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THE DESIGN AND DEVELOPMENT OF A THEORETICALLY
GROUNDED HYPERMEDIA LEARNING ENVIRONMENT: EASE
HISTORY

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BRIAN PATRICK COLLINS

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Doctoral degree in Educational Psychology and
Educational Technology

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THE DESIGN AND DEVELOPMENT OF A THEORETICALLY GROUNDED
HYPERMEDIA LEARNING ENVIRONMENT: EASE HISTORY

By

Brian Patrick Collins

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Educational Psychology and Educational Technology

2009

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ABSTRACT

THE DESIGN AND DEVELOPMENT OF A THEORETICALLY GROUNDED
HYPERMEDIA LEARNING ENVIRONMENT: EASE HISTORY

By

Brian Patrick Collins

Learning environment design and development is essential for the field of educational technology, because it is a relatively new field compared to many disciplines of scholarly inquiry. The focus of this dissertation is on the design and development of the EASE system and the general design of EASE History, a case-based learning environment that is grounded in learning theory and designed to support nonlinear work with content related to history and civics content. EASE stands for experience acceleration support environment. It was given this name because the EASE environment's use of new video techniques and arrangement of cases might shorten the amount of time that learners require to develop expertise, for cases are revisited in multiple contexts and examined from different perspectives. This dissertation will examine EASE History design through multiple lenses, because a rich, multi-perspectival of the account of the system will allow the value-added of each perspective to cumulatively build to a more complete picture. It will be argued that the program has clear fidelity to the underlying theoretical ideas that supported the design and development of the program and demonstrates what the theoretical ideas would look like in practice. The dissertation will also describe lessons learned about computer learning environment design from a detailed examination of the design process.

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ACKNOWLEDGMENTS

I would like to thank Rand Spiro, Aparna Ramchandran, Jeffrey Caulum, and the

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CHAPTER 1

INTRODUCTION

The focus of this dissertation is on the design and development of a hypermedia learning environment based on learning theory. EASE History, a specific application of the EASE system, is an online learning environment that features over one thousand cases related to historical events, campaign advertisements, and core values.

Origins of the Name

The entire hypermedia system featured in this dissertation is referred to as "EASE". This acronym stands for "experience acceleration support environment". "EASE History" refers to a specific implementation of the EASE system that features history and civics content.

The approach of this dissertation is to apply a critical mindset to the design of EASE History, including the placement of the program, and the theory that supports its design, in context, seeing how the program connects with other kinds of approaches, and examining the program from multiple perspectives.

Overview

The field of educational technology is relatively new compared to many disciplines of scholarly inquiry. As a field that is still very much in development, paradigms for scholarly work in the area continue to evolve, along with an ongoing process of calibration of the needs of the field and traditions of scholarship connected to educational technology.

Educational psychology, a related field of educational technology, has tended to privilege empirical research over computer-supported learning, but it could be argued that learning environment design and development is equally important for the field of educational technology, independent of data collection. It also could be argued that learning environment design and development results is its own kind of data, independent of the study of learning effects and that there are multiple stages of learning environment development that may stand on their own as works of scholarship for several reasons.

First, the process of design is interesting in its own right. One important reason for having thorough and insightful descriptive accounts of the design of an actual hypermedia learning system is to inform similar efforts in the future. The field would benefit from knowing details of earlier development efforts. Another reason that an account of the design of an actual hypermedia learning system is that design is a proper field of study. The present dissertation is not intended as a contribution to the literature of design, except perhaps in an indirect manner. The intent of the dissertation is to provide useful data about a specific kind of hypermedia design and development, one that might advance knowledge about the design of hypermedia learning environments.

Second, the production of an actual, working system, available to all for their scrutiny, is a kind of educational technology data as well. It is a kind of existence proof, showing that something that can be imagined can be built. Too often, work in areas like artificial intelligence and educational technology consists of theoretical conjecture. Building a working system shows that theoretical ideas of system design can be actualized. In artificial intelligence, this is the primary form of data, and its importance is captured by the AI slogan, "demo or die". The working program demonstrates that a

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proposed set of ideas can be actualized in a full-functioning program. The goal is even more important given the relative rarity of having large-scale, full-blown systems (rather than "toy" systems that implement a small part of what would ideally be a much larger system) of the type found in this dissertation.

Third, the functioning program makes ideas expressed in the abstract concrete. Often one reads abstract and theoretical proposals in the educational technology field and is not sure what the ideas would look like in practice. The working program concretizes ideas and shows what the ideas would look like in a large-scale, fully operating system of the type developed for this dissertation.

Fourth, with the ideas in concretized form, it becomes possible to evaluate the face validity of the finished program. The program can be examined to answer questions such as the following: Does the instantiation of the underlying theoretical ideas have clear fidelity to those ideas? Does the program offer compelling examples of how its design is matched to the achievement of its design goals? What can be learned about computer learning environment design from a detailed examination of the design process?

Fifth, the development and design effort to create a working program can be compared, contrasted, and integrated with other kinds of related activities in educational technology.

For all of these reasons, it seems entirely appropriate for a dissertation in the field of educational technology to have two primary components absent the presentation of data on effects of use, the details of system design and development and the program itself, as two kinds of data that might be useful to the developing field of educational

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technology. Because the production of a working system is arguably the greatest challenge in educational technology, the EASE system itself is the central aspect of this dissertation.

In this analysis, a premium will be placed on being critical, on contesting and deconstructing assumptions, and on contextualizing work in a larger context. An effort to achieve such a critical stance is another characteristic of this dissertation.

In summary, the goal of this dissertation is to provide a view of the development of a full-fledged, functioning, large scale hypermedia learning environment as data and analysis, appropriate to the field of educational technology in all ways outlined in this section. The working program itself is as integral to the dissertation as the text, and is meant to be used in conjunction with the reading of the text.

Theoretical Origins

This dissertation examines design through multiple lenses, because any single lens will be inadequate. Design is not a well understood area, and the hope is this rich, multi-perspectival account of the system will allow the value-added of each perspective to cumulatively build to a more complete picture. Program design is examined from the following perspectives: the Cognitive Flexibility Theory (CFT) perspective, the theory that supported program design; narratives concerning the design and development of EASE and EASE History; the examination of program features from different learning perspectives; an overview of EASE History, a full-fledged, working system; examples of how EASE History might support history and civics learning; the perspectives of five contemporary, online programs and KANE, a previously built Cognitive Flexibility Hypermedia (CFH) system; a critical lens that problematizes CFT and discusses changes

that might be made to the program; and a design framework from the field of design itself. It is worth noting that the emerging discipline of "design" itself is only one of the lenses applied. As Chapter 6 demonstrates, much of what a prominent framework from the area of design reveals is redundant with perspectives that had been applied to the program in earlier chapters in this dissertation.

The literature review reflects the dissertation's focus on the design and development of a CFH system by providing an overview of relevant research from hypertext and hypermedia literature regarding the definition of related terms, an historical review of hypertext and hypermedia, a review of specific hypermedia features, hypermedia applications, and research related to hypermedia learning, with special attention to six areas of hypermedia learning research that study individual differences in order to find ways to reduce disorientation and cognitive load. They are: learning styles, advance organizers, site maps, information structure, learner control mechanisms, and mixed media effects.

Chapter 3 provides an overview of CFT, a constructivist learning theory that is designed to support learning in ill-structured domains, where general principles do not account for enough of the variability in the way knowledge has to be applied. According to the theory, learners must have experience with a large number of cases to see the different ways that conceptual knowledge is combined and applied in real world contexts. The theory also argues that new media might support nonlinear work with cases. CFT is compared and contrasted with Cognitive Theory of Multimedia Learning (CTML), a learning theory that, like CFT, is designed to support hypermedia learning and the

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construction of hypermedia systems. CTML's approach to the design of educational hypermedia is discussed in this chapter.

Chapter 4 describes the design and development of the EASE system and discusses how design decisions were made based on learning theory, the affordances of specific technologies, limits on time and financial resources, usability issues, and programmer expertise. The development of the EASE system began in spring 2003 and the program was operational in summer 2004. The EASE system is designed to support nonlinear juxtapositions of cases, hold an array of multimedia, support learning in multiple ill-structured domains, and have a database-driven design that enables non-programmers to create, maintain, and modify projects. Chapter 4 provides an overview of program features, the theoretical motivation behind program features, compares those features with other computer learning environments, and examines the features from the perspectives of multiple learning theories.

Chapter 5 provides an overview of the design and development of EASE History, describing the costs, in terms of effort and financial resources, to develop EASE History, and the development of program content. Chapter 5 discusses the initial difficulties that I had securing copyrighted materials, the gathering of public domain images and videos, and the researching of the domains of advertising, civics, political science, and history that supported the development of themes and case specific content. Chapter 5 also describes the deployment of the system, including efforts to promote EASE History. This chapter discusses lessons learned from designing the EASE and EASE History programs. These lessons, related to design, include: the need to adapt to new situations, tolerate uncertainty, compare and contrast multiple programs, place programs in context,

compensate for an individual program's weaknesses by taking advantage of the strengths of other programs, and apply learning theory to program design. In order to demonstrate how the description of program use matches what is done when the program is actually used, Chapter 5 provides a tour of EASE History and an example of how one might use the Weave viewing mode to examine how music is applied in similar and different ways in campaign advertisements.

Chapter 6 applies a framework from the discipline of design, outlined in *The Design Way,* a book authored by Nelson and Stolterman (Nelson & Stolterman, 2003; Stolterman, 2008), to the design of EASE programs. The authors advocate the use of a "rich set of rigorous and disciplined design methods and techniques" (Stolterman, 2008) to support the examination of program design from multiple perspectives (Nelson & Stolterman, 2003, p. 108). The authors argue that this kind of approach might support innovation in the complex world. The Nelson and Stolterman (2003) framework is one that is designed to support the examination of the complex nature of systems using the following lenses: the ability of designers to adapt to new situations, the establishment of a project as a purposeful activity, and limits on time and financial resources that shape design decisions.

Chapter 7 features a detailed hypothetical exploration of EASE History in order to simulate what a student might do when working with cases coded on 'freedom' in EASE History, an online hypermedia environment that is designed to support a deeper understanding of concepts by showing how the application of concepts vary across cases – and the need to place events in context and examine cases from multiple perspectives. In order to convey some of the potentialities of the system, the reader is invited on a

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hypothetical exploration, or a kind of "thought experiment", to examine the system

through the lens of a more sophisticated understanding of freedom.

Six learning programs are used in Chapter 8 to situate EASE History and examine

the tension between what the built environment does and what other learning

environments do. The six environments that are used to situate EASE History are:

KANE, Living Room Candidate, The Valley of the Shadow, MediaMatrix, Scratch, and

Google Search. EASE History is compared and contrasted with KANE, a previously built

CFH system. This chapter argues that EASE History builds upon KANE, because it

features online videos, multiple theme searches, a database, multiple viewing modes, a

timeline, and mindset modeling videos. The six programs are compared and contrasted

from multiple perspectives, including CFT, Cognitive Load Theory, CTML, Project

Goals, and New Media perspectives. Chapter 8 also describes ways that programs might

be integrated in order to take advantage of individual program strengths and compensate

for program weaknesses.

EASE History is critiqued as a finished product in Chapter 9. The

problematization of CFT includes: CFH systems do not replace real world experience;

larger versions of CFH programs are more difficult to test than smaller ones; the use of

the term "case" is problematic in CFH systems, because it is often used ambiguously; and

previously built CFH programs have not taken advantage of the strengths of other

programs. The critique of EASE programs in Chapter 9 also includes: an explanation of

the rationale behind certain content and design choices and a discussion of why some of

the design choices that I made during the development of the program might not be ones

that I would make today; an examination of EASE History's use of multiple viewing

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Chapter 10 evaluates the face validity of the finished program from the following perspectives: Does the instantiation of the underlying theoretical ideas have clear fidelity to those ideas? Does the program offer compelling examples of how its design is matched to the achievement of the design goals? What can be learned about computer learning environment design from a detailed examination of the design process? Chapter 10 also describes the limitations of the work presented in this study, and future directions, including the development of a research program that evaluates how individuals learn when placed in EASE History and a brief description of how lessons learned from designing the EASE programs might be applied to the design of a new application.

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CHAPTER 2

LITERATURE REVIEW

Chapter 2 examines literature that informed the design of the EASE system. This chapter provides an overview of relevant research from hypertext and hypermedia literature regarding the definition of related terms, an historical review of the media, a review of specific hypermedia features, hypermedia applications, hypermedia learning research, with specific focus on six areas that examine issues related to how individual differences influence performance in hypermedia systems: learning styles, advance organizers, site maps, information structure, learner control mechanisms, and mixed media effects.

Hypertext

Hypertext is interconnected text in a digital format that enables users to explore content in nonlinear directions. Carlson describes hypertext as "nonlinear prose, interactive print, or dynamic text using electronic capabilities to overcome the limitations of linear, printed text" (Carlson, 1990, p. 16). Conklin describes hypertext as "a computer-based medium for thinking and communication" (Conklin, 1987, p. 32). Heller describes hypertext as "a nonlinear database with tools for selecting information from the database and presenting the information to the user" (Heller, 1990, p. 431).

Vannevar Bush is credited with the idea for hypertext programs. In 1945, in an article published in the *Atlantic Monthly*, he proposed a mechanical device called Memex that would store associated information, including books, pictures, periodicals, newspapers, and annotations from microfilm recordings, which could "be consulted with

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exceeding speed and flexibility". Bush wrote, "It is exactly as though the physical items had been gathered... from widely separated sources and bound together to form a new book. It is more than this, for any item can be joined into numerous trails" (Bush, 1945, p. 107). Bush argued that the system could supplement memory thus extending the human mind. The Memex was never built but served as a driving force in the development of hypertext and hypermedia.

Ted Nelson invented the term "hypertext" in 1963. Nelson defined hypertext as "non-sequential writing". Like Vannevar Bush, Nelson argued that hypertext is free from the constraints of sequence imposed by printed materials and more closely resembles the associative nature of the mind. Nelson wrote,

> It (the human mind) operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is transitory. Yet the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else in nature.

Ted Nelson and Douglas Engelbart, working separately, developed two of the earliest hypertext systems. The Xanadu project, developed by Ted Nelson in 1960, was a networked system developed to store and index all of the world's literature and other forms of public and private information and be accessible through a "non-sequential" pattern of branches going in different directions, based on association. The NLS (oN Line System) was developed by Douglas Engelbart in the mid-1960s at the Stanford Research Institute. NLS was a computer-interface that included elements such as hypertext and groupware. The goal of the project was to use computers to support nonlinear work with complex information structures.

