desktop computers." (Joralmon, 1997)

C. INSTRUCTIONAL DESIGN ISSUES

Regardless of the type of courseware developed, CBT, IBT or WBT, the courseware must be based upon some model of instruction and learning (Kearsley, 1983; McManus, 1995; Schneider, 1994). One of the greatest dangers associated with current advancements in CBT development and delivery systems is that the quality of the courses will decrease as responsibility for course development moves away from the training and instructional design specialist and more towards the information systems department (Fritz, 1993; Hefner, 1996).

Instructional Systems Development (ISD) refers to "the systematic approach to design and development of training materials and systems." (Kearsley, 1983) The five major phases of ISD are shown in Figure 2.1. ISD procedures help to minimize the problems most often attributed to training program failures. It represents the foundation for designing and developing effective CBT courseware. (Kearsley, 1983)

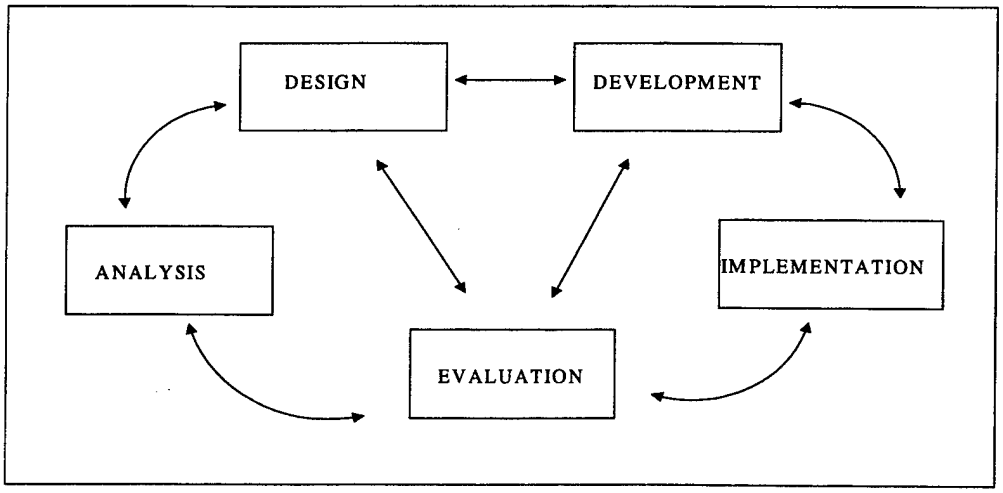

Figure 2.1 Major Phases of ISD (Kearsley, 1983)

McManus (1996) uses Cognitive Flexibility Theory (Spiro, Feltovich, Jacobson, and Coulson, 1991) as the foundation for advocating use of the Hypermedia Design Model (HDM) for developing instruction for the web. Cognitive flexibility theory focuses on the nature of learning in complex and ill-structured domains. Learning is best achieved within this environment through the use of non-linear and multidimensional exploration of subject matter (McManus, 1996). Hypertext, by its nature, is conducive to supporting the presentation of information from multiple perspectives to promote learning in accordance with cognitive flexibility theory.

HDM (Figure 2.2) employs a "geography/cartography design metaphor." (McManus, 1996) A design metaphor is primarily concerned with how the designer structures the learning domain while creating the learning environment. Unlike traditional instructional systems development, HDM focuses on learner objectives–"what the learner

actually comes to the environment wanting to learn," (McManus, 1996) and provides the guidance to help the learner meet those objectives.

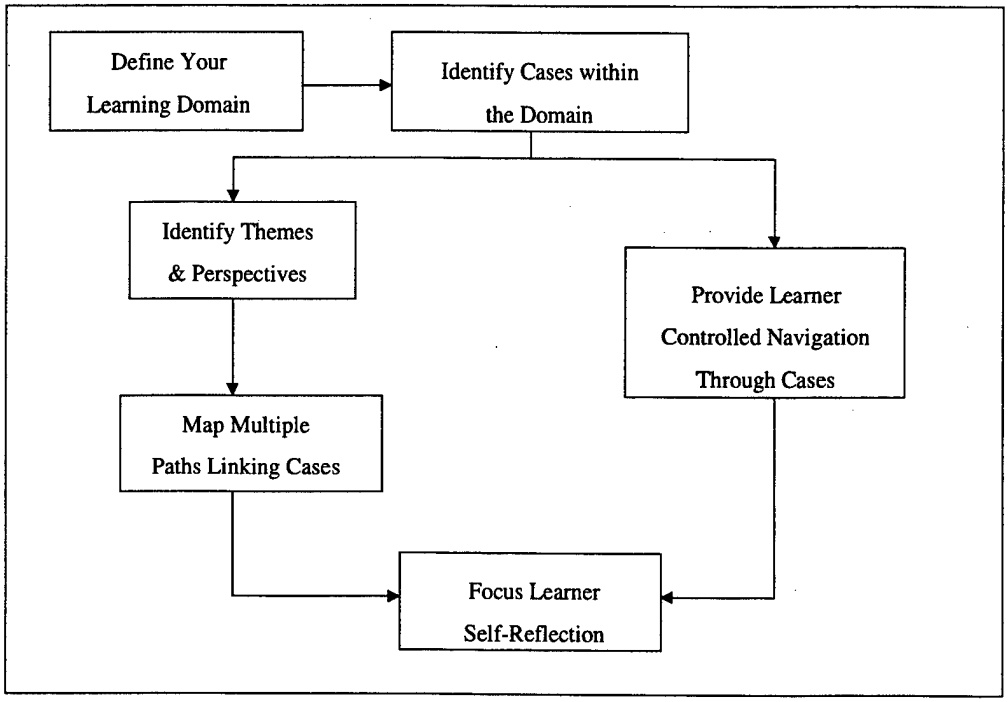

Figure 2.2 Hypermedia Design Model (McManus, 1996)

Gagne (1979), Gery (1987) and Alessi (1991) have formulated other systematic design steps. Easton (1997) best summarizes the approach to be taken when considering developing CBT courseware- "it must be better thought out than more conventional training strategies."

D. AUTHORING TOOLS

The final area that warrants discussion is that of CBT authoring tools. Older DOS-based authoring systems such as *TenCORE*, *Quest* and *Phoenix Micro* have lost a sizable

portion of their market share to newer Windows-based systems. The proliferation of training programs which incorporate multimedia; coupled with the dominance of Microsoft Windows in the workplace, has reshaped the CBT authoring field (Fritz, 1993). The current trend in CBT authoring software development is to provide products that incorporate tools for course design, course delivery, web integration and course administration features, in one package.

The traditional CBT authoring process involved an instructional designer who knew what the program should do and a programmer who knew the authoring language. The evolution of easy to use authoring tools has enabled both instructional designers and non-instructional designers to create CBT courseware without the use of a programmer. This technological advancement also harbors the potential consequence of poorly designed courseware being produced by non-qualified people. (Hefner, 1996)

In *The 1996 CBT Report* (Kemske, 1996), survey respondents identified 139 different CBT or multimedia authoring products that they either use or have used previously. According to the report findings, the five most commonly used authoring products were:

1. Authorware
2. IconAuthor
3. ToolBook
4. Quest
5. Director

The report results disregard software version and implementation (DOS or Windows). *AuthorWare, IconAuthor, ToolBook* and *Quest* are considered dedicated CBT development products. *Director* is ordinarily considered to be a presentation developer (Kemske, 1996). Table 2.7 provides a comparison of the current Windows version of these products.

	Authorware 3.5	IconAuthor	ToolBook 11 Instructor	QuestNet+	Macromedia Director 6.0 Studio
Price	$4,995	$1,295	$1,995	$3,995	$995
Authoring Metaphor	Icon/flowchart	Icon/flowchart	Page/object	Icon/flowchart, object oriented authoring	Icon/object oriented authoring
Internet Capabilities	Yes	Yes	Yes	Yes	Yes
Help Wizards	No	No	Yes	Yes	No
Programming Language Capabilities	DLLs, Xcommands, Xtras	DLLs	OpenScript Java	ANSI C	Lingo, Xtras, C++, Java
Hypertext Capabilities	Yes	Yes	Yes	Yes	No*
Templates	Yes	Yes	Yes	Yes	No

*Hyperlinks can be established by using Lingo scripting

Table 2.7 Latest CBT Authoring Tool Comparison

III. METHODOLOGY

In this project, the Instructional Systems Development (ISD) model, introduced in Chapter 2, was used as the framework for the structured design and development of the CBT program. ISD is an iterative process in that each phase provides feedback to one or more previous phases for the purposes of modifications and enhancements. The major phases involved in ISD are:

- Analysis
- Design
- Development
- Implementation
- Evaluation

The purpose of this chapter is to describe the process involved in applying the ISD model to the Electre training presentation.

A. ANALYSIS

1. Determine Training Technique

The concept for the training was extremely unique in that the goal was to combine hypertext documents, multimedia-based business case studies and an on-line software application, through seamless integration. The resultant product would be delivered over the World Wide Web utilizing Internet protocols. The multimedia-based case study is the main portion of the training program. The case study is a simplified version of an actual

application of the Electre method to solve a decision support problem. As a result, the demonstration/presentation technique for CBT program design was selected.

2. Determine Training Objectives

The program was designed to supplement classroom instruction and/or textbook reading on the Electre method. The desired outcomes were to:

- Introduce the student to the Electre method via creation of a hypertext document of the corresponding textbook chapter
- Present the student with an animated demonstration of the Electre method's application to reinforce knowledge gained from the reading
- Enhance student learning and retention through a self-testing module
- Provide the student with understanding of the underlying methodology of the Electre portion of the Co-oP decision support software program

B. DESIGN

1. Script Design

The script was created utilizing the facts contained in the case study. Additional characters were created in order to develop a dialogue that would stimulate the user's interest. Careful consideration was given to designing interactions that would not intimidate, frustrate or insult the user.

The teach-back approach was used to derive initial ideas for the script. Questions and explanations arising from the live presentation of the Electre method were used in the actual script. Beta testing was performed using the first draft of the script to present the

Electre method to several volunteers. Volunteer questions and feedback were used to modify the script's content. The final script is included as Appendix A.