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Barthes (1970) argued for the non-hierarchical organization of text in open networks. He wrote,

> In this ideal text, the networks are many and interact, without any one of them being able to surpass the rest; this text is a galaxy of signifiers, not a structure of signifieds; it has no beginning; it is reversible; we gain access to it by several entrances, none of which can be authoritatively declared to be the main one; the codes it mobilizes extend as far as the eye can reach, they are indeterminable; the systems of meaning can take over this absolutely plural text, but their number is never closed, based as it is on the infinity of language.

Hypermedia Learning Systems

With innovations in technology, hypertext environments evolved into hypermedia learning systems, which are designed to promote learning through nonlinear paths connecting video, audio, graphics, and text. Marchionini (1988) wrote that hypermedia systems "take advantage of the random access capabilities of computers to overcome the strictly sequential medium of print on paper" and extend "the nonlinear representation and access to graphics, sound, animation, and other forms of information transfer". Others describe how hypermedia systems offer, "rich, authentic contexts that can increase engagement and help learners develop more complex views of issues" (CTGV, 1992). Heller (1990) argues that hypermedia systems support unplanned opportunities for exploration. Shin, Schallert, and Savenye (1994) emphasize the benefits of self-directed, non-sequential, dynamic hypermedia environments. Spiro & Jehng (1990) argue that different nonlinear paths enable users to explore multiple interpretations of the same topic.

Features of hypermedia. Hypertext and hypermedia, hypermedia and multimedia, are often used interchangeably in literature, since nodes and nonlinear links are the basic elements of the systems (Altun, 2000; Jonassen, 1989). Marchionini describes nodes as

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"the information units" such as paragraphs, images, and articles (Marchionini, 1988, p. 8). Similarly, Jonassen (1989) defines nodes as information fragments, which may include text, video and audio segments, and graphics.

Conklin (1987) argues that links are the essence of hypertext as they support nonlinear paths between nodes. He describes two types of links: referential links and organizational links. Referential links connect a source in the current node to a referent in the destination node. Organizational links connect a parent node to its children in a tree fashion. Marchionini (1988) argues that links can be both explicit and implicit. Explicit links are suggested paths through linked information, while implicit links are used often as guided tours. Marchionini also describes how links "offer learners individualized access to rich intellectual environment" (Marchionini, 1988, p. 9).

Xerox's NoteCards, Apple Computers' HyperCard, and KANE are examples of hypermedia systems developed in the 1980s. NoteCards was released in 1985. It featured scrolling windows for each notecard, pre-formatted specialized notecards, and a separate browser/navigator window. HyperCard was introduced in 1987. The hypermedia program integrated a database with a graphical and customizable interface, enabling users to build local stacks of cards on a single machine. It was included free with all Macintosh machines and is credited with popularizing hypertext. The KANE (Knowledge Acquisition in Nonlinear Environments) hypermedia learning environment, the first hypermedia system based on CFT, was launched in 1987 by Rand Spiro and his team at the University of Illinois. KANE content was stored on a videodisc, which was divided into twenty-five video cases that were between thirty to ninety seconds in length. Each case was coded on themes like ambition, power, fallibility, and lifelessness. Text

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descriptions and expert commentaries were available as case resources. The program was designed to support the understanding of the processes of literary interpretation through work with the film, "Citizen Kane". In the hypermedia system users compared and contrasted cases from multiple perspectives, placed cases in context, and examined interdependent themes through nonlinear work in a computer environment.

In 1991 Tim Berners-Lee demonstrated a World Wide Web server, which stores nodes of information that could be accessed by nonlinear hyperlinks. He developed HTML (HyperText Mark-up Language), a coding system that enables content creators to create links and created HTTP (HyperText Transfer Protocol) that enables content to be linked together on computers across the Internet. At first the Web server hypertext editor only stored information in text format, but later included other types of media, including audio and video.

Advocates of hypermedia learning argue that the systems have the potential to support more advanced learning, because they externally represent the way humans think (Fideria, 1988; Jonassen, 1986; Quillian, 1986). Studies have shown that hypermedia systems promote transfer and are more effective than traditional teaching methods (Jacobson & Spiro, 1995; Jonassen, 1996; Koehler, 2002). Participants in a literacy instruction program were randomly assigned to experimental and control conditions (Palincsar, Spiro, Collins, & Ramchandran, 2007). The researchers kept content, time on task, and assessments the same for both conditions. The only difference was that the control condition worked with content in a linear fashion, while the experimental condition worked with content in a nonlinear CFH system. Study results suggest that the experimental group demonstrated a deeper understanding of domain concepts in

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Problems with hypermedia use often relate to disorientation (Conklin, 1987; Heller, 1990; Jonassen, 1989; Liu, 1994; Marchionini, 1988; McDonald & Stevenson, 1999), and cognitive overload (Conklin, 1987; Jonassen, 1989; Liu, 1994). Roselli argued, "A major problem with hypertext is that, as the structure of the material becomes more complex, so does the chance of the users becoming lost and disoriented" (Roselli, 1991, 42). The wide range of choices within a hypertext program might produce cognitive overload, for users have to continually assess whether or not it is worth continuing along the current path. Marchionini (1988) identifies two causes that lead to disorientation: the quantity of information to which a user has access and the lack of physical feedback about quantity or scope. This overload may lead to conceptual disorientation.

<div align="center">Individual Differences and Hypermedia Learning</div>

This section provides a general overview of studies that have examined how individual differences influence performance in hypermedia systems. The six research areas are: learning styles, advance organizers, site maps, information structure, learner control mechanisms, and mixed media effects.

Learning styles. In order to design hypermedia systems that might better support individual differences, researchers have examined how learning styles (i.e., thinking, remembering, perceiving, problem solving) influence performance in hypermedia systems.

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Kolb's Learning Style Inventory (LSI) and Witkin's Group Embedded Figures Test (GEFT) are two examples of cognitive style tests used to evaluate work in hypermedia systems. In the LSI individuals are divided into convergers/divergers or accommodators/assimilators. According to Kolb (1984), convergers tend to solve problems through deductive reasoning, while divergers tend to rely on brainstorming and idea generation to solve problems. Assimilators tend to solve problems by inductive reasoning and accommodators through experimentation. An individual learner might utilize combinations of the four components but be more inclined toward one mode. In the GEFT individuals are described as field independent, who demonstrate reductive thinking, and field dependent, who have greater awareness of the importance of context.

Two studies reviewed utilized the LSI to determine participant learning style. A study by Rasmussen and Davidson-Shivers (1998) used the LSI and found that accommodative learners scored higher when using the hierarchical structure in immediate and delayed post-tests, while assimilative learners scored higher on tests when they used a hierarchically structured system that enabled them to link nodes. To the authors of the study, the results suggest that accommodative learners may have preferred the efficiency of the hierarchically structured hypermedia system, and the assimilative learners may have preferred the ability to structure program content. A study by Kettanurak et al. (2001) used the LSI and found that modes of interaction (e.g., no interactivity, low interactivity, and high interactivity) in a hypermedia system had no significant effect on attitude, regardless of learning style with participants preferring high levels of interaction.

Three studies reviewed used the GEFT to determine participant learning style. A study by Chou and Lin (1998) used the GEFT to examine the effects of cognitive style on

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searching, cognitive map development (ability to reconstruct the relationships among hypermedia topics), and attitude. The authors found no main effect for cognitive style on searching and attitude, but field-independent participants scored significantly better on the cognitive map test. A study by Palmquist and Kim (2000) examined participants performing web site searches and found a significant effect for field dependency but saw its importance diminish as participants gained experience. Participants with little online experience and who were field dependent spent more time and visited more nodes than the field independent students with comparable online experience. A study by Jonassen and Wang (1993) found that field independent subjects generally preferred to impose their own structure on information rather than accommodate the structure that is implicit in the materials. From these findings the authors concluded that it was likely that field independent learners benefit from hypermedia that is more referential and less structured.

Findings from a study by Ford and Chen (2001) seemed to point to the benefits of matching cognitive style to learning experience. In the study participants were asked to develop web pages using a hypermedia tool. Participants were either matched or mismatched to their cognitive styles. Learning benefits for subjects in the matched conditions was significantly higher as compared to those in mismatched conditions.

Advance organizers. Advance organizers, in multiple forms (i.e. concept maps, spatial maps, text-based lists), are designed to help users become aware of how hypermedia systems are structured. There is evidence of their effectiveness to support learning outcomes with text (Glover & Krug, 1988; Kraiger, Salas, & Cannon-Bowers, 1995; Snapp & Glover, 1990; Townsend & Clarihew, 1989), but the effectiveness of advance organizers with hypermedia has been mixed. Dillon and Jobst offer one

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explanation, "the endless possibilities for design within hypermedia means that such representations could take multiple forms thereby complicating any recommendation on their use" (Dillon & Jobst, 2005, p. 573).

McDonald and Stevenson (1999) examined the differences between advanced organizers, including spatial, conceptual maps and text-based lists and no advance organizer use, when learners with low prior knowledge used a science hypermedia program. The spatial map seemed to support more efficient navigation in the first experiment, as compared to the other overview conditions, but there was no significant difference in learning outcomes between the overview conditions. The condition unaided by an advanced organizer performed worst on navigation and learning measures. In the second experiment, subjects without an advance organizer navigated poorly, but learned more than those in the spatial map group. According to Dillon and Jobst, "this suggests that having to form linkages and structures for oneself may encourage active processing of the text, which could enhance learning" (Dillon & Jobst, 2005, p. 574).

Benefits of advanced organizers accompanying hypermedia learning environments have been reported in studies using a control group. A study by Brinkerhoff et al. (2001) found that advanced organizers did not affect post-test scores, but participants in the overview condition spent more time in the system and had a more positive attitude. A study by Yeh and Lehman (2001) examined effects of the presence or absence of an advance overview. They reported that an advanced organizer improved post-test performance. Advanced organizers for a hypermedia learning program for biology used by students with low prior knowledge of featured content showed no

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Other studies have compared different types of advanced organizers without a control group. A study by Chou and Lin (1998) examined how cognitive style affected searching, cognitive map development, and attitude. The results of the study suggested that global maps were more supportive than local maps, but an interaction was not found between cognitive style and map type. A study by Hofman and van Oostendorp (1999) examined the use of advanced organizers as compared to lists and found that advanced organizers were more useful in a hypermedia learning science program, although the advanced organizers seemed to not benefit less knowledgeable users.

Site map structure. Hypermedia site maps represent how site content is organized within a system. Site map structures are designed to support user navigation through the system, reducing issues of disorientation that users often experience in hypermedia systems (Shapiro, 2005).

Findings from research on the effectiveness of site maps to support learning goals has been mixed. Chen and Rada, in a review of studies concerning hypertext learning programs, concluded that site maps "appear to be necessary for users to dealing with large and complex information structures and to be useful to resolve the problems of disorientation and high cognitive overhead" (Chen & Rada, 1996, p. 149). Other studies have shown little or no benefit of site map use. A study by Wenger and Payne (1994) found that the availability of a site map had no significant impact on learner recall and understanding of program content, but did have an impact on more efficient navigation

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A study by Shapiro (1998) found that participants with high levels of prior knowledge were able to create representations of program content. These participants needed less assistance from the site map. The findings from the study also suggest that there were learning benefits when site map information was explicit for subjects with low levels of prior knowledge.

Structure of information. Information structure describes the organization of the physical structure of hypermedia systems. For example, a system's nodes and links can have a hierarchical or a networked arrangement.

Many studies have not found a correlation between how information is structured in hypermedia learning systems and learning outcomes. A Melara (1996) study found that structure (hierarchical versus network) did not affect post-test scores, but that learners spent significantly more time using the hierarchical structure than the network structure. A Shapiro (1998) study compared learning outcomes between the linear and strictly hierarchical structures of a history hypermedia system. Subjects using hierarchical hypertext showed significantly more factual knowledge acquisition, but no significant differences on short-answer questions or the essay question. According to Shapiro (2005), the findings from the study suggest that structure is not a leading cause of learning outcome. Shapiro's hypothesis has been supported in multiple studies (De Vries & de Jong, 1997; McDonald & Stevenson, 1996; Spruijt & Jansen, 1999).

Learner control mechanisms. A review of literature by Dillon and Gabbard found that "one of its [learner control mechanism's] greatest benefits is that the learner can

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control the learning situation and this factor was deemed generally significant" (Dillon &

Gabbard, 1998, p. 576). Findings from a study by Jacobson et al. (1996) suggest that

providing learners in hypermedia systems with control improved learning on short

answer and essays, as compared to learners with no control over movement through

content. A study by Yeh and Lehman (2001) found that participants who had control in

the hypermedia system had higher scores on recall tasks.

Mixed media. The use of well-organized mixed media (text, photos, video, audio)

to support learning has been described as "the greatest promise of hypermedia learning

tools" (Dillon & Jobst, 2005, p. 575), but empirical research on the effects of hypermedia

learning is limited. A study by Kalyuga et al. (1999) suggested that there were learning

benefits when information accompanying the diagram was read aloud instead of being

presented on screen, while the presentation of information both visually and aurally

negatively impacted learning. A Mayer and Moreno (1998) study demonstrated that

concurrent narration that paired spoken words to an animation sequence was more

beneficial than providing students with explanatory text matched to the animation

sequence. According to the authors, the effect might be due to the added load of text on

visual processing, while audio takes advantage of the learner's dual processing capacity.

Findings from a Kalyuga et al. (1998) study showed that study participants with low prior

knowledge preferred diagrams with text, while more participants with higher levels of

prior knowledge found diagrams with text explanations to be redundant. Gains in

experience and competency impacted learner preferences and learning benefits of one

type of material over another (Kalyuga et al., 2000). (Note that the multiple

representations discussed here are different from the multiple conceptual representations

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Some have called for the teaching of new strategies to support hypermedia learning. Jonassen (1989) argues that effective learners need meta-cognitive strategies to understand, integrate, and synthesize information. Liu (1994) calls for a new type of literacy that can support effective learning in hypermedia environments. Hypermedia literacy is an example of an area of scholarship that studies ways to help learners remain oriented during traversals through hypermedia systems that feature ill-structured content (Daniels et al., 2002; Horton, 2000; Lee & Hsu, 2002; Piacciano, 2001), and develop the ability to create mental models of the networked content.

Learning is complex, as it is comprised of multiple, interconnected factors. The research is clear that individual differences exist among learners. These differences should be considered when designing hypermedia systems. Further research is needed on how individual differences influence performance in hypermedia systems, in order to find ways to better manage complexity by reducing learner disorientation and cognitive load in hypermedia systems.