2. System Considerations

The minimum system configuration was one of the first design considerations discussed. This configuration had to be such that a majority of computers would be able to play the training module. To this end the following is considered to be the minimum system configuration to use the training module:

- 486 compatible CPU
- At least 30 Mb free hard disk space
- Super VGA video card with a monitor capable of displaying 640x480
- Multimedia capable sound system with speakers
- Mouse
- Internet Explorer with the Shockwave plug-in. (Shockwave can be downloaded from the Co-oP Web site)
- Access to the Internet (recommend a 28.8 bps modem or higher)

A faster CPU will improve playback of the video. The limiting factor for viewing this training module over the Internet is the speed of the connection, which affects the download time.

3. Media Selection

Both digital motion video and animation were considered as media options for developing the case study presentation. Each format has its own strengths and weaknesses. The evaluation was based on choosing the media that would create a quality product given the computer resource limitations of both the developer and end-user.

a. Motion Video

Motion video will produce motion picture like quality on a computer. Professional results can be achieved with minimum investment. To get the video from the tape to the computer requires a video capture card. The average cost for a card that produces a quality picture is somewhere in the $1,000 range.

The resolution, frames-per-second (fps), color depth and duration (in seconds) are needed in order to calculate storage requirements for full motion video. The resulting value is the storage requirements in bits. To convert this value to bytes, divide by eight. The following is an example for uncompressed video:

Video Duration: 5 minutes.
Resolution: 640 x 480 with 24-bit color
Frame Rate: 16 fps
Compression: uncompressed
Storage space required = (5 (minutes) x 60 (seconds) x 640 x 480 x 24 x 16)/8 (bits per byte) = 4.5 gigabytes [Using a compression technique like MPEG or motion JPEG can reduce this to 1.5 megabits per second (Andleigh & Thakrar, 1996)]

Full motion video clips can still be very large even when a compression scheme is used. To play MPEG or motion JPEG video files on a computer may require a video card that is capable of decoding these file formats.

Full motion video provides fluid playback with professional results however, this format was not chosen for the following reasons:

- the large file size of the clips
- the inability to control the clips within the training program
- the potential requirement for a higher quality video card in the playback computer to decode the video clips

b. Animation

Animation is the colorful illustration of movement with rich sound. Animated imagery, unlike video, can be made machine readable (Hapgood, 1997). As a result, animation requires less bandwidth and storage space. Objects can be created that exist only in the mind of the creator and manipulated in any manner.

Animating bitmaps allows for greater developer control over file sizes. There are numerous collections of bit-mapped images available commercially as well as on the Internet. Images may be selected from any of these collections. The copyright information describes license requirements and limitations for use of the images.

The use of a bit-map editor is required to modify a single image in order to produce other images that can also be used in a production. This process of cutting and pasting a single image to produce several others can be very time consuming. This is

partly why it takes approximately 200 man-hours to complete one hour of finished multimedia (Kemske, 1996).

Animation file size is directly related to bitmap resolution, measured in pixels per inch, and color depth. Resolution and color depth impact upon the quality of the bitmap image. As discussed previously, animation requires less storage space then video. Part of the reason for this is that the bit-mapping process can be partially done by the CPU of the computer the images are being shown on. Although this may require less storage space, it will also require more computational power from the CPU.

4. Audio Considerations

Sound is an analog signal that is normally converted to a digital signal for use by the computer. One way to convert this signal is to take many small pictures of the analog signal's waveform. Each of these small pictures is called a sample. Sampling rate is the number of pictures that are taken in a second. The actual process of converting an analog signal to digital is much more complicated and beyond the scope of this discussion.

Sound quality is measured in terms of the sampling rate at which the sound is recorded. A sampling rate of 44.1 KHz indicates that 44,100 pictures per second are taken of the analog waveform. A sampling rate of 4 KHz at 8 bits is considered the minimum acceptable for (mono) voice-grade sound. A sampling rate of 8 KHz at 16 bits is the minimum required for music. A CD is sampled at 44 KHz at 16 bits.

The higher the sampling rate, the better the sound quality. The number of bits used to store each same also affects the sound quality. 8 bits and 16 bits are commonly

used. The more bits used, the better the sound quality. The trade-off is that if a higher sampling rate or a higher number of bits is used, the size of the file increases dramatically.

5. Software Considerations

Several software packages for creating a CBT were considered. An authoring package, a graphics program, and audio software were required to create the training module.

a. Authoring Packages

In selecting an authoring system, consideration was given to each of the following:

- the cost of the system
- training that may be required to learn the system
- whether the system provided the required functionality

There are several types of authoring systems. Mastering an authoring system can become very time consuming. A dedicated authoring system is the simplest type of system. It is designed for a single user and generally only allows for single streams or a single object. Timeline-based authoring systems arrange objects along a timeline. The timeline is on the screen or in a window. The user selects an object and must position it in the timeline. Structured multimedia authoring is based on object-level

construction. It is designed for very complex multimedia presentations. It allows for modular construction.

b. Graphics Programs

The graphics program should allow for the manipulation of different image formats. The program's features should allow the user to cut and paste bit-mapped images and then create new images using this cut and paste technique. The program should have the ability to save these images to any of the popular file formats.

Image conversion is also an important consideration. A flexible program allows for converting to different file formats and changing the size and/or color scheme of the image.

c. Audio Software

The software selected should allow the user to record, convert, and edit sound files. These features are usually available in one program. For recording, the user should have the ability to select different input sources, i.e. microphone, CD, and video. A graphical display that shows the waveforms can be used to edit audio files. The ability to cut and paste the sound files is also important.

C. DEVELOPMENT

A timeline-based authoring tool from Macromedia called Director Suite was selected for developing the training module. The initial version was 5.0 and was later

upgraded to 6.0. Director was selected because it has an intuitive interface and appeared easy to learn. The software interface closely resembles a Hollywood movie production, in that both contain cast members, scripts, score and stage. Bundled with the Director suite were several other programs for sound editing, 3-D rendering and some very good graphics tools.

Several decisions had to be made regarding format for the movie. Animation rather then video was used due to the size of the files related to video. Download times for the movie also contributed to the choice of animation. Screen size was set to 640x480 to ensure that any user could view the movie from the Internet regardless of their screen size. Color depth was set to 8-bit to allow for compatibility with older video displays. Audio settings were set to a 22KHz sampling rate at 16 bit to provide high quality sound. These settings gave the best sound quality while limiting required storage space.

1. Animation Creation

As discussed previously, animation was chosen rather than motion video for use in the training movie due to the requirement to make the training available over the Internet. An exhaustive search was conducted through several collections of bit mapped images to select those images that could be manipulated to obtain the necessary characters and props for the animation.

Resolution and color depth were modified to control file size. These trade-offs were done for those portions of the presentation where high resolution and color depth were not integral to effectively presenting the information. Careful consideration was

given to balancing trade-offs in order to avoid degrading the quality of the overall presentation.

Various graphics programs were used to make alterations to the images chosen including Paint Shop Pro, Microsoft Paint, Freelance, Director XRes, and the Director 6.0 paint window. Paint Shop Pro provided a good all around program allowing for importing art from many different types of formats, making alterations as needed, and storing the altered picture in a useful format, such as a BITMAP file (.bmp), for importing into Director 6.0. The paint window within Director 6.0 also provided a useful tool for making alterations to pictures once they were imported into the movie's file.

Using these graphics programs to cut and paste the images produced several images different from the original. These images were then stored as new images. This was a very time consuming process. The cutting and pasting of a single image to produce several other images took several hours.

The bulk of the animation's creation was accomplished within Director 6.0. The score within Director 6.0 provided the ability to put these different images together thereby giving the appearance of motion. Ten seconds of animation took approximately 4 to 6 hours of production time.

Director handles each object and sound within the movie as movie cast members. A movie score is used by Director to make each cast member, both visual and sound, appear at a given time and place within the movie. Control over when and how each cast member enters and exits the movie is also controlled in the score with a variety of

transition effects. Many different transitions were used to break up the flow of the movie and provide some variety for the viewer.

Control over the movies' flow and execution is also provided in Director's scripting language called Lingo. Lingo provides the ability to control many of the movies' features such as navigation, play back delays, and interactivity commands. Lingo was used to control navigation, control sound play back levels, and provide user feedback within the training movie. Some sample Lingo script is included in Appendix B.

2. Audio Creation

Audio in the training module includes both voice and music. The WAVE (.wav) audio file format was used for recording due to its universal use and the flexibility provided within its many optional sampling rates. Various sampling rates were tried with predictable results. Initially, an 8-bit, 11KHz audio test recording was conducted. The result was a smaller file size with poor sound quality due to a high noise level. A compromise between providing high quality sound and producing the lowest media file size was reached by recording the sounds at a rate of 22KHz.

Two computer-recording programs were used for the recordings: Sound Blaster's Wave Studio and Sound Forge. Wave Studio was easier to use, but Sound Forge provided a greater choice of sound editing and manipulating features; many of which were not needed for this project.

Individual recordings of each statement made by the movie's participants were made. This allowed for more precise control and synchronization of cast members in the

Director 6.0 score. Synchronizing the player's voices with the movie animation was a time consuming, interactive process. Introducing sounds into the movie in short segments rather than one long dialog facilitated the job of synchronizing the action with the sounds. This does not present a problem as long as the visual cast members are processed to appear along with the sound cast members. Delays were utilized within the score to synchronize audio and animation. Synchronization was assured throughout the movie by breaking the movie up into logical production segments.

Director 6.0 does not allow for stopping or pausing a sound file during playback and then continuing or resuming the sound file from that point. The animated portion of the movie can be paused and restarted, but the sound file associated with that portion of the movie must restart at the beginning of that sound cast member. This means that in order to stop the movie and then resume playing the movie, requires that both the animated and audio portions of a given movie segment be replayed.

3. Movie Layout

The movie was divided into two parts during development. This was done to facilitate movie production and ease of Internet access and downloading. Part I introduces the movie and case study. Part II demonstrates the ELECTRE 1 method of GDSS. Color selection within the entire movie was based upon the developers' preferences.

Part I uses animated cartoon type graphics on a photo background as well as photo images on an animated background to demonstrate the usefulness of both animated and photo images. The training was introduced in an office environment.

Part II presents the training material on a simulated computer screen to represent the use of computers in GDSS equipped conference rooms. The screen was divided into four areas to emphasize particular areas of the training materials. The four areas from top to bottom are: title area, working area, background information area, and navigation area.

The title area provides a title for the given section of the movie being played. The working area is centrally located on the screen and contains the critical information for the training topic under discussion. Bolded text is used to emphasize the current information being presented by the training tool. Transitions are also used to draw the viewer's attention to a particular part of the screen and to keep the viewer engaged.

The background information area is used to provide the viewer with a quick reference to previously displayed information that is needed for input to the current topic. Bold text is used to highlight pertinent information for the current discussion or calculation. Transitions are used to focus the viewer's attention.

Navigation tools are placed at the bottom of the computer to facilitate movie viewing and navigation. Navigation buttons provided allow a user to move between sequential areas of the movie and to the Main Menu or Exam section. The user is notified by animated graphics when the current training section has been completed and it is time to move on to the next section. Figure 3.1 is a sample screen from Part II of the movie.

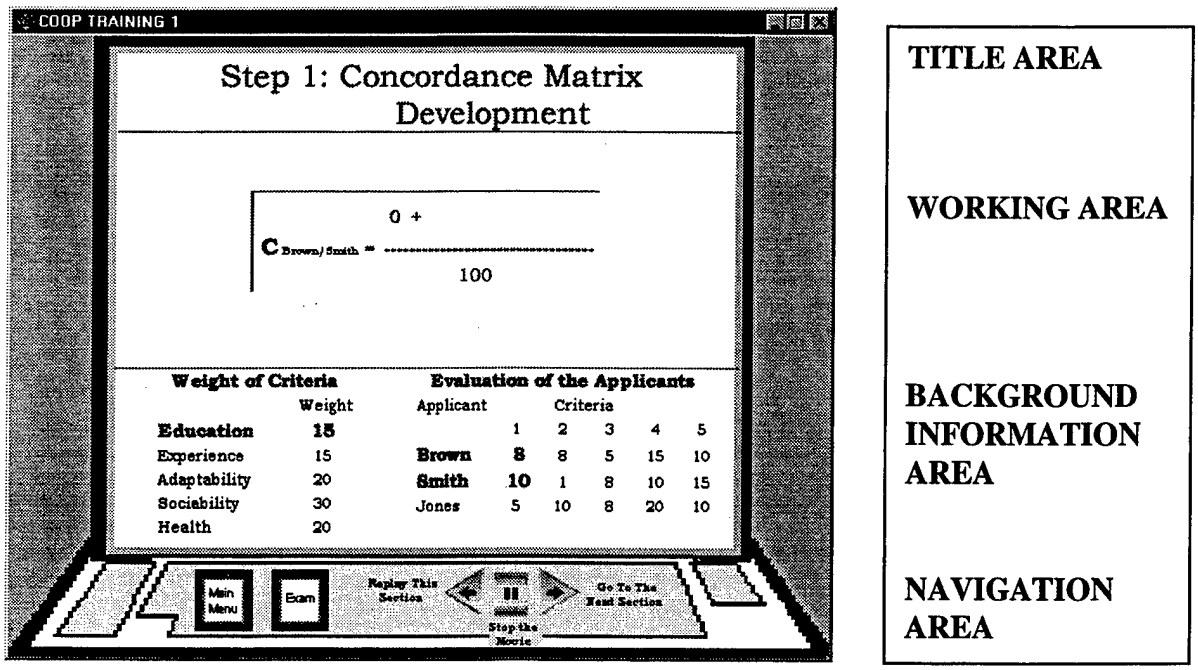

Figure 3.1 Sample Screen

D. IMPLEMENTATION

The next step in the ISD model required that each phase's decisions up to this point be bought together in a final training product. The overarching goal for this training module was to make it available to users on the Internet. A Web-based integration scheme made up of text-rich Web pages hyperlinked together was chosen for the training module. This design scheme provided a logical base from which to present other graphical and animated training media. The training package was put together using some of the most up-to-date tools available for Web site design and implementation.

1. Web Page Implementation

Web pages are made up of HyperText Markup Language (HTML) and can present many different types of media to the user including text, graphics, sound, animation, and video. Most major vendors of word processing software are beginning to include the capability to save and convert files into HTML format. Desktop publishing programs such as Adobe's PageMaker 6.5 and Microsoft's Word 97 have this ability.

NetObject's NetObject Fusion 2.0 was chosen to build the site's Web pages. This program provides the capability to create an entire Web site with automatic links between each layer of pages. Objects can be imported and placed within any Web page desired ranging from text, which can be typed in many popular word processing programs, to graphics, animation, sound, and video. NetObjects automatically creates the HTML code as each object or string of text is inserted on the Web page.

The creation of frames and the placement of navigation buttons and text within those frames provide navigation within the Web site. This design gives a visual clue to the user that other areas exist at the Web site and provide a ready means to return to parts of the site previously visited. Links are also placed within the main body of each page to allow moving to definitions and training media contained on other pages. NetObjects provides a quick method for creating and designating each of these types of links.

There are also a large number of Web site layout schemes within NetObjects including buttons, background colors, and text formats and colors. Simple, subdued colors with a large use of black text on white background were chosen to provide for a

more universal look and to make the text easy to read. Choosing simple colors also works well with different browsers and various display settings.

2. Movie Internet Preparation

Director 6.0 prepares a movie to play on the Internet by compressing it and changing its format to a .dcr movie. Director 5.0 used a feature called Afterburner to "Shock" the movie for the Web. Director 6.0 provides a save option in the file menu to save the movie as a Shockwave Movie. An option is also available to create a stand alone executable movie called a projector. A great deal of computer processing is required during this compression evolution which can be time consuming and even overpowering when large movies are processed on computers with slower CPUs or limited hard disk space.

Most of the development work was accomplished on a Pentium 166 computer with a 1.6 gigabyte hard disk and approximately 60 MB of free space. The first portion of the training movie required 32 MB of disk storage as a Director movie but only 3.4 MB as a compressed Shockwave movie. Processing the compression on this segment did not cause any noticeable problems with the computer. However, the second portion of the training movie was considerably longer requiring nearly 90 MB of storage space prior to compression.

A problem was encountered while Director was compressing the second portion of the movie. As director goes through the process of compression it must first expand the movie. In the case of part two, the movie expanded to 158 MB which required more

space than the hard drive had available. It also took a great deal of time going through the process. The final processing on this portion of the film was accomplished on a computer with a Pentium 233 processor and 4 gigabyte Ultra-SCSI hard drive, which significantly decreased the compression processing evolution. The hard drive had in excess of 500 MB of free space, which supported the processing requirements of Director. The final size of the second part after compression was 4.1 MB, a significant reduction making it Internet ready.

E. EVALUATION

The final phase of the project development cycle involved the use of a survey to gain valuable feedback from the program users regarding the training application. The feedback areas of interest for the development team were the levels of knowledge gained by the user, the user's opinion of the Web site and graphics, and the type of computer and Internet connection equipment used. The NetObjects Fusion program was used to create a Web interface with a database to capture the users' answers to the survey. A flat database was created with Microsoft Access to capture the inputs gained from the Web based survey. Appendix C contains a printed version of the Web-based questionnaire.

IV. OPERATION OF THE GROUP DECISION SUPPORT SYSTEM TRAINING MODULE

A. INTRODUCTION

The major emphasis of this thesis is to create computer-based training (CBT) for a decision support system model and to make the CBT available for access via the Internet. The ELECTRE 1 multi-criteria decision support model and the Co-oP decision support system application were chosen for use to demonstrate the feasibility of this application development as well as to identify areas of difficulty and concern when applying CBT to an Internet based training (IBT) environment.

This chapter will discuss the IBT application, procedures for running the IBT, and Internet browser requirements.

B. INTERNET-BASED TRAINING APPLICATION

The IBT application was developed as one module embodied of two parts:

- The first part consists of web pages, which provide hyperlinked text-based information about numerous models used in multi-criteria decision making. A more detailed discussion is provided for the ELECTRE 1 model, which is the focus subject of the CBT module

- The second part is a case study involving a decision-maker, two assistants for the decision making process, and an actual business decision to be made

The web page documents provide an introduction to all of the decision support models that are used by the Co-oP DSS. Hyperlinks for key ideas and definitions are provided to assist students in their learning and understanding. The ELECTRE 1 model pages have been enhanced with excerpts from Co-oP: A Group Decision Support System

for Cooperative Multiple Criteria Group Decision Making (Bui,1987), to provide the student with a thorough explanation of this model prior to viewing the case study portion of the IBT.

The second part of the IBT is an animated, interactive training movie that has three sub-lessons. These consist of an introduction, the ELECTRE 1 model application example, and an exam. The presentation begins by providing a list of course objectives, an introduction to the decision-makers, and the case study details. Figure 4.1 is a screen shot of the introduction, which provides the course objectives for the ELECTRE 1 training module. These objectives provide the student with the overall course outline, which is followed throughout the animated portion of the training. The student will have a good understanding of the material if each of these points is understood, and will be able to demonstrate this knowledge at the end of the training portion of the module.

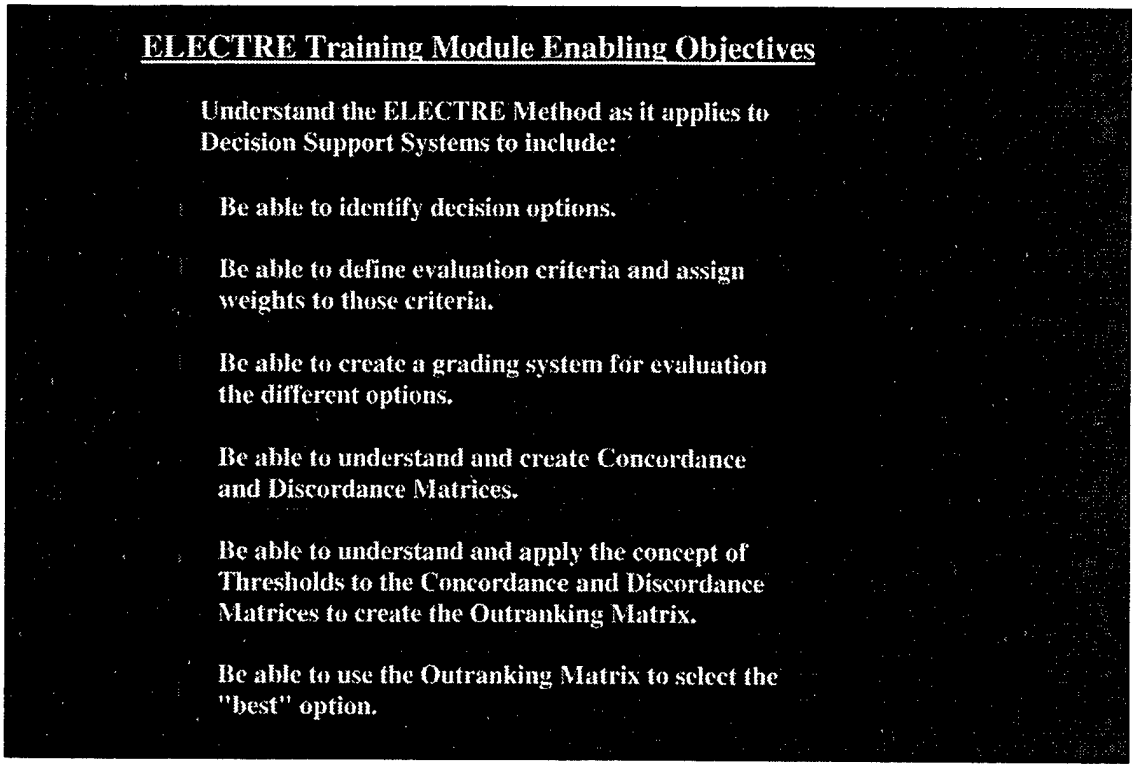

Figure 4.1 Introduction/Course Objectives

The second sub-lesson presents the ELECTRE 1 model in detail with illustrations of its application in the case study. The student is also provided examples of this case study's application in the Co-oP GDSS with screen shots and explanations of how to use the Co-oP program.