Ideas from literature informed the design of the EASE system in a general way, but also, in some of its specifics. For example, the evolution of hypermedia systems is reflected, in the description of how, EASE History builds upon, and improves on, previous CFH systems. The need to limit disorientation and cognitive overload by providing feedback about the quantity or scope of materials, as discussed above, is reflected in the design of the search history feature.

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CHAPTER 3

HYPERMEDIA LEARNING THEORIES

One of the most frequent criticisms of systems in educational technology is that they are ad hoc, driven by the power of the technology rather than guided by theory. Accordingly, Chapter 3 examines two of the most prominent hypermedia learning theories, Cognitive Flexibility Theory (CFT) and the Cognitive Theory of Multimedia Learning (CTML) (Dillon, 2005, p. 570).

Cognitive Flexibility Theory

CFT is a constructivist learning theory that "emphasizes an adaptively creative response to new situations, rather than the more mechanical following of routinized schemes that already exist in memory" (Spiro et al., 2003). The theory is designed to support learning in ill-structured domains where general principles do not account for enough of the variability in the way knowledge has to be applied. Instead, learners must have experience with a large number of real world cases to see the different ways that conceptual knowledge is combined and applied in real world contexts. CFT argues that the random access capabilities of computers might best promote this kind of nonlinear and multi-perspectival learning (Spiro et al. 1988; Spiro & Jehng, 1990; Spiro, Collins, & Ramchandran, 2006; Spiro, Collins, & Ramchandran, 2007).

CFT had its origin in the mid-1980s, a time when Schema Theory was the dominant model of learning (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987; Spiro, Coulson, Feltovich, & Anderson, 1988). Schema theory (e.g., Ausubel, 1968; Bartlett, 1932; Bransford, 1977; Minsky, 1975) is "an approach that placed a

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premium on using organized packets of knowledge in memory as a basis for understanding and applying knowledge" (Spiro et al., 2003). Spiro and Myers (1984) noted that the problem with Schema Theory was that one could not have a pre-stored schema for every situation because most domains of knowledge are made up of events or cases that are at best irregularly related to each other. While Schema Theory was designed to support procedural knowledge application, CFT was designed to support learning in complex domains.

Reductive Bias

According to CFT, when faced with complexity, people have a natural tendency to simplify and rely on preconceived notions. This tendency to simplify interferes with the development of complex understanding and the ability to apply knowledge to a wide variety of situations (Spiro et al., 2003; Spiro et al., 1992). According to Spiro (1988), there are seven types of oversimplification:

1. Oversimplification of complex and irregular structure.

2. Overreliance on a single basis for mental representation.

3. Overreliance on top down processing.

4. Context independent conceptual representation.

5. Overreliance on precompiled knowledge structures.

6. Rigid compartmentalization of knowledge components.

According to CFT, problems in ill-structured domains require more than just the procedural application of prepackaged schema. These domains require a more flexible and adaptive approach to problems, but learners, in general, have difficulty transferring learning from one context to new contexts. Problems in well-structured domains, on the

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other hand, have well-defined initial states, goals, and constraints. An example of a well-defined problem is an algebraic equation that has one correct answer. Simon (1973) argues that ill-structured problems include the social, political, economic, and scientific problems that make up everyday life.

Table 1. Ill-Structured vs. Well-Structured Domains

Characteristics of ill-structured domains (Spiro et. al 1987, 1988)	Characteristics of a well-structured domain
1. There can be no unifying laws in ill-structured domains because phenomena are unpredictable.	1. There can be unifying laws in well-structured domains because phenomena are predictable.
2. Conceptual meanings change across uses.	2. Conceptual meanings do not change across uses.
3. Knowledge is web-like not hierarchical.	3. Knowledge is hierarchical.
4. Concepts are interdependent.	4. Concepts are not interdependent.
5. Conceptual variability and multiple representations of knowledge support understanding.	5. Single best cases of knowledge representations support understanding.
6. Many cases are needed.	6. Relatively few cases are needed.

The presence of any of these six characteristics indicates ill-structured knowledge. There is recognition that domains may possess both ill-structured and well-structured aspects (Spiro, 1987; Voss 1987).

CFT is intended to support learning in ill-structured domains by changing "the underlying worldviews (e.g., epistemological beliefs, habits of mind) that an individual employs when approaching the acquisition and use of knowledge," (Spiro et al., 2003) "towards those more compatible with complexity and flexibility" (Feltovich, Spiro, & Coulson, 1989; Mishra, Spiro, & Feltovich, 1996; Spiro et al., 1996). CFT attempts to

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combat early closure by placing a "premium on illustrating the variable uses of concepts across contexts in order to prepare people to better apply conceptual knowledge on their own" (Spiro et al., 2003).

Principal tenets of CFT and its applications to Cognitive Flexibility Hypermedia (CFH) learning environments include:

Conceptual variability and context awareness. Ill-structured concepts are defined through their use, so it is essential that learners see multiple examples of how concepts are applied in real world situations. Early closure, which is all too common, "interferes with the development of complex understanding and the ability to apply knowledge to a wide variety of real-world contexts" (Spiro et al., 2003). Research suggests that transfer is supported when learners are given opportunities to practice knowledge application in a variety of contexts (Carraher & Schliemann, 2002; Gagné, Briggs, & Wager, 1992; Greeno, 1997; Lave, 1988). This active integration of new knowledge into well-organized web-like knowledge structures stands in contrast to rote learning (Bransford et al., 2000; Seixas, 2001; Stearns, 1993, 1998; Wineburg, 2001).

Multiple representations of domain knowledge. There is no single best way to represent knowledge in ill-structured domains, so it is important to use multiple schemata and mental models. "Knowledge that has to be used in many ways has to be represented in many ways" (Spiro et al., 2003, p. 6). According to Spiro et al. (2003), the use of multiple thematic perspectives is necessary in ill-structured domains because it is designed to combat early closure and reveal the complexity of real world cases.

Knowledge is interconnected. CFT argues that conceptual knowledge should be organized in a multitude of different chapter headings and juxtaposed with a number of

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Cases. In order to prepare individuals for real world complexity and variety, CFT advocates work with many real world cases when general principles do not provide an adequate plan of action (see the introduction of for a discussion of how the word "case" is used in CFT and in this dissertation). In order to accelerate the acquisition of that experience and make complexity more manageable, CFT advocates the use of dense, real world cases that have the basic features of complexity but are smaller and easier to work with (Spiro et al., 2003).

There are four components that characterize CFT cases.

1. Cases have the basic features of complexity but are in a more cognitively tractable form (mainly because they span a chronologically short period of time). For example, cases can feature video clips sometimes as short as seven seconds in length.

2. Cases have attached to them resources such as descriptions of context and themes, explanations of how cases are connected, analysis from multiple perspectives, and reminders to not rush to early conclusions.

3. Cases are linked to form an interconnected knowledge network that better reflects the complex world. Linking cases and thematic perspectives support more

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complex and deeper understanding of the domain (Jacobson, Maouri, Mishra, & Kolar, 1995).

4. Cases feature real world events because they are more authentic and better prepare learners to apply knowledge in real-world settings.

CFT and its case-based hypermedia applications, CFH systems, embrace the idea that events, themes, and ideas are interconnected and learning does not proceed in one direction, and that new media, computers being one example, support linear and nonlinear learning. CFH systems have been created for medicine, biology, history, literature, military strategy, and teacher preparation. Cardioworld Explorer, a CFH system, was found to support medical students in their understandings of the complexities of the human heart (Spiro, 1988). Knowledge Acquisition in Nonlinear Environments (KANE) is the first example of a CFH system. The program, launched in 1987, was designed to support the understanding of the processes of literary interpretation through work with the film, "Citizen Kane". The hypermedia system was designed to help users examine cases from multiple perspectives, place cases in context, compare and contrast cases, and see how themes are interdependent through nonlinear work in a computer environment. A "Citizen Kane" videodisc was divided into twenty-five video cases that were between thirty to ninety seconds in length. Each case was coded on themes like ambition, power, fallibility, and lifelessness. Text descriptions and expert commentaries were available as case resources. Research findings have suggested that the KANE system supported the learning of complex structures of the film "Citizen Kane" (Spiro & Jehng, 1990).

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CFT argues for the development of critical habits of mind and deep understanding of content through nonlinear work in case-based hypermedia environments, while the CTML proposes a different approach to the effective design of educational hypermedia, the management of cognitive load through control over presentation and pacing.

Cognitive Theory of Multimedia Learning

This section describes the CTML, a hypermedia learning theory. The section begins with a discussion about Cognitive Load Theory and Dual Coding Theory, two theories that support the CTML.

Cognitive Load Theory. Cognitive load is the total amount of mental activity imposed on working memory in an instance of time (Sweller, 1994). Cognitive Load Theory (Chandler & Sweller, 1991; Sweller, 1988, 1994) states that working memory is limited in its capacity to selectively attend to and process incoming sensory data. It is based on the premise that people have a limited working memory (Miller, 1956) and an enormous long-term memory (Chase & Simon, 1973). The theory is based on the deGroot's (1965) analysis of chess grand masters who were consistently able to defeat more novice players with relatively little cognitive effort. The study suggested that the commitment of board configurations and scenarios to long-term memory prepared the grand masters to respond to situations. This finding was supported in a Simon and Chase (1973) that estimated that chess masters require from 50,000 to 100,000 hours of practice to reach that level of expertise and rely on a knowledge base containing some 50,000 familiar chess patterns to guide their selection of moves. The researchers concluded from the study that information stored in long-term memory was what constituted "expertise" (Sweller, 2005a, p. 20).

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According to Cognitive Load theorists, a major function of effective instruction is to increase availability in working memory by reducing cognitive load. Cognitive load has been found to have three components:

1. Intrinsic load reflects the level of complexity of the information to be learned and is determined by the interactivity of elements. When concepts are highly interrelated, the intrinsic load imposes a heavy cognitive load.

2. Extraneous load is caused by the inappropriate elements of instructional design. It is lessened when focus is placed on schema construction and the development of automaticity.

3. Germane load relates to the effective cognitive load that supports learning of new schema construction and automaticity (Paas & Van Merrienboer, 1994). Providing multiple examples increases cognitive load but is likely to support learning so is germane.

Appropriate instructional designs can reduce extraneous load, free working memory and increase germane cognitive load (Sweller, 1990), so the effects of extraneous load have implications for the design of instruction. These effects are: split attention effect, redundancy effect, and modality effect.

1. Split-Attention effect. The split-attention effect (Sweller, 1990) occurs when attention must be split between multiple sources of information causing a higher cognitive load on working memory and impeding learning. This effect can be diminished by more closely integrating textual pieces to eliminate the unnecessary load factor. For example, the placement of text adjacent to an illustration produces less cognitive load for the learner, since less effort is involved in the integration of

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2. Redundancy effect. The redundancy effect occurs when one source of instruction is sufficient to support learning, rather than having redundant sources of information (Chandler & Sweller, 1991). The removal of redundant instructional materials increases available working memory for the process of learning.

3. Modality effect. The modality effect produces increased working memory capacity with the addition of audio narration to a visual presentation in order to support the integration of multiple sources of information (Tindall-Ford, Chandler & Sweller, 1991).

An assumption of Cognitive Load Theory is that humans possess separate channels for processing visual and auditory information. Dual Coding Theory describes these channels.

Dual Coding Theory. According to Dual Coding Theory, humans process verbal and non-verbal information through two independent, but connected, channels (Paivio, 1986. 1990) so words that denote concrete objects can be dual encoded into memory in terms of verbal and non-verbal attributes thus mitigating new information overload of either system. The channels are connected as verbal stimuli activate visual representations, and visual stimuli precipitate verbal representations (Childress, 1995).

The two cognitive channels, each with equal weight, have different functions; the verbal subsystem processes and stores linguistic information whereas the visual subsystem processes and stores images and pictorial information. Multiple studies have found benefits of imagery on learning and retention (Pavlio, 1971). In a study by Schnorr

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and Atkinson (1969) items learned by imagery were recalled at more than 80% accuracy, compared to about 40% by rote learning.

Mayer (1997, 2001) outlines three cognitive assumptions from the dual coding perspective that are responsible for multimedia learning. The first assumption is that text is processed and encoded in verbal channels and pictures are processed in both verbal and visual channels. Because of the double encoding, pictures may be more memorable than text (Paivio, 1986). The second assumption is that there are limits to the amount of information that both channels can process (Baddeley, 1992). The third assumption is that meaningful learning occurs when learners integrate both words and pictures to form a meaningful frame of reference (Reimann, 2003; Wittrock, 1989), enabling content held in long-term memory is to be more easily brought into working memory (Ericsson & Kintsch, 1995).

Cognitive Load Theory and Dual Coding Theory form the basis for the CTML. Multimedia is the presentation of text (including spoken and written text) and pictures (including photos, animation or video). Multimedia learning is the ability to learn from verbal and visual representations used to present instruction (Mayer, 2003). Verbal representations are spoken and written text, and visual representations are static and dynamic pictures. Examples of multimedia instruction include: online learning, computer-based training, and hypermedia environments.

The CTML is based on the assumption that humans possess visual and verbal information processing systems (Mayer, 1997) and that in multimedia learning learners engage in the following three processes: selection of incoming verbal information that yields a text base and is applied to incoming visual information to yield an image base;

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the organization of the word base to create a verbal model of the system and organization of the image base to create a visual model of the system; the integration of events in verbal and visual based models.

There are four principles related to the CTML: multiple representation principle, contiguity principle, individual differences principle, and coherence principle.

Multiple representation principle. The multiple representation principle is to make use of two modes of representation rather than one in explaining a concept (Mayer & Moreno, 1997). Corresponding words and pictures must be in working memory at the same time in order to facilitate the construction of referential links between them. Coding knowledge in at least two different forms of coherent and meaningful visual representations are necessary in order to integrate information into existing knowledge structures (Mayer & Moreno, 1997).

Two examples illustrate the multiple representation principle. Students who listened to a narration explaining how a bicycle tire pump works while also viewing a corresponding animation generated 50% more useful solutions to subsequent problem-solving transfer questions than did students who viewed the animation before or after listening to the narration (Mayer & Anderson, 1991, 1992; Mayer & Sims, 1994). Similarly, students who read a text explaining how tire pumps work that included captioned illustrations placed near the text generated about 75% more useful solutions on problem-solving transfer questions than did students who read the same text and illustrations presented on separate pages (Mayer, 1989; Mayer, Steinhoff, Bower, & Mars, 1995). Other researchers have found similar patterns (Chandler & Sweller, 1991;

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Contiguity principle. The contiguity principle states that text and graphics should be presented contiguously rather than separately (Mayer & Moreno, 1997), since disjointed text and images put stress on working memory. Contiguous placement of text and images, on the other hand, enables learners to construct more coherent knowledge structures by making visual connections. Cognitive load theorists have described this as the split-attention effect (Chandler & Sweller, 1991; Sweller, 2002). Placing text next to corresponding images is an example of how design can support learning (Clark & Mayer, 2003). The contiguity principle is supported by Baddeley's theory of visual and auditory working memory subcomponents, which states that the capacity of working memory can be increased by the integration of auditory and visual working memory.