Figure 4.2 is a screen shot of the opening screen of the ELECTRE 1 training section that breaks the training down into separate lesson subjects. This menu allows the student to navigate within the training module section's training subjects, to go to the exam section, and to exit the module when complete. Each of the listed sections can be viewed successively while proceeding through the training. They can be accessed directly from the menu, which supports the review of a particular section if the student desires.

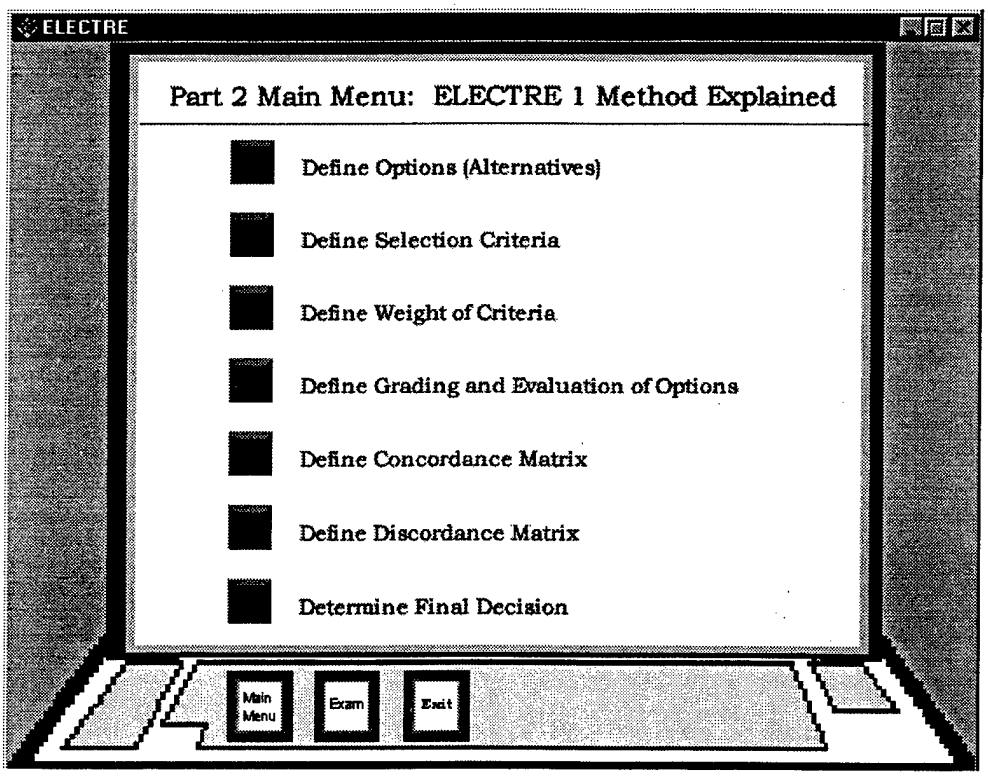

Figure 4.2 Menu of Part II

The third sub-lesson tests the student's level of understanding of key points presented in the training module and provides for revisiting applicable training areas within the IBT. It contains both theoretical and practical questions taken from portions of the web page training information and the animated movie. Positive and negative feedback are provided to guide the student to the correct answer. The student may also return to the training movie's ELECTRE 1 sub-lesson to review any of the key areas presented in order to refresh and solidify his or her knowledge.

C. PROCEDURES FOR ACCESSING AND RUNNING THE IBT

This GDSS training module can be run by accessing the Co-oP training Web site, which is located at [**http://www.cimnet.nps.navy.mil/coop**]. The Web site training is enhanced due to the availability of Web pages containing textual instruction in the various DSS models with a focus on the ELECTRE 1 method.

A Web browser such as Netscape or Internet Explorer must be used to access the Co-oP training site on the Internet. Web browser usage and restrictions for this application are discussed in the next section. Instructions regarding site content and navigation are provided on the Co-oP Home Page with links to Macromedia's Shockwave plug-in to enable the students to download the plug-in. Details on obtaining the plug-in are also discussed in the next section.

Access to the ELECTRE 1 animated training movie is provided from the ELECTRE 1 Web page. The movie is built in two parts, which was designed to shorten the lengthy down load evolution for the entire movie. A table listing approximate Internet download times is provided.

Part I presents an introduction to the movie and explains the navigation buttons used throughout the movie. Figure 4.3 is a screen shot of the introduction and figure 4.4 is a screen shot of the navigation scheme used throughout the movie. Unlike other CBT applications, this Shockwave movie does not allow for synchronous playing of the animation and the audio portions. Therefore, the stop button can be used to stop at any given spot in the movie, but the movie cannot be restarted from that position. The current

section being played must be started over in order to provide for the built in synchronization between the animation and the audio.

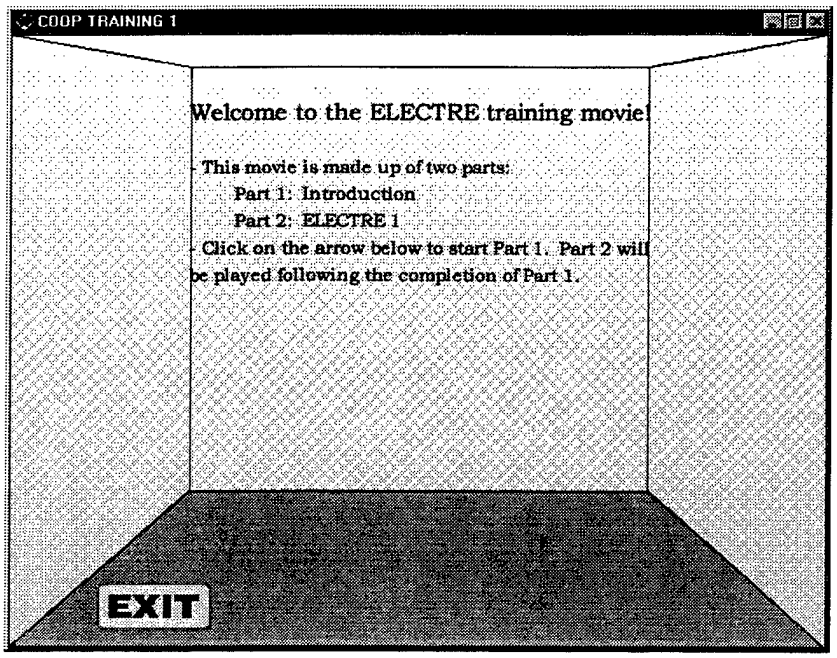

Figure 4.3 Introduction

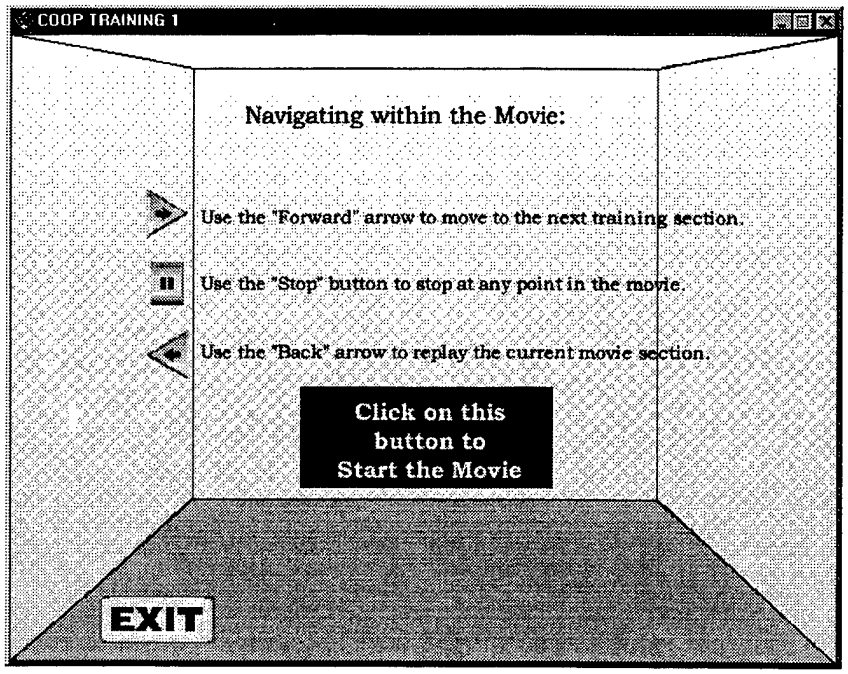

Figure 4.4 Navigation

A link to Part II of the movie is provided within the Part I section as shown in Figure 4.5. The student is also provided a means to exit the training at any time within the movie.

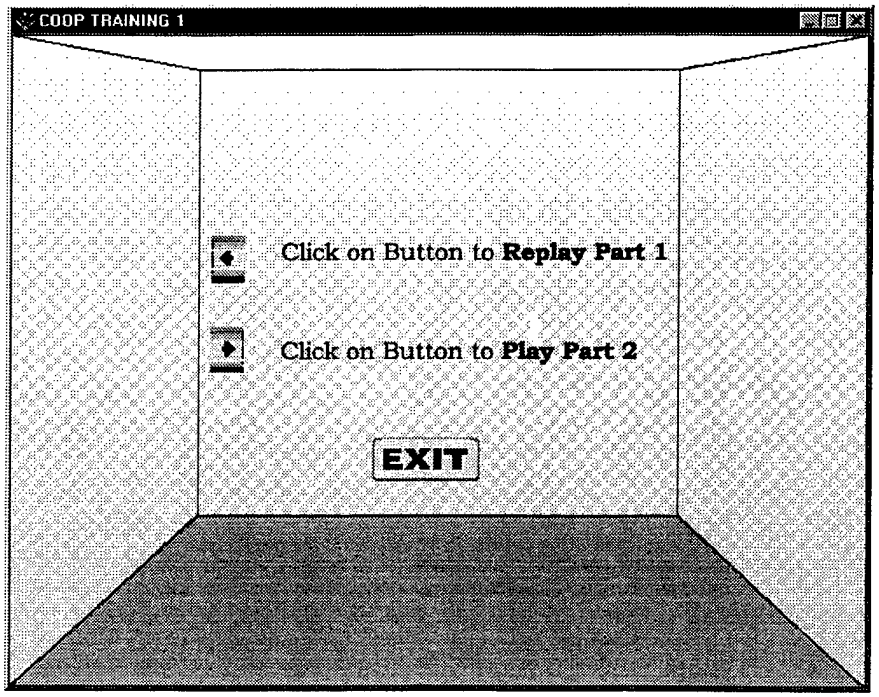

Figure 4.5 Play Part II

An exam is provided for the student following completion of the ELECTRE 1 Web page and movie training. Figure 4.6 is a screen shot of a sample question with the instructions for taking the exam. The picture also shows the navigation available to return to Part II 's Main Menu in order to go to any lesson section for review.

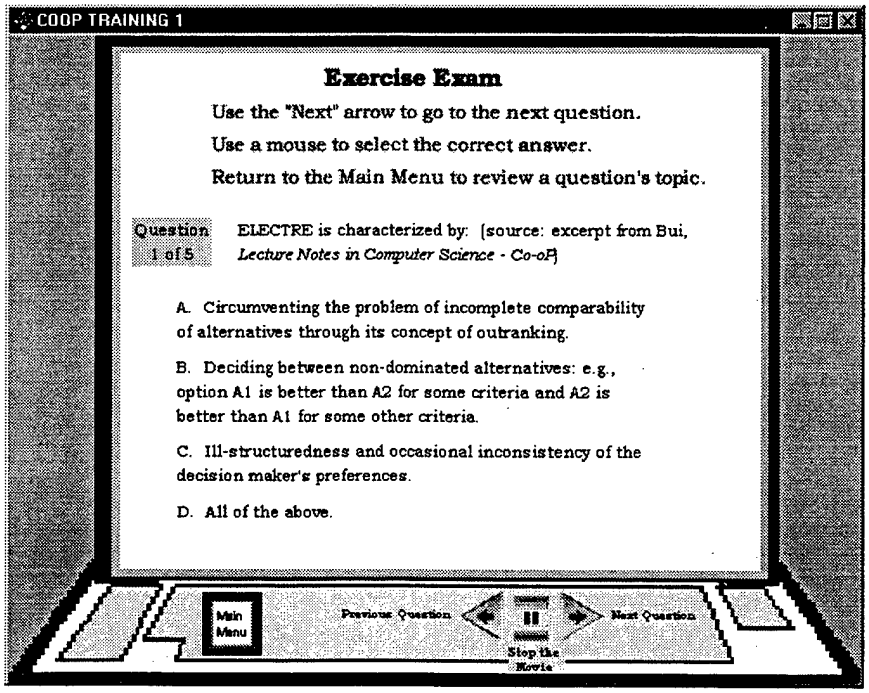

Figure 4.6 Exam

Once a student peruses the Web site and interacts with the ELECTRE 1 training movie, a questionnaire included in Appendix C is provided to allow the student to give feedback on the training site. This questionnaire was designed to obtain student input on the quality of the training, quality of the Web site; opinions on the feasibility of Web based training, and user's platform configuration. The results of the survey are captured in a database, which can be used to do statistical analysis on the data provided and to identify areas needing future improvements.

D. INTERNET BROWSER REQUIREMENTS

The use of multimedia within Web documents is becoming a major focal point of Web development. This is because the Web is a natural medium for the distribution of

media-based information resources across computing platforms. In addition, creating Web ready media resources has become simpler as development and conversion tools continue to evolve.

There are a number of things that must be considered prior to downloading the animated ELECTRE 1 movie. They include the type of Web browser being used, the computer's processor, the connection type in use for the Internet, and the status of the hard disc drive on which the Browser files are cached or stored.

Multimedia materials referenced on Web documents cannot be played back within the Web browser. Instead, when a browser encounters a media format it can not display, it looks for a helper application appropriate for the format. Newer Web browsers are now being developed with many of these helper applications built in, however, adding media viewers as plug-ins can support most media formats.

To view the multimedia-animated movie provided with this IBT application, the free *Shockwave* plug-in from Macromedia [**http://www.macromedia.com**] must be installed in the student's Web browser.

The two most popular Web browsers in use today are Netscape and Internet Explorer. The ELECTRE 1 training movie has been tested on both the Netscape 3.01 and Internet Explorer 3.0 browsers with the latest Shockwave plug-in installed. Though both of these browsers support the Shockwave format, we have found that the movie does not play properly on Netscape due to a restriction within the Naval Postgraduate School's Web server software. The movie will play properly through Internet Explorer 3.0 with

the most recent Shockwave plug-in installed. This information has been included on the appropriate Web pages in the training module.

Movie downloading has been tested on various computer platforms and types of connections. The computer platforms ranged in processor type from Pentium 166s to PentiumII 233s. Very little variance was noted in the processing of this movie between the different processor types. Students using these ranges of computers will not notice any significant difference in processing speed.

Movie downloading was also tested on various connection types ranging from 28.8 Modems to T-1 line connections. A significant difference in download times was expected and noted between these various types. The connection type rather than the computer's processor is by far the factor with the greatest impact on the movie's download time. Table 4.1 shows the approximate download times for a variety of connection types.

Type of Connection	**Part 1 3.4 Mb**	**Part 2 4.1 Mb**
T-1 (1.5 Mbps)	30 sec	1 min
LAN (10Mbps shared)	45 sec	1 min
MODEM 14.4 Kbps	33 min	45 min
28.8 Kbps	15 min	24 min
33.6 Kbps	14 min	23 min
56 Kbps	11 min	20 min

Table 4.1 Download Times

Web browsers use temporary storage space on the computer's hard disc drive to store Web browser downloaded files. In the case of Shockwave movies, the hard disc space is also used for temporary storage while the compressed files being received from the Web are processed in order to play back on the computer. Normal browsing of Web pages does not have a significant impact on the hard disk's storage, but multimedia of the size of these movies, requires a significant amount of additional hard disc space to load, process and run properly. It was found that a hard drive with less than 30 MB of free space had a significant negative impact on downloading and playing the entire ELECTRE 1 training movie. Having a minimum of 30 MB available free space on the browser's hard drive prior to attempting to view the ELECTRE 1 movie is recommended. This space should be available on the drive in which the browser stores its downloaded pages, which is normally the C: drive.

V. SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

A. SUMMARY OF RESEARCH

This thesis was initiated to research the feasibility of using various Internet technologies to provide computer-based training for a Group Decision Support System application. Current trends in Internet development and a few of the most up-to-date development tools were examined. This research supports the idea of using the Internet as a viable means for providing training material to a broadly distributed audience. It also demonstrates the usefulness of some of the latest tools provided for this type of application development.

The IBT method of distributing and executing training material has some advantages that can be useful to the military. This method provides the training material to an almost limitless audience. The only requirement for a user to access the material would be to have an Internet connection and current browser. The training material's controlling organization could make changes and updates to the material and almost immediately provide the updated material for use by the next user/student with a minimum cost for distribution.

The limiting factor to full usefulness of the Internet for distributing training materials is still the bandwidth available to the user. Most modern CBT modules contain animation and/or video and sound typical of the ELECTRE 1 movie. Use of this type of media results in large file sizes even when the most up-to-date compression techniques are used. Downloading these training movies from the Internet through a modem, which

is the most probable type of connection for most users, takes a significant amount of time. If the computer training material is distributed and used over an organization's Intranet, the bandwidth restriction can be overcome making the download and processing time a less significant negative factor.

A modification of the ISD model for training system development was used. This design methodology was found to be straightforward in its application and very useful to our development team. The following list provides an estimate of the percentage of time spent in each phase of the method.

- Analysis 10%
- Design 15%
- Development 60%
- Implementation 10%
- Evaluation 5%

B. LEASONS LEARNED

The tools available today to create Internet training material provide solid and easy to use resources. As inexperienced training and Internet material producers, the tools used to develop this project were intuitive and well supported by the software's documentation and help function. There are also a number of good Internet resources and "How-to" books available by professional users of the tools.

Using a personal computer to develop multimedia-based training applications for use in the Internet requires the latest hardware. A computer with a fast, high powered

CPU and a minimum of 32 MB RAM (64 MB RAM if possible) provides the required horsepower to process movies in the compressed format required for the Internet. Use of a hard drive with a high access rate and a minimum of two times the movie's uncompressed size in free space, is also recommended to provide the required processing support. Use of a high capacity removable storage device, such as a 1 gigabyte JAZ storage drive, was also found to be very useful. The JAZ drive provided a back-up source and allowed for the transportation of large files to other computer systems.

The greatest challenge to this development process was creating the animated art for the training movie. This aspect of the development phase consumed the greatest amount of time and had the steepest learning curve. Based on the experience gained from this project's development, the time required to create this application again would be reduced by 25 to 33%. To obtain a more professional animated product will require formal training in animation development, or more appropriately, the services of a graphic illustrator.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

The restriction of download time may be lessened in the future as streaming technologies become maturer. Streaming was attempted in this project with unacceptable results. As this technology progresses, it should be looked into as a possible enhancement to Internet multimedia training materials.