Individual differences principle. Multimedia effects, contiguity effects, and split-attention effects depend on individual differences. For example, learners with less prior knowledge tend to demonstrate stronger multimedia effects and contiguity effects than learners with more prior knowledge (Mayer & Gallini, 1991; Mayer, Steinhoff, Bower, & Mars, 1995). According to the CTML, this may be due to the ability of more advanced learners to generate their own mental images.

Coherence principle. The coherence principle argues that few unrelated words and pictures should accompany a multimedia explanation and understanding may not be achieved with materials that distract learner attention (Mayer, 2001; Mayer & Moreno, 2003). For example, students who read a passage explaining the science content with corresponding illustrations generated 50% more useful solutions on a transfer test than

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Comparing Cognitive Flexibility Theory and the
Cognitive Theory of Multimedia Learning

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This section compares and contrasts CFT and the CTML and describes how the two theories might complement one another.

CFT and the CTML are constructivist theories, as they both argue that meaningful learning occurs when learners actively develop their own knowledge representations. The two theories stand in opposition to rote learning, arguing that the transmission of knowledge impedes learning.

CFT and the CTML share the goal of promoting transfer while acknowledging the difficulty of such action. CFT argues that transfer is difficult because most domains of knowledge are ill-structured and require more than just the procedural application of prepackaged schema, but a more flexible and adaptive approach to knowledge construction. The CTML argues that complex materials, limits on working memory, and instructional design may limit the learner's ability to transfer knowledge to new situations.

CFT argues that the ability to represent knowledge in different ways supports a deeper understanding of domain knowledge. CFT advocates work with mindset modeling videos that integrate video, audio, and special learning effects. The use of multiple knowledge representations is supported by CTML, which argues that meaningful learning

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CFT describes certain habits of mind, including context awareness and a multi-perspectival approach to content that might support the construction of flexible knowledge structures. CFT takes a holistic approach, as the theory informs the integration of tools that support work with multiple cases. CTML, on the other hand, is more reductive in its approach, for it looks at smaller parts to understand the whole, placing emphasis on the development of specific features and the arrangement objects. For example, CTML focuses on specific elements of instructional design, including how the placement of pictures and text and the connection of elements, such as nodes and links, might reduce cognitive load. CTML's focus on specific features might support the design and testing of specific features in CFH systems, like multiple viewing windows and the timeline, and the arrangement of objects in the interface.

CFT argues that for the development of flexible knowledge structures it is necessary to introduce complexity from the start, so that an oversimplified mindset will not be established, but to do so in way that it is manageable, so learners will not become overwhelmed. More cases and thematic perspectives might minimize bias and support the development of more open, flexible knowledge structures, but will increase cognitive load. An example of how CFH systems are designed to make learning more cognitively manageable is its use of small, dense segments of cases that are complex, allowing for the same case to be examined from multiple perspectives and placed in context. Smaller cases are more manageable. The development of an open, flexible mindset and the overlearning of cases might enable learners to more quickly work with cases in a

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cognitively flexible manner, and might support the theory's goal of experience

acceleration. CTML argues for the management of cognitive load through control over

presentation, including pacing and arrangement of instructional material. The theory

offers specific principles that describe how instructional designers can decrease cognitive

load. These principles might support the CFT's goal of building more supportive

hypermedia learning environments.

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CHAPTER 4

DESIGN AND DEVELOPMENT OF THE UNDERLYING EASE SYSTEM

Chapter 4, and the one that follows, presents the most detailed description of the program itself. The fully developed and usable learning environment is a kind of "data" in its own right. Educational technology is a relatively new field, and it is not clear how the development of working systems should be credited. There are clues from related areas, however. For example, in the field of Artificial Intelligence (AI), the single most important act a researcher does is build a working system, "demo or die" is a motto in AI. Their reasoning is that it's easy to develop conjectures of how a system might be built but the proof is in the demonstration of the working system itself that is data in AI. A major published paper or dissertation in AI will essentially present a description of the working program, along with screenshots and an account of why and how it was built. In educational technology, the context is similar. First, as in AI, the development of these systems requires large amounts of time. In the case of EASE History it was almost two years. More important, the need to show that theoretical principles can be instantiated in an actual, full blown working system, the heart of "program as data" argument in AI, applies equally in educational technology. Therefore, the program discussed in this chapter and the next is a major component of the dissertation.

EASE History is a specific application of the EASE system, a learning environment based on Cognitive Flexibility Theory (CFT) and the approach to the design of hypermedia learning environments articulated in that theory (Spiro, et al., 2003; Spiro et al., 1988/2001; Spiro, Feltovich, Jacobson, & Coulson, 1991; Spiro & Jehng, 1990). EASE project goals included the creation of a learning environment that would enable

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users to easily search and compare cases, hold an array of multimedia, support learning in a variety of disciplines, and have a database-driven design that would enable non-programmers to create, maintain, and modify projects.

EASE stands for Experience Acceleration Support Environment. It was given this name because the EASE environment's use of new video techniques and arrangement of cases might shorten the amount of time that learners require to develop expertise, for cases are revisited in multiple contexts and examined from different perspectives and once video cases become overlearned learners are able to work with overlearned cases at an accelerated rate.

EASE Costs

It is difficult to determine how much time and money went in to the creation of the EASE project. For example, I, as a graduate student, was being paid to work on the project and to study. This would not have been the case if the project had employed a full-time designer. This section attempts to give the reader some sense of what a budget proposal would entail if one were to replicate the project or do a variation of the project.

The development of the EASE system was supported by a Preparing Tomorrow's Teachers to Use Technology grant from 2002 to 2004, and an Interagency Education Research Initiative grant from 2003 to 2005. The design of the EASE shell began in the winter of 2003. In 2002 the team focused on video editing and case construction. The Interagency Education Research Initiative (IERI) grant supported the design and development of the EASE system and Teaching Text Making Meaning (TTMM), an EASE application that is designed to support the instruction of two reading comprehension programs. The EASE system and the EASE History and TTMM

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applications were operational in the summer of 2004. The development of the EASE system and the TTMM application cost approximately $400,000 in total (~ $265,000 in direct costs, ~ $135,000 in indirect costs).

The EASE design team included: the Principal Investigator (PI), a Michigan State University (MSU) professor of educational psychology. The PI's role was to advise and consult on the design of the system. He was given release time from teaching and time to work on the project during summers; two half-time (20 hrs/week) research assistants (RAs), a doctoral student in MSU's educational technology program (the writer), and a Flash programmer, who was seeking her master's degree in MSU's communication arts program (approximately $72,000 in total costs for the two RAs; ~ $64,000 in fringe costs); an unpaid programming consultant; an HTML and JAVA programmer; and an SQL programmer. These latter two programmers served as consultants on the project, with a small portion of their salaries being paid for out of the IERI grant (~ $15,000 for the two programmers).

The following hardware was used to develop the EASE system (approximate costs follow description of hardware):

●Three G3 Mac's were used during the first year of the project to edit video (~ $3,500/each);

●Two G5 Mac's were used between 2003 and 2005. The G5 computers were used to edit videos and do Flash programming. The G5 computers were more powerful than the G3 models and better supported video editing (~ $3,500/each);

•Extra RAM was purchased for the G3 and G5 models in order to boost performance (~ $600);

•A video-editing deck was used to convert VHS cassettes to Digital Video (DV) tape, a necessary step before importing video into Final Cut Pro. The video deck had been purchased by a previous grant;

•DV tapes were used to store video (~ $500);

•A PC desktop computer was purchased to host the project. It was later decided that the project would be placed on MSU's College of Education servers (~ $2000);

•A Flash communication server was used to host Flash videos. MSU's School of Education provided free access to the school's Flash communication server;

•External hard drives were used to back up files (e.g., video, audio, text) (~ $1000).

Since technology changes so quickly, money was set aside in the budget to pay for software updates. The following software tools were used to develop the EASE project:

•Flash, a programming tool, was used to create the EASE interface, including its video player. Two versions of Flash were purchased since the software was updated during the development of the EASE system (approx: $300/each);

•Final Cut Pro, a video-editing tool, was used to edit video cases and create mindset modeling videos. Two versions of Final Cut Pro were purchased

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since the software was updated during the development of the EASE system (~ $800/each);

•Sorenson Squeeze, a video compression tool, was used to resize and compress videos. Two versions of Sorenson Squeeze were purchased since the software was updated during the development of the EASE system (~ $200/each).

This section discusses the theoretical rationale and design of features used across EASE applications. These features are: cases, multiple viewing windows, theme searches, icons, and timeline. The discussion begins with cases for they are central to the understanding of the design of the EASE system.

<div align="center">EASE Cases</div>

Cases feature short videos, sometimes less than ten seconds, and are coded on multiple themes, connected to related cases, and have multiple resources, including descriptive text, interviews, and artifacts. Theme searches retrieve multiple cases and display search results in a timeline. Cases can be viewed in three different viewing modes, the single-window viewing mode, the two-window viewing mode, and the four-window viewing mode.

Cognitive Flexibility Theory's theoretical rationale for cases. CFT advocates the use of dense cases that are cognitively manageable but still maintain the basic features of complexity, including interconnectedness and context-dependency. CFT contends that in order to develop more open and widely knowledge structures learners should examine multiple cases to see how concepts are applied differently across cases, view cases from multiple thematic perspectives to see the multi-faceted nature of cases, and place events

in context to understand how cases are similar and different (Feltovich et al., 1989; Feltovich, Coulson, & Spiro, 2001; Spiro et al., 1988; Spiro, Feltovich, Coulson, & Anderson, 1989).

Compare with other learning theories. From the Cognitive Load Theory perspective, one of the strengths of CFH systems is that they strive to make complexity more manageable, since working memory is limited in its capacity to selectively attend to and process incoming sensory data (Chandler & Sweller, 1991; Sweller, 1988, 1994). From the CTML perspective, cases make use of two modes of representation rather than one in explaining a concept thus demonstrating the multimedia principle. Also from the CTML perspective, the display of contiguous case videos and case descriptions in the one and two-window viewing modes demonstrates the contiguity principle, but hidden descriptions in the four-window viewing mode may place stress on working memory because the information is not contiguous. This perspective also may view short case descriptions as a demonstration of the coherence principle because the concise descriptions that accompany the digital images feature relevant information. The ability to place events in context enables experts to overcome limits of working memory by retrieving applicable knowledge for a given situation (Glaser, 1992; Simon, 1980).

Cases and design implications. From the CFH perspective, it was necessary to design a system that featured short video cases. From the usability perspective, it was important that video cases play seamlessly and instantaneously within the interface not pop-up outside of it and not be downloadable.

Flash, a software programming tool, was chosen because the platform: used compressed video files that play quickly and are difficult for users to save onto their

computers; enabled Flash videos to play seamlessly inside any browser (something that

HTML, a programming tool that the design team explored could not support), and across

platforms; and was well established, well supported, and was ubiquitous for most web

users had the Flash Player installed on their computers. The latter was important because

it was anticipated that EASE applications might use videos that had restrictions placed on

them, in terms of use. Also contributing to the decision to use Flash was that a member of

the EASE team was a Flash programmer and the project had access to MSU's

Macromedia Flash Communications Server and could use it as EASE's server-based

platform.

The EASE system's database, which enables non-programmers to create,

maintain, and modify projects, has a case-centered approach. Each project in the EASE

database has its own set of cases, resources, and themes. Each case has digital media

associated with it, including a video that is visible in viewing mode windows and small

thumbnail images that represent cases in the timeline. Each case has its own text

description, theme-codings, and resources, including interviews, artifacts, and links to

related project cases. Other information that is related to each case includes: case title,

event date, video timings, and the title background color that appears on the thumbnail

image in the timeline.

There are multiple examples of video being used in education, business, and

commerce. Jasper Woodbury Problem Solving Series is an example of an education

project that features multiple video cases. The program's focus is on mathematical

problem finding and problem solving. IVAN (Interactive Video Access Neighborhood) is

an example of a tool that enables users to feature, segment, and assign resources to video

cases. Charles Ruggiero, a member of the EASE team, developed the system for MSU's Teacher Education program.

Videos are not edited inside the EASE system. I used Final Cut Pro, a well-established multimedia editing tool, to edit videos and Sorenson Squeeze to compress videos.

<u>EASE Viewing Modes</u>

The EASE system has three viewing modes: the four-window viewing mode, the two-window viewing mode, and the one-window viewing mode.

<u>Cognitive Flexibility Theory's theoretical rationale for viewing modes</u>. According to CFT, the physical arrangement of placing cases side by side is designed to support across case comparisons, for it might increase the number of possible connections that can be more easily noticed and facilitate the development of more advanced understanding by supporting work with multiple cases.

<u>Other learning theories</u>. EASE's multiple window viewing modes are designed to help users compare and contrast cases. Contrasting cases can support the conditionalizing of knowledge- the learner's understanding of when, where, and why to use new knowledge (see, e.g., Bransford & Schwartz, 1999; Gagne & Gibson, 1947; Garner, 1974; Gibson & Gibson, 1955). Neutstadt and May (1986) argue that seeing a variety of cases that illustrate a particular concept helps learners see that concepts are sort of similar and sort of different from each other. From the Cognitive Load perspective, work with complex, interconnected cases in multiple viewing modes may impose a heavy cognitive load on users and produce a split attention effect because learner attention is divided between multiple sources of information causing an increased cognitive load on working

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memory. From the CTML perspective, work in single and two-window viewing modes might be supported by the contiguity principle for text and graphics are presented contiguously rather than separately.

Design of viewing modes. Early iterations of the EASE interface featured a single, 640x480 pixels video window. During the first year of the development of the EASE system it was decided that the interface would need to simultaneously display four viewing windows. This decision had a ripple effect on design decisions, primarily due to limitations on available space in the interface. For example, because of limited space in the four-window viewing mode, case descriptions and case videos would not be visible at the same time in the interface, unlike in the one and two-window viewing modes, which have space available below the videos for the text description box. In order to see descriptive text related to cases in the four-window viewing mode, a link, the "Open Description" button, appears in the right hand corner of the viewing window when a case is placed inside the window. Users click on the "Open Description" button to see text descriptions and click on the button again to see the video.