Future development should be considered for other GDSS models and concepts as a result of the successful demonstration in this application of the latest in Internet

multimedia development to one aspect of the multi-criteria decision models. Integrating Internet training with an Internet ready GDSS application would be a good enhancement as well. Migrating the Co-oP GDSS program to JAVA-based applets would provide a more versatile resource for that type of application.

APPENDIX A. ELECTRE PRESENTATION SCRIPT

Characters: **Narrator**
Mr. Castella
Mr. Henry
Mrs. LeFlore
Applicants 1-5

Scene 1

(multimedia presentation has been launched by user clicking link from text)

Narrator: The following presentation is an example of how the Electre Method was applied to an actual problem. The main characters are Mr. Castella **(character/obj appears on screen),** President of Castella Enterprises, Inc., Mr. Henry, **(character/obj appears on screen)** VP of Operations, and Mrs. LeFlore **(character/obj appears on screen)**, head of the Operations Research Department. Mr. Castella is searching for a replacement for his head accountant, who is retiring. Five applicants **(add applicants A1-A5 to screen, one by one)**, answered his advertisement placed in the business section of a local newspaper.

Fade out...

Narrator: The demo begins with Mr. Henry and Mr. Castella discussing how to make a selection from the five applicants.

Scene 2

Fade in... Mr. Castella on screen alone looking at applications (papers, folders)
Mr. Henry appears on screen from left as if entering an office and begins talking

Mr. Henry: Good Morning Mr. Castella. I understand we have received a total of five applicants for the head accountant position. Have you selected the one you wish to hire?

Mr. Castella: Good Morning Mr. Henry. No, I have not made a final selection however, after studying all of the resumes, I eliminated two of the applicants, **(dissolve/fade out? A4 and A5)**, whose qualifications were good, but not precisely what I wanted. The three remaining applicants **(reposition A1-A3 on screen)**, present a difficult choice; none of them stands out from the others as clearly the best choice. I have no idea how best to decide among these three.

Mr. Henry: Hmmm. **(Show Henry with thinking bubble over his head, then change to light bulb for idea) (sounding very excited)** I have just the answer Mr. Castella! During last week's management meeting, Mr. Andrews in Marketing, briefed the group on how his department

applied a decision support model called the Electre Method to determine which campaign strategy was best for next quarter's operations.

Mr. Castella: **(sounding doubtful)** Electre Method you say? Have you seen a demonstration of this model? How does it work? Do you think it will help me?

Mr. Henry: I have not had the opportunity to see the method demonstrated. Mr. Andrews was so enthusiastic about it that I invited him to provide a demonstration for the entire management group next month. He was supposed to contact Mrs. LeFlore in Operations Research since she is the person who introduced his department to the Electre Method and guided them through the steps involved in using it. I think I should contact Mrs. LeFlore and arrange for her to demonstrate this Electre Method for you and I using your applicant selection problem. When would you like me to set the demonstration up for?

Mr. Castella: As soon as possible. I have a pretty open schedule for the next two days. See if you can make this happen by then.

Mr. Henry: Very well. I will see what I can do.

Have Henry heading back off screen form the same direction he entered.

Fade out...

Scene 3

Print on screen "Two days later in the Operations Research Department"

Fade in.... Mrs. LeFlore is on screen. Mr. Castella and Mr. Henry walk in from the left.

Mr. Henry: Good morning Mrs. LeFlore **(shaking Mrs. LeFlore's hand)**. May I introduce Mr. Castella. He is very anxious to see the presentation you have prepared for us.

Mrs. LeFlore: (smiles warmly) Good Morning Mr. Henry. **(Turns to Mr. Castella)** Good morning Mr. Castella. It is a pleasure to meet you. Everything is in place for the presentation and I am ready to begin whenever you are.

Mr. Castella: (smiles, shaking LeFlore's hand) Good morning and thank-you for preparing this on such short notice. I hope what you are about to show us will help me decide which applicant is best for the company.

Mrs. LeFlore: No problem sir. I'm sure we can do something to help you out. If you gentlemen will follow me this way, we'll get started.

Fade out....

Scene 4

Fade in... all three characters are in what appears to be a briefing room. Mr. Henry and Mr. Castella are sitting and Mrs. LeFlore is standing in front of a large presentation board.

Mrs. LeFlore: The first part of the process involves data collection. The first step in data collection is to define your options **(Print on screen "1. Define options" in upper left-hand corner)**, which represent all the different possible actions. We should refer to the three remaining applicants by their real names. Mr. Brown is A1 **(bring/fade-in A1 on screen but print "Brown")**, Mr. Smith is A2 **(bring A2 on screen but print "Smith"**) and Mr. Jones is A3 **(bring A3 on screen but print "Jones")**. Do you have any questions so far?

Mr. Castella: No. Please proceed.

Mrs. LeFlore: Good. The next step is to define the criteria you would like to use for evaluating each of the applicants. Did you bring the papers I had faxed up to your office yesterday?

Mr. Castella: Yes. I have them right here. I can't say that I understand everything you asked me for.

Mrs. LeFlore: (Takes the papers Mr. Castella hands her) Thank you. Don't worry sir. Things will all come together as we proceed through the demonstration.

(Print on screen "2. Definition of criteria" under step 1)

Mrs. LeFlore: I see you have decided on five criteria Mr.Castella: Education **(Print "1. Education" to screen)**, Experience **(Print "2. Experience" to screen)**, Adaptability **(Print "3.Adaptability" to screen)**, Sociability **(Print "3. Sociability" to screen)**, and Health **(Print "4. Health" to screen)**. Do you still feel these are valid criteria for evaluating an applicant or would you like to make some changes?

Mr. Castella: No, I do not want to make changes. I am satisfied with the criteria already chosen.

Mrs. LeFlore: O.K. The next step is to assign weights to the criteria. **(Print on screen "3. Weight of criteria" under step 2)** If you will recall Mr. Castella, the questionnaire I sent you asked you to place different levels of importance on the five criteria with the only condition being that the weights had to be divided up out of a total of 100.

Mr. Castella: Now here is where I started becoming confused. I am not sure that I completed this portion correctly.

Mr. LeFlore: Don't worry sir, we'll take a look at what you've written and see if you want to change any of your previous choices. Let's see. According to your answers here, Education is assigned 15 **(Print "15" next to "1. Education")**. Experience is assigned 15 **(Print "15" next**

to "2. Experience" forming even column for weights). Adaptability is assigned 20 **(Print "20" in column).** Sociability is assigned 30 **(Print "30" in weight column).** Health is assigned 20 **(Print "20" in weight column)** . The weights you have assigned have to be based on the level of importance you feel each criteria holds with regard to your decision making. Would you say these values correctly represent your assessment?

Mr. Castella: Well, now that you have explained it that way, I suppose it makes more sense...yes I am happy with the values I have assigned.

(Print on screen "4. Grading system " under step 3)
Mr. LeFlore: Very good sir. Now we will help you establish a grading system to use for evaluating each applicant. In this step, we will assign maximum numeric values corresponding to the following alphanumeric ratings: Excellent, Good, Average, Fair, Weak. After you have completed this, the result is a table of points to award for each grade. Do you have any questions before we proceed?

Mr. Castella: No. Not at this point.

Mrs. LeFlore: Okay then. Please fill out this piece of paper **(hands Castella a piece of paper),** with the scores you would assign to each criteria based on its alphanumeric rating.

(Show Castella looking over paper and writing on it for a brief period of time before handing it back to LeFlore)

Mrs. LeFlore: Now if we take the numbers you have assigned for each criteria and rating **(have LeFlore look as if she is reading and either inputting info into a computer or writing on presentation board),** we come up with the following criteria matrix. **(Print on criteria matrix on screen. See following table:**

	Criteria				
	1	**2**	**3**	**4**	**5**
Excellent	**10**	**10**	**10**	**20**	**15**
Good	**8**	**8**	**8**	**15**	**10**
Average	**5**	**5**	**5**	**10**	**5**
Fair	**0**	**1**	**1**	**0**	**3**
Weak	**0**	**0**	**0**	**0**	**1**

Mr. Castella: I think I understand what we've done so far, but where are we headed next?

Mrs. LeFlore: I'm glad you asked that sir. The next step is for you to evaluate each applicant based on the established criteria. **(Print to screen "5 Evaluation of the applicants" under step 4)** Please fill out this form and base your evaluation on everything you have learned about the applicant through resumes, interviews and references. **(LeFlore hands another paper to**

Castella. Castella takes the form and takes some time filling it out. You can have him consult some notes in his briefcase or portfolio)

Mr. Castella: (hands the paper back to LeFlore) I think this should do it. How do we use these numbers to come to a final answer?
Mrs. LeFlore: Well sir, let's have a look at what you've written and then we'll go over the procedures for calculating the results. **(Print on screen the following matrix:**

Applicant	Criteria				
	1	2	3	4	5
Brown	8	8	5	15	10
Smith	10	1	8	10	15
Jones	5	10	8	20	10

Mrs. LeFlore: This is what the scores you've assigned for each criteria look like in matrix format. Now let's look at how we calculate the results.

Fade screen out....

Scene 5

Print to screen "The Results"

Fade screen out...

Print on screen "Step 1 Concordance Matrix Development" in upper left-hand corner of the screen.

Mrs. LeFlore: (speaking to Mr. Castella) The Electre Method uses the concordance and discordance coefficients to make paired comparisons between different options.

Mr. Castella: I'm afraid I don't quite follow you. What are concordance and discordance coefficients and how are they derived?

Mrs. LeFlore: The Electre Method is based on a rule written by a French philosopher, dating back to 1750. To paraphrase, let's say you have two actions, A&B, which you need to choose between. If action A is better than action B for the majority of the decision criteria and there is no criteria for which A is clearly worse than B, then it stands to reason that A outranks B. Does this make sense to you so far sir?

Mr. Castella: Yes, I understand what you have said thus far, but this does not explain the concordance and discordance you mentioned earlier.

Mrs. LeFlore: The concordance and discordance conditions are direct descendants of this principle. The condition of concordance requires that a majority of viewpoints favor A. A condition of discordance requires that no criterion favor B excessively.

Mr. Castella: (exclaim happily) Now I get what they are, but how do we use them?

Mrs. LeFlore: The Electre method uses the concordance and discordance coefficients to make paired comparisons between different options. In our case, we will use the concordance and discordance coefficients to make paired comparisons between Mr.'s Brown, Smith and Jones. Would you like me to go over any of this again?