The addition of the four-window viewing mode had positive and negative impacts on the system. The four-window viewing mode is designed to enable users to compare and contrast cases, but the mode requires users to take extra steps to access case-related information. Opening and closing the drop down case description boxes might limit the use of information designed to support case comparisons. The use of a drop down text description box supported the goal of creating a seamless learning environment where work was done inside the interface, not in multiple pop-up windows, but the drop down

text description box covered the video meaning that users would have to close the text description box before playing the video.

The decision to simultaneously display four video windows had a ripple effect on other design decisions as well, including video size, the placement of icons, the design of the timeline, and theme searches. Impacts related to the design of the four-window viewing mode are discussed later in this section.

From the usability perspective, it was important to have an interface that supported seamless work with cases. There were six design decisions related to viewing modes that supported the overall goal of seamless work inside the interface. First, videos do not pop-up outside of the interface, they appear inside the Flash player. Second, switching back and forth between viewing modes occurs inside the interface. Third, cases that appear in the timeline remain unchanged when users move between viewing modes, so users do not have to perform theme searches again. Fourth, cases remain inside viewing windows when a switch is made to another viewing mode. For example, video cases in windows "1" and "2" remain when users switch back and forth between the two and four-window viewing modes. Finally, the design and placement of icons support easy movement back and forth between viewing modes. Three viewing mode buttons appear in the upper right hand corner of the interface when searched items are displayed in the timeline. Buttons related to the three main topics are placed above theme menus in the upper left hand corner of the interface. The four-window viewing mode icon features four boxes, the two-window viewing mode icon features two boxes, and the one-window viewing mode icon features one box. The title of the project is placed in between the

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topics and viewing mode buttons in order to indicate to users, along with the icon design and titles, that the buttons serve different purposes.

The design of the EASE system began with a one-window viewing mode then underwent changes after the decision to feature four videos simultaneously in the interface. The two-window viewing mode was the last viewing mode to be added. From the usability perspective, it was thought that users might find the two-video viewing mode more cognitively manageable, as compared to the four-window viewing mode.

Compare with other computer learning environments. The one-window viewing mode is the most common way to display video on the web. BBC, CNN, and ESPN websites feature single-window viewing modes. The ability to open multiple QuickTime movies and place them side by side on a computer screen inspired the creation of the four-window viewing mode.

EASE Theme Searches

There are multiple ways to search on cases in the EASE system. These include: single and combinatorial theme searches performed through theme menus, an advanced theme search page, a keyword search, and an index page.

1. Single theme searches can be performed through the main theme menus and in the advanced theme search page. Themes that appear in theme menus have sub-themes. Themes can be featured in more than one theme menu.

2. Multiple theme searches enable users to do combination searches within and across project topics. These searches can be done in the advanced theme search page.

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3. Keyword searches enable users to search on case text descriptions. Keyword searches can be done on the home page and in the advanced theme search page.

4. The index enables users to search on specific cases. All cases available in the project are listed in the index, and can be organized in alphabetical order or by other criteria.

Theme searches and design. Single theme searches are done efficiently inside Flash, taking only a few seconds to retrieve cases. The ability to perform multiple theme searches efficiently required the use of multiple technologies. This section describes how the technologies are connected and the rationale behind the selection of technologies.

ASP is connected to the SQL database because Flash cannot connect directly to an external database. When a request for content is made in the Flash front end a request is sent to an ASP page where information is returned. Flash processes and converts this information into what is visible on the front end of the EASE application. The use of different programming tools enabled the project to take advantage of the affordances of the different technologies. For example, Flash was used to design a user-friendly interface that featured video but was not the right tool to be used to develop an advanced search function that occurs on the back end. In this case Javascript better supported this goal. In the EASE system ASP, SQL, Javascript, and Flash are connected in order to support project goals. The blending of different technologies also took advantage of the different kinds of expertise held by EASE developers. Aparna Ramchandran had expertise in Flash, Charlie Ruggiero in ASP and Javascript, and Laurence Bates in SQL.

Cognitive Flexibility Theory's theoretical rationale for theme searches. According to CFT, there are no single best cases of knowledge representations to support

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understanding of concepts in ill-structured domains. Instead, learners need to see how concepts have been applied in similar and different ways across multiple cases in order to better to prepare for real world knowledge application. The retrieval of multiple cases through theme searches is intended to support this goal. CFT also argues that concepts in ill-structured domains are interconnected and that the understanding of one concept often relies on the understanding of another. Multiple theme searches, in particular, are designed to help users see how themes are intertwined for search results produce cases that have been coded on shared themes. CFT maintains that the use of a decentralized theme structure, as opposed to a hierarchical theme structure, better reflects the web-like nature of ill-structured domains. The use of sub-themes and the appearance of the same theme in multiple menus are examples of how EASE theme menus employ a non-hierarchical structure.

Compare with other learning theories. According to multiple studies (Bransford et al., 2000; Chi, Glaser, & Farr, 1988) experts are able to flexibly retrieve relevant domain knowledge and strategies with minimal cognitive effort. From the Cognitive Load perspective, a heavy load is placed on the learner when concepts are highly interrelated but might be germane since they are conceptually related and are likely to support new schema construction and automaticity. From the CTML perspective, EASE theme searches might demonstrate the multiple representation principle because they return cases with corresponding words and pictures.

Compare with other computer learning environments. Many online learning environments enable users to search on single themes. For example, The Smithsonian American Art Museum enables its users to search on single topics related to artist,

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century, and medium. The Smithsonian American Art Museum also enables its users to do keyword searches. Google Search is an example of a search engine with a more complicated algorithm that is designed to support more complex searches.

<div align="center">EASE Timeline</div>

Searched items are displayed in a scrollable two-columned timeline in EASE applications. Representative images of cases are arranged in chronological order with more recent cases at the top of the timeline and older cases at the bottom. If the user rolls over a thumbnail image in the timeline, then a comment box with a short description of the case appears to the right of the thumbnail image and two boxes appear on top of the image. If the user rolls over the small image and clicks on "1", then that case is placed inside the "1" viewing window. Two boxes appear when users are working in the two-window viewing mode and four boxes appear when users are in the four-window viewing mode.

Design of the timeline. In early versions of the EASE interface the titles of searched cases were displayed in alphabetical order in a single column. The decision to include a four-window viewing mode led the design team to reevaluate how the system displayed searched items. The re-assessment of this feature led the team to conclude that displaying only cases titles would not provide enough information for users. After a period of research and development, I decided that representative thumbnail images should appear in a two-columned scrollable timeline with more recent cases appearing at the top of the timeline and older cases at the bottom. I selected the two-columned timeline because I thought it was an efficient use of space and was visually striking. One of the problems of the two-columned timeline was that thumbnail images would have to

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be 50x38 pixels, making many of the thumbnail images look similar. I decided that additional information would be provided through thumbnail images, including colors related to topics, case titles, and comment boxes with short descriptions.

An issue the design team faced was how to place retrieved cases inside the two and four-window viewing modes. The project had started with a one-window viewing mode. A case was placed in the window by clicking on the theme name that appeared after a search. A one-click solution was still possible with the single-window viewing mode but not with the two and four-window viewing modes. The team attempted to implement a drag and drop feature but this proved unworkable because cases could not be dragged across quadrants "1" and "3" and dropped into quadrants "2" and "4". After time was spent investigating the drag and drop function, I decided that small boxes with numbers, each representing a viewing window, would appear on top of timeline thumbnail images when users were working with cases in the two and four-window viewing modes.

Cognitive Flexibility Theory's theoretical rationale for the timeline. One of the goals of CFT is to make work with multiple cases manageable in a nonlinear environment. The EASE timeline is designed to help users hold a large number of relevant cases in their cognitive workspace, something novice learners might not normally be able to do. Another CFT goal is to fight conceptual oversimplification of complex concepts. The EASE timeline combats early closure by showing all cases that have been coded on a particular thematic concept.

Timeline, the intersection of EASE and EASE History. The reassessment of how searched cases would be displayed in the EASE interface took place at the time when I

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was designing a timeline for EASE History. During the design process I searched for examples of timelines on the web. The Living Room Candidate (http://livingroomcandidate.org/) is a website that features presidential campaign commercials with searched videos displayed in multiple columns. For searches on election year, representative images are arranged by presidential candidate and displayed in separate columns. For searches on commercial type and issue, representative images are returned in a single column with older cases at the top and more recent cases at the bottom. I also examined timelines created by Second Story Interactive Studios, and the Smithsonian Institute. The team used ideas from other sites and adapted them to create something new. From its research of Second Story timelines, the team added a scroll bar to the timeline. The team used the multi-columned approach implemented by the Living Room Candidate. The idea to have representative images in the timeline was gotten from Second Story timelines and from the Living Room Candidate.

Other learning theories. The timeline organizes cases in chronological order. Well-organized domain knowledge has been shown to support problem understanding and problem solving (e.g., Glaser & Chi, 1988). From the Cognitive Load perspective, the timeline may demonstrate the germane load principle because the retrieval of multiple cases is well organized and likely to support learning.

<center>EASE Icons</center>

Icons appear on top of a video case after the case has been placed inside a viewing mode. Each icon signifies the type of content or action that is available through it. The Back icon appears after a video has been replaced in the viewing window, while the other icons appear only when related content is available. When users roll over an icon, titles of

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related cases and resources appear below the icon in the form of a drop down menu. When a video case title is clicked on in the drop down menu, it replaces the case inside the viewing window. Information available through the Artifacts icon appears in a pop-up box. There are five icons designed for use in EASE applications:

1. The Back icon enables users to move one step back to the previous video in the system. An icon with an arrow pointed to the left signifies its action.

2. The Audio icon lists audio resources such as interviews and commentaries. An icon with a microphone signifies the availability of audio content.

3. The Video icon with an image of a filmstrip notifies users of the availability of mindset modeling videos.

4. The Related Cases icon lists related project cases. An icon with two overlapping video boxes signifies the availability of Related Cases content.

5. The Artifacts icon alerts users to the availability of case-related resources, like graphs, transcripts, and links to articles and other websites. An icon with a treasure box signifies the availability of artifacts.

Design and icons. At first it was proposed that an icon would appear on a video when a resource was available and the icon would disappear when the resource was no longer relevant. This proved difficult to implement, so the team decided that icons would be placed on video cases inside the viewing window and would appear throughout the video. The drawback of this decision is that even if a resource was thought to be only relevant during the first five seconds of the video the icon would appear throughout the entire video. The decision to place icons on the video instead of above or below the viewing window was made because of the limited space left by the four-window viewing

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mode. There was space to place icons next to the case title that appears below the video window in the one and two-window viewing modes but not in the four-window viewing mode. In order to better support the goal of design consistency, icons were placed on the video in all three viewing modes. I decided that materials designated as artifacts (i.e., maps, transcripts, graphics) would appear in pop-up windows, because the artifacts could not easily be viewed inside the 320x240 pixels viewing windows.

Cognitive Flexibility Theory's theoretical rationale for icons. CFT argues that conceptual knowledge cannot be isolated into separate mental compartments. The theory promotes nonlinear movement through networked knowledge systems in order to support the goal of transferable knowledge. Icons support the traversal of interconnected knowledge by linking program content in a user friendly manner.

Other learning theories. Research findings suggest that experts possess a great deal of interconnected domain knowledge. From the Cognitive Load perspective, one of the strengths of EASE icons is that they are designed to link related cases and resources.

EASE Mindset Modeling Videos

Mindset modeling videos are short videos that use innovative video presentation formats, including narration, quick editing, video effects, and strategies to open and deepen perception of the complexity of cases and accelerate the process of knowledge acquisition in a cognitively tractable manner. The videos remind users of several issues: the need to open perception, the need to look closely at a wide variety of cases, and the power of revisiting cases from multiple perspectives. Different effects, which are often used in combination and with narration and text, are featured in mindset modeling videos. They include:

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1. Dissonance effects. The dissonance effects are designed to disrupt reductive thinking and get people to develop a habit of saying, "wait, it's not that simple" and "it depends". The learner needs to move towards a realization that judgment should be withheld—that there must be an understanding of context and contingency. Dissonance is created with a series of special effects. They include the lightning effect, the x-ray effect, the shattered screen effect, the shaking screen effect, and audio effects, such as thunder and other loud noises. Oftentimes the effects are used in combination. For example, learners are warned of the traps of early closure by having the screen disintegrate and hearing a sharp piercing sound.

2. Conceptual variability effect. The conceptual variability effect is designed to show learners how concepts are used and tailored to context. In a mindset modeling video, for example, video is shown of how a concept has been applied to a specific case then followed by a series of short clips, sometimes three seconds in length, from overlearned cases where the concept is applied in different ways. Viewing concepts of multiple illustrations is intended to challenge formed assumptions and remind learners of their tendency to become complacent when they embrace single answers and simple definitions.

3. Spotlight effect. Different colors of physical light are used in order to cast a scene in a different light. Colored spotlights are designed to demonstrate how actions and words can be interpreted in many different ways. The quick crisscrossing of domain knowledge occurs when different colored spotlights simultaneously appear on screen. Colored spotlights, when accompanied with the slow motion

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effect, offer a way to redirect the gaze of learners showing them what they might have missed.

4. X-ray effect. The application of the x-ray effect, a video effect that turns video into a black and white image resembling an x-ray, is intended to remind people that there is usually more to a situation than what appears on the surface and that many situations cannot be defined after a single viewing. The x-ray effect is accompanied by text and narration describing connections that might not be obvious.

5. Color washes. Colors wash across the screen when themes are active in the video. Multiple theme washes can be applied at the same time to show how themes are interconnected.

6. Music effect. Music can be applied to video to express mood. For example, a mindset modeling video might feature festive music when a perspective identifies the event as a positive occurrence.

7. Juxtapositions. Cases can be placed side by side in mindset modeling videos. This arrangement is designed to model how cases can be compared and contrasted in the two and four-window viewing modes.

Cognitive Flexibility Theory's theoretical rationale for mindset modeling videos.

Mindset modeling videos are designed to open perception and help learners look for multiplicity and interconnectedness. The use of short videos, with effects such as music, spotlights, and slow motion are designed to reduce cognitive overload so subject matter does not become "confusing and discouraging" (Spiro, et al., 2003). According to CFT, simplistic thinking, which mindset modeling videos are designed to combat, interferes

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Other learning theories. The ability of experts to notice more and identify features and meaningful patterns of information has been found in multiple studies (e.g., Bransford et al., 1988; Sabers et al., 1991). The arrangement of related cases in mindset modeling videos (e.g., juxtaposing cases and demonstrations of conceptual variability) is an example of how the videos might support deep learning. According to Bransford and Schwartz (1999) research suggests that the methods of selection and arrangement of cases can help draw attention to connections among cases that are not transparent or establish case contrasts that illustrate surprising differences and similarities.