Mr. Castella: No. I understand everything you've said so far. What's next?

Mrs. LeFlore: The concordance factor varies from 0 to 1. A perfect value for the concordance coefficient is 1. The formula for determining concordance coefficients may be summarized as follows:

Print on screen the following formula:

$$CA/B = \frac{\textbf{Sum of the weights of the criteria by which A outranks B}}{\textbf{Sum of the weights of all criteria of the model}}$$

Mrs. LeFlore: The concordance coefficient indicates to what extent one option is better than another. I will save the discussion of the discordance coefficient calculations for later when we are ready to look at the actual values. Is there anything you would like to review before we move ahead.

Mr. Castella: No. Please continue.

Mrs. LeFlore: Very well then. Utilizing the data in this example, the Index of concordance, assuming Mr Brown outranks Mr. Smith, is calculated as follows:

Print to screen the "Weight of criteria" scale and the "evaluation of applicants" matrix

Mrs. LeFlore: Performing a pair-wise comparison of Mr. Brown versus Mr. Smith for each criteria, we find the following results. Mr. Brown does not outrank Mr. Smith for criteria 1 **(Highlight Brown and Smith and their values under criteria 1 column in matrix)** , which is education, so a score of zero is assigned.

Print on screen the following. Note that we will add values to this calculation as the narrator proceeds through discussion of the calculation

$$\text{CBrown/Smith} = \frac{0 +}{100}$$

Mr. Castella: Why did you assign a zero?

Mrs. LeFlore: Whenever option A does not outrank option B for the criteria being examined, a score of zero is assigned.

Mr. Castella: Well what happens when option A does outrank option B? What value do you assign in that case?

Mrs. LeFlore: I'm glad you asked sir. As you will see further on in this evaluation, whenever option A outranks option B for a given criteria, the value assigned is the weight of the criteria. Let's take a look at criteria 2. Here Mr Brown outranks Mr Smith **(Highlight Brown and Smith and their values under criteria 2 column in matrix)**. In this instance, the weight of criteria 2, which is 15, is added to the formula. **(Print "15 +" on formula screen)**. Does this make sense sir?

Mr. Castella: Absolutely.

Mrs. LeFlore: Great. Why don't you do the comparison for criteria 3 sir.

Mr. Castella: Okay. Looking at criteria 3, we find that Mr. Brown does not outrank Mr. Smith, **(Highlight Brown and Smith and their values under criteria 3 column in matrix)**, therefore a score of zero is added **(Print "0 +" to formula screen)** How did I do.

Mrs. LeFlore: Fantastic sir! I think you have the hang of it. How about doing the next criteria?

Mr. Castella: (smiling and sounding very enthusiastic) For criteria 4, Mr. Brown outranks Mr. Smith, **(Highlight Brown and Smith and their values under criteria 4 column in matrix),** therefore a score of 30 which is the weight of criteria 4, is added to the formula. **(Print "30 +" to formula screen)** For criteria 5, Mr. Brown does not outrank Mr. Smith, **(Highlight Brown and Smith and their values under criteria 5 column in matrix)**, therefore a score of zero is added to the formula. **Print "0" to formula screen.**

Mrs. LeFlore: The outcome of the calculation is .45 or 45%. This value is placed in the concordance matrix.

Print to screen the following matrix which will be filled in as the instructions progress:

Concordance Matrix

	Brown	Smith	Jones
Brown	--	45	
Smith		--	
Jones			--

Mrs. LeFlore: The same steps are followed to determine the Index of Concordance, assuming that Mr. Smith outranks Mr. Brown. The results are as follows:

Print this formula to screen:

$$\text{CSmith/Brown} = \frac{15 + 0 + 20 + 0 + 20}{100} = .55$$

Mrs. LeFlore: This value is added to the matrix in the appropriate column. **Print "55" to correct column in matrix**

Concordance Matrix

	Brown	Smith	Jones
Brown	--	45	
Smith	55	--	
Jones			--

Mrs. LeFlore: Do you have any questions on what we've covered so far sir?

Mr. Castella: No. I understand the comparison and calculations. Do we just keep repeating the same procedure?

Mrs. LeFlore: I'm glad this is making sense. Yes, the steps are repeated until all of the remaining pairs of alternatives have been evaluated. In an effort to conserve time, the results have been filled in for convenience.

Fill in values for matrix as follows:

Concordance Matrix

	Brown	Smith	Jones
Brown	--	45	35
Smith	55	--	55
Jones	85	65	--

Mrs. LeFlore: We will now move on to the discordance coefficient calculations. Recall the example from our earlier discussion which required choosing between actions A and B. Well, the condition of discordance requires that no criterion favor option B excessively. The discordance coefficient indicates to what extent an option contains discordant elements that might make the option unsatisfactory. Calculation of the discordance coefficient requires unitizing the evaluation scores, not the weight. Just as in the concordance coefficient calculations, the discordant factor's value varies between 0 and 1. A 'fatal' score for the discordance coefficient is 1. The formula for determining discordance coefficients may be summarized as follows:

Print the following formula on the screen:

$$DA/B = \frac{\text{The greatest negative variation (i.e., B outranks A) between the evaluation scores for a single criterion}}{\text{The maximum range between the highest possible score and the lowest possible score}}$$

Mr. Castella: This seems rather overwhelming. Perhaps if we move on to the calculations things will become clearer for me.

Mrs. LeFlore: Fine sir. Feel free to stop me at any time if you have questions or would like me to go over something again. Once again we will perform pairwise comparisons. Let's begin by assuming Mr. Brown outranks Mr. Smith and examine the evaluation scores they received for criteria 1. **Print the evaluation scores matrix to the screen.** Remember, we are looking for the greatest negative variation, so for criteria 1 Mr. Brown received an 8 and Mr. Smith received a 10. Since we are assuming that Mr. Brown outranks Mr. Smith, he would have to outrank him by a negative value of 2. This value is placed in the numerator. **Print the following to the screen:**

D Brown/Smith = Max (2,

Mr. Castella: So for criteria 2, Mr. Brown received an 8 and Mr. Smith received a 1. There is no negative value here so what would the answer be?

Mrs. LeFlore: In this instance, we would assign a value of zero. How about trying the next one?
Print to screen:

D Brown/Smith = Max (2, 0,

Mr. Castella: For criteria 3, Mr. Brown received a 5 and Mr. Smith received an 8. Therefore we would place a 3 in the formula you have on the board. **Print to screen:**

D Brown/Smith = Max (2, 0, 3,

Mrs. LeFlore: Absolutely. To finish off the numerator, criteria 4 would be 0 and criteria 5 would be 5. **Print to screen:**

D Brown/Smith = Max (2, 0, 3, 0, 5)

Mrs. LeFlore: Do you have any questions before we move on to the set of values in the denominator?

Mr. Castella: No. Please continue.

Mrs. LeFlore: Now for the set of values in the denominator, we use the range between the highest and lowest scores which could have been assigned for each criteria. Recall our grading criteria matrix. **Print to screen grading matrix.**

	Criteria				
	1	**2**	**3**	**4**	**5**
Excellent	**10**	**10**	**10**	**20**	**15**
Good	**8**	**8**	**8**	**15**	**10**
Average	**5**	**5**	**5**	**10**	**5**
Fair	**0**	**1**	**1**	**0**	**3**
Weak	**0**	**0**	**0**	**0**	**1**

Mrs. LeFlore: Would you care to take a shot at filling in the appropriate values?

Mr. Castella: Sure. Criteria 1 is 10, criteria 2 is 10, criteria 3 is 10, criteria 4 is 20 and criteria 5 is 14. How did I do?

Mrs. LeFlore: Perfect. Our formula now looks like this: **Print to screen:**

$$\text{D Brown/Smith} = \frac{\text{Max (2, 0, 3, 0, 5)}}{\text{Max (10, 10, 10, 20, 14)}}$$

Mrs. LeFlore: Now we have to select the highest value from each set. In this case, the numerator would be 5 and the denominator is 20. It is important to point out that the denominator value will be the same for all of our calculations. The discordance coefficient is .25.
Print to screen:

D Brown/Smith = 5/20 = .25

Mrs. LeFlore: We create a discordance matrix and place this value in the appropriate column.
Print to screen:

Discordance Matrix

	Brown	Smith	Jones
Brown	--	.25	
Smith		--	
Jones			--

Mrs. LeFlore: Now assume Mr. Smith outranks Mr. Brown. What would our calculation look like?

Mr. Castella: Criteria 1 is 0, criteria 2 is 7, criteria 3 is 0, criteria 4 is 5 and criteria 5 is 0.
Print to screen:

$$\text{D Smith/Brown} = \frac{\text{Max (0,7,0,5,0)}}{\text{Max (10, 10, 10, 20, 14)}}$$

Mr. Castella: The discordant coefficient is equal to 7 divided by 20 or .35.
Print to screen:

D Smith/Brown = 7/20 = .35

Discordance Matrix

	Brown	Smith	Jones
Brown	--	.25	
Smith	.35	--	
Jones			--

Mrs. LeFlore: Fantastic. Now let's go ahead and fill in the rest of the matrix to save time.
Print to screen:

Discordance Matrix

	Brown	Smith	Jones
Brown	--	.25	.25
Smith	.35	--	.50
Jones	.15	.25	--

Mr. Castella: How do we derive a final decision from all of these numbers?

Mrs. LeFlore: The factors from the matrices are used in conjunction with concordance and discordance thresholds.

Mr. Castella: Where do these thresholds come from?

Mrs. LeFlore: They are chosen arbitrarily by the user- you in this case. The concordance threshold, let's call is P, varies from 0.5 to 1, and is more severe as it approaches 1. The discordance threshold which we will call Q, is more severe as it approaches 0.

Mr. Castella: Let's say I decided to make P=.60 and Q=.30. How would I use these values to come to a decision?

Mrs. LeFlore: We create what is called an Outranking Matrix based on an IF-THEN decision table which says the following:
Print to screen while Mrs. LeFlore reads aloud:

If	**Then**
CA/B>=P and DA/B<=Q	A outranks B
CB/A>=P and DB/A<=Q	B outranks A
A outranks B, and B outranks A	The options are equivalent
Otherwise	The comparison is characterized by Indetermination or incomparability

Mr. Castella: Okay. Let's see how the matrix is developed.

Mrs. LeFlore: Well if we look at the situation where we assumed that Mr. Brown outranks Mr. Smith, the concordance coefficient value of .45 is not greater than or equal to our P value of .60. The discordance value of .25 is less than the Q value of .30; therefore we cannot say that Mr. Brown outranks Mr. Smith. A zero is placed in the appropriate column of our matrix. **Print to screen:**

	Brown	**Smith**	**Jones**
Brown	--	**0**	
Smith		--	
Jones			--

Mr. Castella: How can we conclude this when the Q value was less than .30?

Mrs. LeFlore: Only one of the two conditions in the IF statement was met. In order for the THEN statement to be applicable all conditions in the IF statement must be met.

Mr. Castella: Okay. That makes sense. Let me see if I can apply this to the case of Mr. Smith outranking Mr. Brown. Now, the concordance coefficient value is .55 which is less than the P value and the discordance coefficient value is .35 which is greater than the Q value. In this case, the IF conditions are not met and a 0 is assigned. How was that?

Mrs. LeFlore: Great! This is what our matrix looks like so far.
Print to screen:

	Brown	Smith	Jones
Brown	--	0	
Smith	0	--	
Jones			--

Mrs. LeFlore: Let's try one more. How about the case where we assume that Mr. Brown outranks Mr. Jones?

Mr. Castella: The concordance coefficient value is .35 which is less than the P value, and the discordance coefficient is .25 which is less than the Q value. Since both conditions of the IF statement have not been met, a zero is assigned.
Print to screen:

	Brown	Smith	Jones
Brown	--	0	0
Smith	0	--	
Jones			--

Mrs. LeFlore: Just for completeness sake, how about the case where Mr. Jones outranks Mr. Brown?

Mr. Castella: The concordance coefficient is .85 which is greater than the P value and the discordance coefficient is .15 which is less than the Q value. Both conditions of the IF statement have been met. According to the IF-THEN Decision Table, Mr. Jones does outrank Mr Brown. What value do we place in the matrix?

Mrs. LeFlore: We place a 1 in the matrix. I will go ahead and fill in the rest of the matrix with the appropriate values.
Print to screen:

	Brown	Smith	Jones
Brown	--	0	0
Smith	0	--	0
Jones	1	1	--

Mrs. LeFlore: Now we are ready to draw some final conclusions. According to our table, Mr. Jones outranks both Mr. Brown and Mr. Smith, the values of 1 for those conditions support a condition of dominance on the part of Mr. Jones.
Print to screen: (with arrows pointing from Jones to Brown and Smith)

Brown **Smith**

Jones

Mr. Castella: So, Mr. Jones should be selected for the job, but what about the relationship between Mr. Brown and Mr. Smith? Which one is a better choice between those two?

Mrs. LeFlore: I'm glad you asked. We ended up with a case of incomparability between Mr. Brown and Mr. Smith, meaning that we can not prove any relationship between the two. As a result, we cannot draw any conclusions as to the dominance of one over the other.

Mr. Castella: I see. **(Standing and walking over to shake Mrs. LeFlore's hand)** This has been a great learning experience for me. I see now why Mr. Andrews was so excited about all of this. Thank you for taking the time to demonstrate the Electre Method for me today. I highly endorse your teaching this to all of our Department Managers.

Mrs. LeFlore: Thank you for your kind words sir. It has been my pleasure. I look forward to helping anyone who is interested in applying this method for other decision making situations.

Mr. Castella: I will have Mr. Henry send out a memo to all the Department Managers. Thank you again and have a nice day.

Mrs. LeFlore: You're welcome sir. Good-bye **(Mr. Castella departs)**

Fade out.....

APPENDIX B. LINGO SAMPLES - MACROMEDIA'S PROGRAMMING SCRIPT LANGUAGE

This appendix presents selected examples of Macromedia's script language Lingo. Lingo was used to control movie cast member characteristics, navigation, interactivity, and playback timing within the ELECTRE 1 training movie. A helpful listing of Lingo commands is provided in the Director 6 documentation and in Director 6's Help files. Examples of Lingo script can also be found on the Internet at the Macromedia Web site and links to other sites provided there.

A. Controlling Cast Member Characteristics

Sound Cast Members:

```
on enter frame                - reduces the sound play back level of a sound cast
   set the soundLevel to 1    member when the movie player enters the frame
end
```

B. Navigation

Moving to specific areas of the when with user input movie:

```
on mouseUp                    - movie player goes to the "welcome" flag within
   go to "welcome"            the movie when the left mouse button is "up" after
end                           being clicked.
```

Movie navigation without user input:

```
on exitFrame                  - keeps the playback of the movie within a frame
   go to the frame            indefinitely waiting usually to wait another
end                           command
```

Navigation to a different movie outside of the current movie:

```
on mouseUp                    - Goes to and starts downloading another movie
   gotoNetMovie "http://www.cimnet.nps.navy.mil/coop/brief2/brief2.dcr"
end
```

C. Interactivity

Provide feedback to the user given a specific input:

```
on mouseUp                    - Provides the audible reply "clap" to the user for
   puppetSound "clap"         the input of mouse up
end
```

Allow user to control play status of the movie:

```
on mouseUp          - Stops the movie at the present location waiting
  pause             for another input
end
```

D. Control Playback Timing

Control synchronization by delaying within a frame

```
on enterFrame       - Stops the visual playback in a given frame
  delay 6 * 60      while the sound channel continues to play the
end                 audio member (delay is designated for 6 seconds)
```

APPENDIX C. Co-oP TRAINING SURVEY

Please complete the following questionnaire after you have viewed the Decision Support System training provided at the **http://cimnet.nps.navy.mil/coop** web site. In particular, we are interested in your feedback regarding the ELECTRE 1 movie. Completing the questionnaire should not take more than 15 minutes. Thank you in advance for your time and interest in providing feedback for this project!

First Name _____ Last Name _____ E-mail _____
(Filling in the personal information fields above is optional)

1. How much did you know about Decision Support Systems (DSS) prior to the training session?
   - O A lot
   - O A fair bit
   - O A little
   - O None

2. How much did this training session add to your knowledge about DSS?
   - O A lot
   - O A fair bit
   - O A little
   - O None

3. How much did you know about the ELECTRE 1 model?
   - O A lot
   - O A fair bit
   - O A little
   - O None

4. How much did this training session add to your knowledge about the ELECTRE 1 model?
   - O A lot
   - O A fair bit
   - O A little
   - O None

5. To what degree do you feel this training session explained the concept of Concordance?

- O A lot
- O A fair bit
- O A little
- O None

6. To what degree do you feel this training session explained the concept of Discordance?

- O A lot
- O A fair bit
- O A little
- O None

7. To what degree do you feel this training session explained the application of these concepts to the process of decision making?

- O A lot
- O A fair bit
- O A little
- O None

8. Do you feel you will be able to apply this DSS model to a decision-making requirement as a result of this training session?

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

9. How did you access this training program?

- O Local hard drive
- O CD ROM drive
- O WWW (Internet)
- O Other

10. The quality of the web site pages is:

- O Very good
- O Good
- O Average
- O Bad
- O Very bad
- O No opinion

11. Did you try to download the Director Shockwave movie?

- O Yes
- O No

12. Could you download it?

- O Yes
- O No

13. How long did it take you to down load of the movies (Minutes)?

Part 1: _____ Part 2: _____

14. Did the movie play correctly on your machine?

- O Yes
- O No

15. What is the speed of your Internet connection?

- O 14.4 Modem
- O 28.8
- O 36.6
- O 56
- O 128
- O T1
- O Other

16. The response time is:

- O Very good
- O Good
- O Satisfactory
- O Unsatisfactory
- O No opinion

17. Despite some time delay factor, demonstration movies on the Web are of practical use for teaching and learning.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

18. Using a Web document is a good and practical way to distribute teaching materials.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

19. As shown by this courseware, multimedia makes the learning process better.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

20. Both sequential access (following the arrows through the tutorial) and branching (via hyperlinks and buttons) are allowed in these documents. Do you think that this is a good way to organize a courseware?

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

21. Hyperlinks in the text make it easier to learn.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

22. The courseware is easy to learn and efficient to use.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

23. The courseware is pleasant to use.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

24. It is easy to remember how to use the courseware.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

25. The courseware is interactive or potentially interactive.

- O Strongly agree
- O Agree
- O Disagree
- O Strongly Disagree
- O No Opinion

26. If you are learning/teaching or want to learn/teach DSSs, will you use this courseware or similar documents on the web?

- O Yes
- O No
- O Not applicable

27. The transitions within the movie when played from the Internet may not always be smooth. If you use this package as a training aid tool, this is:

- O Quite acceptable
- O Acceptable
- O Unacceptable
- O Definitely unacceptable
- O No opinion

28. How would you rate the quality of the animations?

- O Very good
- O Good
- O Average
- O Bad
- O Very Bad
- O No opinion

29. How would you rate the quality of picture and other artwork?

- O Very good
- O Good
- O Average
- O Bad
- O Very bad
- O No opinion

30. Are you familiar with the World Wide Web (WWW)?

- O Very much
- O Pretty much
- O So so
- O Not really
- O Not at all

31. Are you familiar with computers?

- O Very much
- O Pretty much
- O So so
- O Not really
- O Not at all

32. Are you familiar with multimedia applications?

- O Very much
- O Pretty much
- O So so
- O Not really
- O Not at all

33. Are you familiar with computer based training (CBT) applications?

- O Very much
- O Pretty much
- O So so
- O Not really
- O Not at all

34. How have you accessed and run a multimedia/CBT training course in the past (select all that apply)?

- O CD-ROM (Stand-alone or LAN based)
- O Intranet application
- O Internet application
- O Not applicable

35. What kind of microprocessor did you use for running this training product?

- O 486-Based Microcomputer
- O 586-Based Microcomputer
- O Pentium-Based Microcomputer
- O Other
- O Don't know

36. Please specify the amount of system RAM in your microcomputer?

- O 8 Meg RAM
- O 16 Meg RAM
- O 32 Meg RAM
- O More than 32 Meg RAM
- O Don't know

37. For my personal training needs, I prefer multimedia/CBT based training for the following reasons (select multiple answers if applicable):

- O It is more effective than reading a book
- O It can be replayed many times
- O It can be completed at my own pace
- O It cost less than instructor lead training courses
- O No opinion

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