From the Cognitive Load and Dual Coding perspective, one of the strengths of mindset modeling videos is that they take advantage of both verbal and visual channels (Tindall-Ford, Chandler, & Sweller, 1991). A weakness of the mindset modeling videos, from the Cognitive Load perspective, is that they are too long, sometimes more than two minutes in length. Video brevity is an acknowledgment that there are limits to the amount of information that both channels can process (Baddeley, 1992).

Design and mindset modeling. Since mindset modeling videos are created in Final Cut Pro, the only design decision related to the videos was how to access them. It was decided that mindset modeling videos would be available through the "Video" icon.

Other learning environments and tools. The spotlight effect was used in the CFH system KANE and was intended to help users notice more and see how multiple themes could be applied to the same case. Video and audio effects available in Final Cut Pro supported the development of additional mindset modeling videos. For example,

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combining Final Cut Pro's visual lightning effect and audio of thunder created the

lightning effect used in mindset modeling videos. Because Final Cut Pro did not have a

spotlight effect the team created one by combining two Final Cut Pro video effects, a

darkened overlay with colored light.

Online or Offline

There was a question as to whether EASE applications would be presented online

or as a stand-alone DVD-option. The stand-alone DVD was an attractive option because

there were concerns that users would have limited bandwidth, less powerful computers,

or interrupted Internet service. The ubiquity of DVD players in homes and classrooms

also made DVDs an attractive option. There were major problems with using a stand-

alone DVD-option, though. First, there would be limitations in regards to theme searches.

The DVD-option would support single theme searches but not multiple theme searches

since a DVD would not be able to access the project's main server. Second, limited

storage meant that a DVD would be able to store less video than an online program, thus

limiting the number of video cases that could be featured in a project. Third, new DVDs

would have to be created and distributed when the program was updated, a much slower

process than updating an online program.

There were costs and benefits associated with placing EASE programs online. A

limitation of an online system was that some users would have slow Internet connections

and own older computers so the use of the program would be impeded. There were also

worries that it might be more difficult to obtain permission to use video, specifically

classroom videos, if the content was presented on online. There were many benefits of

having online programs, including the ability to have multiple theme searches, more

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easily updatable programs, and the ability to reach a wider audience. As far as concerns about accessing the system online, it was thought that more powerful computers and higher bandwidth would become the norm in the near future. It was also decided that some online projects might have restrictions on video use so would need to be password protected. In the end, a consensus developed that online applications had more affordances than stand-alone applications, but some projects would need to use the stand-alone DVD-option, so the decision to present EASE programs online or offline would be made on a case-by-case basis.

Lessons learned from designing the EASE programs are described at end of Chapter 5.

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CHAPTER 5

DESIGN, DEVELOPMENT, AND DEPLOYMENT OF THE
EASE HISTORY LEARNING ENVIRONMENT

Chapter 5, as in the previous chapter, uses a narrative lens to describe the design,

development, and deployment of EASE History. The full-fledged learning environment is

offered as a kind of "data" in its own right.

EASE History, a specific application of the EASE system, is an online learning

environment that features over one thousand cases related to its three organizing topics:

historical events, campaign advertisements, and core values. These three organizing

topics support one another for they enable users to see historical events through the prism

of U.S. presidential campaign advertisements, better understand the complexities of

campaign issues and their historical context by looking at historical events, and explore

the meanings of core values by examining how these values have been applied in a

variety of real world cases. Three viewing modes, simple and advanced theme searches,

and case resources such as interviews, descriptive text, artifacts, related cases, and

mindset modeling videos, support work with cases.

The EASE History project had multiple goals. These included: helping people

develop a critical mindset and learn difficult content in an online, nonlinear, case-based,

theory-based environment that featured new media; supporting learning in multiple

environments, including inside the classroom and outside; supporting independent and

group work; supporting learning across multiple grades; and reaching a large, global

audience.

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EASE History features content from civics and history. The two domains are ill-structured because conceptual meanings within these domains change over time, and the understanding of domain knowledge depends on the understanding of other concepts, thus necessitating an awareness of the web-like nature of the domain. Understanding in ill-structured domains requires conceptual variability and multiple representations of knowledge. For example, in order to understand 'freedom,' a concept that is featured in civics and history learning, one must look at a number of cases where it has been applied because the idea of freedom has changed over time, and an individual's meaning of the concept is recalibrated with each case. EASE History is designed to support content learning and the development of certain dispositions by demonstrating a wide variety of patterns of use of civics and historical concepts in an educationally friendly manner that prepares students to see the kinds of contextual circumstances in which the concept is either appropriately, or inappropriately, employed.

The development of EASE History began in the spring of 2003. EASE History is a specific application of the EASE system, which was designed to support learning across ill-structured domains. The development of EASE History required only minor additions to the EASE interface, and so I present the EASE History application as a kind of validation of the success of the design of the EASE system.

From the start of development I planned that EASE History would go online before the 2004 presidential election and seek a global audience. The program was launched in September 2004 but new content continues to be added. I led the design, development, and deployment of the EASE History project.

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EASE History Costs

The EASE History project was unfunded. I spent approximately 20 hrs/week designing EASE History features and content, outside of the 20 hrs/week that I worked on the EASE system. The EASE project's Flash programmer volunteered her time to create EASE History's Flash interface, home page, and supported the development of election maps and the tour. The EASE project's JAVA and HTML programmer volunteered his time to connect the Flash interface to the database, and build the advanced theme search and index pages. The EASE project's database programmer volunteered his time to place EASE History on an MSU School of Education server and maintain it. The Principal Investigator (PI) for the EASE project acted as an unpaid consultant on the EASE History project, supporting content development. An MSU graduate student was hired to upload content to the database prior to the launch of the EASE History. The PI paid the student's salary, approximately $1,500, out of his own pocket. Over the course of the project, I purchased presidential campaign advertisement video collections, historical documentaries, books that supported the development of EASE History content, DV tapes, external hard drives, and VHS tapes that were used to record campaign commercials off television. These costs came to about $1000.

EASE lab equipment was used to develop EASE History. This hardware included: two G5 Mac's to edit videos and do the Flash programming, a video-editing deck to convert VHS cassettes to DV tapes, a PC desktop computer to upload content to the database; and a Flash communication server to host the videos. As with the EASE project, Michigan State University's School of Education provided the EASE History project with free access to the Flash communication server. EASE History also used

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software purchased for the EASE project, including Final Cut Pro, Flash, Fireworks, and Sorenson Squeeze.

The EASE design team did not have content for the Teaching Text Making Meaning (TTMM) project between summer 2003 and winter 2004, so, in order to test features, the EASE database and the Flash interface was populated with EASE History themes, videos, and resources. The timeline is an example of a point when the design of EASE History and the design of EASE intersected. The timeline feature was originally designed with EASE History in mind but was integrated into the design of the EASE system, because I thought it could support learning in multiple domains.

If I had it to do over again, knowing what I know now, I would have sought funding for the EASE History project at the beginning stages of development. I asked too much of others, in terms of their time and money, during the development of EASE History. During the summer of 2004, for example, the team produced the Teaching Text Making Meaning (TTMM) project, which was funded by an Interagency Education Research Initiative grant, and the EASE History project. This meant that the team had to work extra hours each week. Project funding might have relieved some pressure on the team, meant more time to design program content, and provided time to develop a research program.

EASE History is online (http://www.easehistory.org/) and not password protected. I made this decision after examining the costs and benefits of online and offline content delivery. An online system would have enabled the program to include more cases, multiple theme searches, be more easily updated, and reach a global audience, as compared to an offline or online program that was password-protected. A password-

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protected program that was only used on campus would have enabled the project to feature copyright protected videos but this type of program would have negatively impacted the goal of reaching a global audience. I decided that the affordances of an online password-protected program, one that would reach a global audience, as compared to a password protected site, were greater, since an online program that was not password protected would enable more people, including designers, educators, and students, to develop a deeper understanding of how a hypermedia environment based on learning theory might support learning in civics and history.

EASE History Content Development

At first I had wanted to create an EASE application that featured footage from 20th century U.S. history documentaries produced by U.S. television broadcasting companies. I was unable to secure rights to use footage from the documentaries in an unrestricted online environment, so I revisited the option of having a system that was password-protected. An online, password-protected program, only used on campus, would enable the project to feature copyright protected videos, such as ones featured in the commercial broadcast history documentaries, but this would negatively impact the goal of gaining a large audience, so after exploring multiple possibilities, including pre-1923 topics (e.g., American Revolution, Civil War), I decided that the program would feature U.S. presidential campaign television commercials and public domain content produced by employees of U.S. government agencies.

There were multiple reasons for selecting presidential campaign commercials and historical events. First, there were only a limited number of documentaries that featured full-length presidential campaign advertisements and there were few websites featuring

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these materials, so the public had difficulty accessing these materials. Second, I thought that the rights holders, including presidential libraries and some the candidates themselves, might be more likely than a commercial broadcasting company to grant permission to use the videos in an online learning environment created by a non-profit group at a large university. Third, I found many historical images and videos in the public domain at websites like the Library of Congress, the National Archives, and NASA. Fourth, I thought campaign advertisements might support understanding of civics and history concepts if treated as cases in a CFH learning environment, where they could be placed in context and linked to other campaign advertisements and historical events. For example, many of the campaign advertisements made specific reference to real world events, so the linking of the historical and campaign advertisement domains seemed like a good fit. Finally, campaign advertisements were chosen because I thought that having a deadline for the launch, the fall of 2004, would provide motivation to complete the project and the release of the project before the election would draw attention to it.

The use of core democratic values themes was the last topic to be included in EASE History. The core democratic values topic was chosen because at the time Michigan students were having difficulties with a core democratic values task in the social studies section of the Michigan Educational Assessment Program (MEAP) exam. To complete this task, students were given information about a public policy issue and asked to write a persuasive letter in which they support their stand with a core democratic value. I thought that a CFH environment could be designed to support the understanding of complex concepts like freedom, for example, and prepare learners to use that concept in the great variety of contexts in which it occurs. The addition of the core democratic

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values topic seemed like a natural next step, since many core democratic values themes, like freedom, common good, and patriotism, appeared in the theme-codings of U.S. presidential campaign advertisements and historical events cases.

Gaining permission from rights holders to use campaign advertisements was more difficult than I expected. I spent four months attempting to search for the rights holders of the campaign advertisements but had no success. In September 2003 I asked Michael Seadle, the Copyright Librarian and Head of the Digital and Multimedia Center at Michigan State University, for his help securing permissions to use campaign advertisements in the project. Over the next year he and his team were able to locate and get permissions from campaign advertisement rights holders. Seadle and his group secured permissions from presidential libraries, presidential campaigns, national political committees, and from the candidates themselves. Their expertise enabled the search for copyrighted content to expand to historical footage produced by video production houses. Seadle and his group secured permission from WhiteStar productions, for example, to use footage from their documentaries about the Republican and Democratic Parties and Martin Luther King, Jr. in EASE History. The agreement signed by rights holders grants permission for EASE History to use the material online on the condition that users are not able to download the videos.

To support the creation of EASE History content I read widely in the domains of political advertising, civics, political science, and history, finding themes that are used in the domains and content related to specific cases. Books included "Interpretations of American History", edited by Couvares et al., "Thinking in Time" by Neustadt and May, and "The American Age" by Lefeber, "The Story of Freedom" by Foner, and "Video

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Rhetorics: Televised Advertising in American Politics" by Nelson and Boynton. Theme categories of codes emerged from this research and from the cases themselves. This process led to a set of themes and sub-themes by which the user could search on. The theme list evolved over time as more cases were added and more research was done. With a coding scheme in place, albeit one that was still emerging, each case was coded on multiple themes. For example, a case about the 1987 memorial AIDS quilt was coded on eight themes: 1980s events, health, protests, Reagan administration, social, social protests, tolerance, and unity. EASE History themes are identified in the appendix. (See Appendix A to see a list of EASE History themes.)

EASE History identifies the author or source of case materials. For example, the "Mother" case identifies the photographer as Dorothea Lange, and the owner of the original print as the Library of Congress. This information is included in the text description box. The "Evaluating Sources" activity, which appears in the Learning Guide, scaffolds the assessment of source credibility. In the activity learners rate the credibility of six cases and explain their ratings. The "Evaluating Sources" activity is embedded in many of the learning guide activities that are designed to help learners compare and contrast cases.

Excel spreadsheets were used to organize content related to cases. Information was organized under database categories, including: case title, color coding, digital file, long description, short description, theme codings, image and video credit, event date, links to related cases, sources, and links to articles.

Videos. Final Cut Pro was used to edit videos. Many of the campaign advertisements and historical events videos came from long documentaries or collections

so they had to be broken up into smaller cases. Some videos had watermarks and titles, so in order to not infringe on copyrights, I removed the overlays using the video editing software. After editing the videos, I gave each case a title and exported the files as FLVs. I also selected representative still images for each case. These images appear in the viewing window before the video plays and in the timeline as thumbnail images. These images were resized in Fireworks and exported as jpg files. It took multiple trials before settling on compression video settings in Sorenson Squeeze that would produce compressed, high quality videos. These compression video settings were applied to videos used in TTMM, another EASE application.

The quality of video used in EASE History varied from case to case. I spent a great deal of time trying to improve the audio and sharpen many of the low quality videos in Final Cut Pro. This became a higher priority after seeing that programs like ESPN, CNN, Living Room Candidate, and BBC, were featuring high quality and well-edited videos. Many of the campaign advertisements were from older documentaries, while others were recorded off television. Some of the U.S. presidential campaign advertisements were of high quality, like the Gerald R. Ford 1976 commercials and the George W. Bush and John Kerry 2004 advertisements. The quality of the historical events videos, like that of the campaign advertisements, varied from case to case. For example, much of the footage from NASA videos and WhiteStar documentaries were of high quality. Other videos, like the Universal and Kinogram newsreel videos, were of lesser quality. The interviews that I did with Ken Dirkin were of high quality since they were shot in high definition video.

EASE History cases feature videos and still images. The addition of still images did not require changes to the database for it recognized jpg files. The addition of still images did require the addition of an icon so that users could see the larger images in a pop-up window and download them. Many of the still images used in EASE History were compressed in Sorenson Squeeze in three different sizes, a small 50x38 pixels image for the timeline, a medium size 320x240 pixels image for the video window, and a larger image that could be accessed through the project's Image icon. The larger images were kept under 640x480 pixels so case descriptions and images would be visible on screen. Hundreds of images were resized in Fireworks so that they would not appear stretched in the timeline, in the viewing windows, and in the larger image pop-up box.

Development of resources. Campaign advertisements are not often featured in social studies classrooms and are not easily found online, so special attention was given to the development of program resources. Case resources, such as election maps, candidate profiles, election issues, and election polling data are available through campaign advertisements. As a former social studies teacher, I developed these resources in order to help learners place events in context and see how cases are connected. For example, George W. Bush's candidate profile includes information about the candidate's strengths and weaknesses, his background, and key points in his administration. "Comparing Historical Cases" and "Comparing Campaign Ads Cases", two lesson plans in the learning guide, feature case comparison charts that are designed to scaffold work in EASE History. Mindset modeling videos, such as ones that define WWII and examine its causes, are examples of content that I designed with more novice learners in mind.

The creation of resources took place over the course of project development. These resources included: case resources, learning resources, glossary, tour, and an FAQ.

1.   Case resources, including interviews, election maps, mindset modeling videos, case connections, were matched and linked with related cases. For example, clips were excerpted from a series of interviews that I did with Ken Dirkin about program related content and from historical documentaries that featured interviews with academics, politicians, and social leaders. Other case resources, including links to external programs, mindset modeling videos, and election maps are discussed in greater detail later in this chapter.

2.   Thirty-one lesson plans related to history, campaign advertisement analysis, and core democratic values content were designed to support the use of EASE History in classrooms.

3.   A glossary was created to explain EASE History themes. The glossary was intended to support classroom activities featured in the learning guide. For example, an activity asks learners to use Thesaurus entries for "experience" to illustrate how campaign advertisements use the concept in similar and different ways. The glossary includes dictionary and thesaurus entries related to core democratic values and to campaign advertisements concepts. Dictionary entries were drawn from multiple sources. Thesaurus entries were drawn from Rodale, J. I. The Synonym Finder and Roget's New Millennium Thesaurus.

4.   The Flash tour was created to provide an overview of the program and was designed to help users to become informed about EASE History features.

5.   The Frequently Asked Questions section was created to answer commonly asked questions about technical issues related to the system and the project's theoretical underpinnings. For example, EASE History's port number is provided because it was anticipated that some users would need to open firewall ports in order to use the Flash application.

Over the course of the project I did informal usability testing of EASE History. In these informal sessions, often very brief, I would ask friends and colleagues for their comments on specific features and content and for their suggestions on how to improve the program. From these sessions I learned that more scaffolding was needed to support the understanding of cases. These informal sessions also supported the design of the more general EASE system for I was able to give feedback to EASE designers on how people reacted to specific features.

The Living Room Candidate updated its site features and content in July of 2004. The updated site featured high quality videos and content and many of their themes and videos overlapped with EASE History. After comparing and contrasting Living Room Candidate and EASE History I realized that the launch of Living Room Candidate would negatively impact my goal of obtaining a large audience for EASE History. At this point, I readjusted my goals and began placing less emphasis on campaign advertisements in EASE History and placing more emphasis on the idea that EASE History is a hypermedia system that is supported by learning theory.

The majority of cases were entered into the EASE database in July of 2004. The project was launched in September 2004. With the help of Victor Inzunza at Michigan State University, I prepared and sent out a press release to announce the release of the

project. I spent fall 2004 and winter 2005 promoting EASE History. I contacted

newspapers, magazines, design experts, state educational departments, local teachers,

museums, media personalities, website reviewers, bloggers (e.g., education, design,

technology, political), and international and domestic newspapers and magazines. I also

entered EASE History into multiple design competitions. (See Appendix B for a

discussion about how the goal of usage and expert reception of the system were

addressed.)

This section describes how EASE features are showcased in EASE History.

Features discussed in this section include: EASE History's cases, three organizing

topics, timeline, resources, advanced theme searches, mindset modeling videos, and

three viewing modes. (Note: This section refers to cases, themes, theme-codings,

resources, and search results in the current version of EASE History. EASE History is

continually being updated, so references might not refer to the current site.)

EASE History Topics and Main Menus

There are three main organizing topics in EASE History: Historical Events,

Campaign Ads, and Core Values. The Historical Events topic includes historical cases

from 1900 to the present. The Campaign Ads topic includes U.S. presidential campaign

advertisements from 1952 to the present. The Core Values topic retrieves cases from

U.S. historical events and presidential campaign advertisements from 1900 to the present

day. Each organizing topic has its own menu, and each menu has its own themes and

sub-themes.

Figure 1. EASE History Menu

The three main topics are designed to support each other to achieve the overall learning goal of deep understanding of the complex domains. In EASE History users learn about U.S. history through the prism of U.S. presidential campaign advertisements, better understand the complexities of campaign issues and their historical context by looking at historical events, and explore the meanings of core values by examining how these values have been applied in both historical events and campaign advertisements.
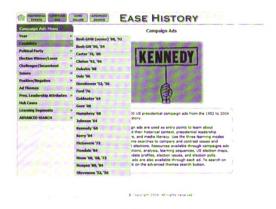
Figure 2. EASE History Themes

EASE History Cases

"I Like Ike", a one-minute video clip, is an example of an EASE History case. It
has a short case description, and is linked to multiple resources, including related cases,
election maps, and candidate biographies. The case is coded on the following themes:
Election Year: 1952; Candidate: Eisenhower; Party Affiliation: Republican;
Positive/Negative Ad: Positive; Election Winner/Loser: Winner; Ad Types: Bandwagon,
Humor, Music; Positive Presidential Leadership Attributes: Likeable, Plain folk;
Negative Presidential Leadership Attributes: Out of Touch; Core Values: Common Good,
and Patriotism.

EASE History currently features one hundred and forty-five themes. Some
thematic-codings are straightforward and others are less so. Straightforward themes

include: election year, candidate, winner, and party affiliation. Examples of straightforward theme-codings from the "I Like Ike" case are Eisenhower, Republican, winner, and 1952 election. Music is an example of a more straightforward theme but even it has its exceptions. For example, The "Revolving 88" case, a Vice-President George H.W. Bush campaign advertisement from the 1988 election, has been coded on music because it has a low, but sustained humming sound that produces a certain mood. Freedom, consensus, and progress are examples of themes that are not straightforward. Deciding on whether themes, such as freedom and consensus, are applied to cases is more of an interpretive process. The linkage of cases is another example of an interpretive process. Since theme creation and application is an iterative process, theme-codings are continually revisited.

EASE History Case Resources

Cases in EASE History have their own set of resources. Resources, available through icons, include: interviews, related links, links to external websites, mindset modeling videos, and artifacts. Resources are designed to help learners place events in context, view events from multiple perspectives, and reveal relationships between the historical events, campaign advertisements, and core democratic values topics. For purposes of this discussion I will continue looking at the "I Like Ike" case.

Figure 3. "I Like Ike" Case

Table 2. EASE History Icons

The Back icon steps back to the previous video.	The Interviews icon lists resources such as interviews and commentaries.	The Mindset Modeling icon lists video resources such as learning sequences.	The Related Cases icon lists related cases.	The Image icon provides a link to the full sized image	The Artifacts icon lists artifacts such as electoral maps, candidate profiles, images, articles and external URL's.

Interviews. Through the Interviews icon users can access multimedia clips of interviews with educators, political commentators, historians, and politicians who hold different perspectives. Hearing multiple perspectives may be unsettling at first but with time the learner might understand the limitations of applying single perspectives and analogies. There is one interview available through the "I Like Ike" case. In it I talk about how the campaign advertisement features the bandwagon effect.

Mindset modeling videos. Mindset modeling videos use video and audio effects to model critical habits of mind. Mindset modeling videos are available through the Mindset Modeling icon. Mindset modeling videos focus on several topics related to campaign advertisements and the Cold War. Campaign advertisement mindset modeling videos examine presidential leadership attributes, the bandwagon effect, and camera angles. Cold War mindset modeling videos focus on Cold War fears, rhetoric in Cold War campaign advertisements and speeches, direct and indirect confrontations during the Cold War, détente, WWII conferences at Yalta and Potsdam, and the U.S. and Soviet space programs. Five examples of mindset modeling videos are described in this section.

Figure 4. "Angle" Mindset Modeling Video

1."Angle", a mindset modeling video, is designed to support the understanding of the "above the people" effect in campaign advertisements. The beginning of the video segment leads viewers to think that the low camera angle is responsible for the "above the people" effect. When, supposedly, everything has been figured out, the narrator says, "Wait, things aren't so simple". The added complexity is that the camera angle is not solely responsible for the "above the people" effect and that looking down is also responsible for the effect. The spotlight effect is used to highlight the candidate looking down. In order to demonstrate conceptual variability short clips from three campaign advertisements show the "above the people" effect when the candidates are looking down and the camera is at eye level. The "Angle" learning segment is one minute and forty seconds long and is available through multiple cases, including the 1952 General Eisenhower campaign advertisement, "Ike Speaks".

Figure 5. "Bandwagon" Mindset Modeling Video

2.Bandwagon effect. This mindset modeling video is designed to support the understanding of the "bandwagon effect". The video begins by showing a short clip from "I Like Ike" and then through narration, text, and video size resizing explains how "I Like Ike" illustrates the stages of the bandwagon effect and the bandwagon's multiplying effect. A spotlight effect highlights a Stevenson supporter riding in the opposite direction of Eisenhower's supporters. This action is spotlighted because it adds to the "bandwagon effect" and is something that users might have missed. The mindset modeling video shows the final stage of the "bandwagon effect", when everyone is on board and then, in order to demonstrate how the concept can be applied in similar and different ways, shows three short clips of candidates with large crowds.

Figure 6. "Multiple Goals" Mindset Modeling Video

3.Multiple goals. This mindset modeling video is designed to show how critical habits of mind might support case comparisons. The video compares "I Like Ike" and "Kennedy 60" from the multiple goals, name recognition, bandwagon, music, and

likeability perspectives. The video uses titles to show how multiple themes are active at the same time. For example, bandwagon and music are two themes that are shown to be active at the same time in the two campaign advertisements. After demonstrating how the campaign advertisements are similar, the screen shatters. This is intended to alert learners that things aren't so simple and that cases are similar and different. The campaign advertisements are placed in context and spotlights, juxtapositions, text, and narration are used to explain how the two advertisements are different from the main goals perspective.

Figure 7. "Direct Appeal" Mindset Modeling Video

4. Direct appeal. This mindset modeling video describes the "direct appeal" effect when candidates look directly into the camera. Slow motion is used to show how Eisenhower shifted to a direct appeal in "Ike Speaks". Three short clips that show presidential candidates looking directly at the camera follow the Eisenhower campaign advertisement.

Figure 8. "Cold War Anxiety" Mindset Modeling Video

5. Cold War Anxiety: This mindset modeling video pieces together a series of conceptual variability segments related to Cold War anxiety. The first conceptual variability segment includes examples of how Cold War tensions played out on the world stage. It includes short clips from cases related to the Marshall Plan, HUAC, and political rhetoric. The second segment provides examples of how the Cold War led to anxiety in the U.S. It includes clips of atomic bomb tests, the use of a warning system, bomb drills, and fallout shelters. The final segment is a series of Cold War presidential campaign advertisements drawn from six elections. The campaign advertisements in this mindset modeling video demonstrate periods of high tension and détente during the Cold War.

<u>Related cases</u>. The Related Cases icon links the case to related historical events and campaign advertisements. Related cases are designed to support context awareness, multi-perspectival learning, conceptual understanding, and relationships between historical events and campaign advertisements. "I Like Ike" has seven related cases.

Three illustrations of how related cases are designed to support the understanding of "I Like Ike" are "Ike Runs", "Jeep 44", and "Luv Gov 52".

1. "Ike Runs" is an example of a related case that is designed to support context awareness by letting users know that there were questions as to whether General Eisenhower would run as a Republican or Democratic in the 1952 presidential election.

2. "Jeep 44" is an example of a related case that connects historical events and campaign advertisements. The "Jeep 44" case, a meeting between President Roosevelt and General Eisenhower during WWII, is designed to help users understand that Eisenhower was a military leader. The juxtaposition of "Jeep 44" and "I Like Ike" might spur learners to compare and contrast Eisenhower the military leader to Eisenhower the politician.

3. "Luv Gov 52" is an example of a related case that is designed to promote conceptual understanding of themes that "Luv Gov 52" and "I Like Ike" share: 1952 election, 1950's decade, Humor, and Music.

Each related case has its own set of resources, so users are able to choose their own routes through the system. These associated links enable users to freely explore the environment in an active, meaningful way. Routes that users take will depend on the question and on user interest. This more natural way of learning is designed to offer users more opportunities to encounter cases at different times, a process that is intended to support multi-perspectival learning.

Back Arrow. The Back Arrow allows users to retrace their steps within EASE History. The ability to retrace one's steps is intended to limit the 'where was I again' problem, something that users might experience.

Artifacts. Through the Artifacts icon users can view candidate profiles, electoral maps, Annenberg Fact Check article summaries, election results, and links to related websites. Links to related websites are important since EASE History is not a comprehensive program. EASE History relies heavily on sites such as BBC, NPR, PBS and FactCheck.org because they are reliable, non-commercial, and frequently updated. Artifacts appear in pop-up boxes, while interviews, learning segments, and related clips appear inside the interface.

The "52 Election Map" is an example of an artifact. By rolling over the artifact icon on "I Like Ike" and then clicking on "52 Election Map" users are able to see that Eisenhower easily defeated Stevenson in the 1952 election. Candidate profiles are also available through the artifacts icon. These profiles feature biographical material and a list of the strengths and weaknesses of each candidate going into an election. Eisenhower's 1952 candidate profile is designed to help users see how "I Like Ike" highlighted Eisenhower's strengths, military heroism and patriotism, and compensated for his weaknesses, including issues related to likeability.

The Image icon is available when cases feature a still image. A larger still image appears in a pop-up window when the Image icon is clicked on. For example, "Lumber 19" is a case from 1919 that features a photo of two African-American women working at a lumberyard during World War I. The photo has been reduced to 320x240 pixels to fit inside the viewing window. Clicking on the Image icon enables users to see a larger

463x600 image. Users can download the larger image onto their desktops by moving the cursor over the image and clicking "save as".
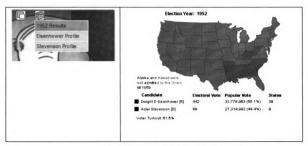
Figure 9. Election Map Artifact

<u>EASE History Theme Searches</u>

There are many different ways to search for cases in EASE History. In addition to single-theme searches that can be performed through the three main menus, there are four advanced theme searches: single theme searches, multiple theme searches, keyword searches, an index search, and a topics search.

1. Single themes can be performed using the Historical Events, Campaign Ads, and Core Values main menus. The Campaign Ads main menu, for example, has fourteen themes and sixty-eight sub-themes. Themes available through the Campaign Ads main menu include: Candidate, Year, Presidential Leadership Attributes, Ad Types, and Ad Issues.

2. The Multiple Theme Search page lists all EASE History themes and enables users to search on single and multiple themes. Users might use the feature to refine their searches. For example, a user might begin a search for campaign advertisements that feature the bandwagon effect and music by searching on "Music". This search would return seventy-six cases. A search on "Music" and "Bandwagon" using the Multiple Theme Search page, on the other hand, would return eight cases that have been coded on both themes. This is a much more cognitively manageable set of clips to begin seeing how these two themes are related.
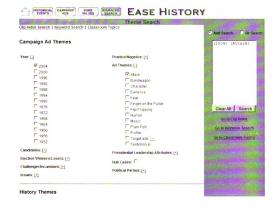
Figure 10. Multiple Theme Search

3. The Clip Index lists all available cases in EASE History. The current Clip Index contains over twelve hundred cases.

Figure 11. Index Search

4. The Keyword Search enables users to search on text in case text description boxes. For example, a search on "Eisenhower" using the keyword search returns 84 cases from the Campaign Ads and Historical Events topics.

Figure 12. Keyword Search

5. The Topics Page includes themes that are commonly studied in U.S. History classrooms. These themes include: Communities, Cold War, Immigration, Social Movements, Transportation, and War. The Topics Page is designed to support usability and usage goals. It was added at the request of California educators who thought that a topics page might support classroom learning by making common topics used in classrooms more easily accessible.

EASE HISTORY

Classroom Topics

Theme Search | Clip Index Search | Keyword Search

Communities

Rural
Suburban
Urban

Culture

Baby Boomers
Cultural Icons
Fashion
Sports
Youth

Movement

Immigration
Migration

Science/Technology

Health
Radio
Space Programs
Telephone
Television

Social Movements

Anti-war Movement
Civil Rights Movement
Labor Movement
Women's Movement

Transportation

Airplanes
Cars

War

Cold War
Korean War
Vietnam War
WW I
WW II

Other

Great Depression
Great Society
New Deal
The year 1968
Political Campaigns
UN

Figure 13. Topics Search

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<u>EASE History Viewing Modes</u>

EASE History offers users three viewing modes: the View, Compare, and Weave. The naming of the one, two, and four-window viewing modes, as View, Compare, and Weave, is specific to EASE History.

1. The View mode is the more traditional interface of the three modes. This one-window viewing mode is designed to help learners focus on a single case. For example, if users wanted to focus on the persuasive techniques in one campaign advertisement, then they might feel more comfortable using the View mode.

Figure 14. View Mode

2. The Compare viewing mode enables learners to place two videos side by side. This physical arrangement of cases is designed to support across case comparisons by assuming some of the cognitive load and increasing the number of possible connections

that can be more easily noticed. For example, users can compare how "I Like Ike" and "Stevenson", two campaign advertisements from the 1952 election, highlighted candidate strengths and hid candidate weaknesses. The Compare viewing mode is EASE History's default viewing mode, because I thought that users might be initially too overwhelmed by the Weave interface.

Figure 15. Compare Viewing Mode

3. The Weave viewing mode is designed to support across case comparisons. In this mode users work with four cases at the same time, thus raising the number of possible connections that can be more easily noticed. I developed learning activities specifically for the Weave viewing mode. The four-part story activity, for example, asks users to demonstrate their understanding of a concept like Cold War by weaving together

an essay about the concept. This activity is included in the Learning Guide, which is available through the main navigation bar.

Figure 16. Weave Viewing Mode

Weave Viewing Mode Example

The following section includes an example of how the Weave viewing mode might support the understanding of how music is used in campaign advertisements, specifically how the application of music depends on context. The four cases featured in this example are "I Like Ike", "Kennedy 60", "Spring 84", and "Remember 88". "I Like Ike" is placed in viewing window "1", "Kennedy 60" in viewing window "2", "Spring 84" in viewing window "3", and "Remember 88" is placed in viewing window "4".

Comparing and contrasting "I Like Ike" and "Kennedy 60". These two campaign advertisements are similar from the bandwagon-music perspective. Both campaign advertisements feature upbeat music that is intended to support the bandwagon effect. "I Like Ike" demonstrates the bandwagon effect by showing a parade that attracts a greater following. Similarly, in "Kennedy 60" the bandwagon effect is demonstrated with photos of young and old supporters, some featured on signs similar to those that Eisenhower supporters carry in "I Like Ike". Both "I Like Ike" and "Kennedy 60" songs repeat the candidate's name but the music used in each campaign advertisement supports different goals. The music in "Kennedy 60" supports the goal of increased name recognition, awareness of candidate biography, his stand on issues, and his connections to former Democratic leaders like Franklin and Eleanor Roosevelt and Harry Truman. The goal of "I Like Ike" is not to describe the candidate's accomplishments and biography. These were the main goals of "Abilene 52", an Eisenhower campaign advertisement also from the 1952 election. Rather the music in "I Like Ike" supports the goal of making Eisenhower more likeable, because in 1952 Eisenhower was well known as a military man but new to domestic politics.

Comparing and contrasting "I Like Ike", "Kennedy 60", and "Spring 84". The music in all three campaign advertisements might be described as positive but the music used in "Spring 84", unlike the music in the other two advertisements, is in the background and without lyrics. In "Spring 84" the music is meant to support the narrator's words of optimism and his calm tone. The goal of "Spring 84", and the other campaign advertisements in President Reagan's "Morning in America" series, was to describe the public's optimism about its future in 1984. The U.S. had emerged from a

recession in 1983, so the intent of the Reagan commercial was to reassure the public that the economy had turned the corner.

Music was used in different ways in "I Like Ike", "Kennedy 60" and "Spring 64", because they had different goals. The music used in "I Like Ike" supported the advertisement's goal of making the candidate more likeable, while the music in "Kennedy 60" promoted the name recognition of the candidate. The "Spring 84" commercial had a different goal. Unlike Senator Kennedy in 1960, President Reagan was a known quantity in politics by 1984. He was elected U.S. president in 1980, ran for the Republican presidential nomination in 1976, and served as governor of California in 1966 and 1970. Likeability was not a problem for Reagan like it was for Eisenhower in 1952. Reagan was telegenic and had worked in movies. "Spring 84" was more like Eisenhower's "Taxi 56", a 1956 campaign advertisement that featured Eisenhower, the incumbent candidate. Both "Spring 84" and "Taxi 56" featured calm music that was intended to support the narrator's description of an optimistic nation, one that should stay the course and re-elect the incumbent.

"Remember 88", a negative advertisement. The Republican National Committees' "Remember 88" campaign commercial is a negative advertisement, unlike the other three "positive" campaign advertisements that I have described in this exercise. "Remember 88" featured a song called "I Remember You". Its music and lyrics were intended to remind the public of the troubled times of 1978 when Jimmy Carter, a Democrat, was president. A series of negative images accompanied the song: gas lines, unemployment lines, OPEC ministers, and President Carter. These images were included in the advertisement to remind viewers of the oil crisis and economic downturn that occurred

during Carter's time in office. In a reminder of the need to place events in context, "I Remember You" was shot in black in white in order to reinforce the negative aspects of Carter's presidency, while "I Like Ike was shot in black and white because few U.S. households had color television in 1952.

Looking again at the other three campaign advertisements from the negative advertisement perspective there are examples of how even "positive advertisements" can feature attacks on the other candidate. "I Like Ike", for example, featured a Democrat riding in the opposite direction of Eisenhower's supporters. This was meant to illustrate how the Democrat was out of step with the rest of the country. In "Kennedy 60", the call for a "fresh new point of view" might have been an attack on Nixon's two terms as Eisenhower's vice-president. In "Spring 84" the narrator said that people no longer think that the job of the presidency is too much for one person. This might have been an attack on President Carter who some thought was overwhelmed by the job.

This Weave example is designed to demonstrate how the viewing mode might support the understanding of how different main goals require different kinds of music by crisscrossing multiple elections through the examination of cases from multiple thematic perspectives, placing cases in context, and making connections between cases. This example was also designed to show how the Weave viewing mode might support the understanding of concepts like likeability, name recognition, negative advertisements, and positive advertisements through work with multiple cases where the concepts have been applied in similar and different ways, and seeing how these themes are intertwined with music and with other themes.

<u>EASE History Timeline</u>

Users can perform a single theme search through any of the three main menus. If users click on "Music", a sub-theme of "Ad Types", in the Campaign Ads menu, fifty-five advertisements coded on music appears in the EASE History timeline. The two campaign advertisements at the top of the EASE History timeline are 2004 advertisements from the President Bush and Senator Kerry campaigns. At the bottom of the queue are advertisements from the 1952 presidential campaign.

Figure 17. EASE History Timeline

All searched items are returned in the scrollable EASE History timeline that is located on the left hand side of the interface. The EASE History timeline is designed to scaffold learning by:

Reducing the learner's cognitive load. The EASE History timeline is designed to help learners work with a large number of cases, and in effect help them hold relevant cases in their cognitive workspace, something novice learners would not normally be able to do. The timeline uses visual cues such as colors, titles, memorable images, and comment boxes to help users quickly identify cases. For example, information related to the "I Like Ike" thumbnail image, includes: the title of the advertisement, the year the advertisement was produced, a short description, a memorable image from the video, and a red title to signal to users that General Eisenhower was a Republican.

Fighting conceptual oversimplification of complex concepts. The EASE History Timeline is designed to combat early closure by showing all cases that have been coded on a particular thematic concept. For example, a search on "Cold War" returns one hundred and eight cases. The examination of multiple cases coded on "Cold War" is designed to help users understand that the Cold War included a competitive space race (e.g., Sputnik, Gagarin orbits the earth, Apollo 11 moon landing), conflict (e.g., Korean War, Cuban Missile Crisis, Vietnam War), and periods of cooperation (e.g., Nixon's Visit to China, Helsinki Accords, IMF Treaty).

Placing events in context. The timeline is designed to help learners place events in context, for users see events that preceded and followed a specific event. In order to develop a deeper understanding the 1992 election, for example, learners might search on "Bush GWH administration" and examine events that may have influenced the 1992

election. Some events that the user might look at include: a Bush-Yeltsin press conference, the Los Angeles riots, and Ross Perot's candidacy.

Rolling over the small image of "I Like Ike" in the EASE History timeline reveals a comment box with a short description of the case and two boxes that lay atop the image. (Two boxes appear when the user is in the Compare viewing mode. Four boxes appear when the user is in the Weave viewing mode.) If the user rolls over the small image of "I Like Ike", a 1952 Eisenhower campaign advertisement, and clicks on "1" then that video case will be placed inside the "1" clip window.

Figure 18. EASE History Timeline Rollover

A complete set of CFT principles were able to be applied in EASE History, a full-fledged computer learning environment. CFT argues that nonlinear, case-based environments can be designed to combat reductive thinking and support an open-minded, pragmatic approach to work in ill-structured domains. CFT tenets instantiated in EASE History are: the use of a case-based hypermedia program, interconnected domain

knowledge, the need to combat reductive thinking, the need to see how concepts vary across contexts, and the need to represent domain knowledge in multiple ways.

Case-based hypermedia program. CFT argues that learning in ill-structured domains is supported by work in case-based hypermedia environments. EASE History is an online case-based hypermedia system. Its cases are designed to make learning in ill-structured domains more manageable and accelerate the process of knowledge acquisition. Cases feature short videos that are intended to be more manageable in size and have resources that are designed to support the understanding of the event. Resources include case descriptions, interviews, links to related cases, links to other programs, and mindset modeling videos. Cases retrieved from theme searches are organized in a timeline that provides visual cues and organizes cases in chronological order to support work with multiple cases across time and regions. The Compare and Weave viewing modes are designed to help learners hold relevant cases in their cognitive workspace (a shared goal of the timeline), something novice learners might not normally be able to do. Mindset modeling videos are designed to demonstrate and promote a critical mindset through short, dense videos.

Knowledge is interconnected. CFT argues that knowledge in ill-structured domains is web-like, not hierarchical (Spiro et al., 1987, 1988). EASE History's use of main topics, theme searches, and case-related icons are three examples of how knowledge is interconnected in the program. First, the integration of EASE History's three main topics, U.S. presidential campaign advertisements, Historical Events, and Core Democratic Values, is designed to help users crisscross three domains in a nonlinear fashion, revealing relationships between the three domains. Second, the web-like nature

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of knowledge is demonstrated by themes, such as freedom and conflict that appear in multiple theme menus. Third, the advanced "Theme Search" is designed to help learners see how multiple examples of cases coded on the same set of themes are interconnected. Lastly, mindset modeling videos are designed to support knowledge connections. For example, "Multiple Goals", a mindset modeling video, is designed to demonstrate how multiple goals, name recognition, bandwagon, music, and likeability perspectives are interconnected.

Combat reductive thinking. Mindset modeling videos, theme searches, viewing modes, and the learning guide are examples of EASE History features that are designed to combat reductive thinking. EASE History mindset modeling videos are designed to demonstrate flexible thinking by using innovative video presentation formats, including narration, quick editing, video effects, and strategies to open and deepen perception of the complexity of cases. The dissonance effect, which is featured in the mindset modeling video "Angle", is designed disrupt reductive thinking and help learners think about context. Theme searches, including single and multiple theme searches, keyword searches, an index search, and a topics search, retrieve multiple cases. The retrieval of multiple cases is designed to open up perception for learners see that the concept has been applied in similar and different ways across multiple cases. The juxtaposition of cases, which CFT argues highlights different facets of each case (Spiro, et al., 2003) and opens perception, is supported by the two and four-window viewing modes that enable users to place cases side by side.

Multiple representations of domain knowledge. CFT argues that each case is complex and cannot be explained by a single thematic perspective and that conceptual

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themes are interdependent. EASE History is designed to support the examination of cases through multiple perspectives by coding cases on multiple themes, which are visible in the case description boxes.

Conceptual variability and context awareness. CFT argues that ill-structured concepts are defined through their use, so it is essential that learners see multiple examples of how concepts are applied in real world situations. Three EASE History features that are designed to help learners see how concepts vary across contexts are: theme searches that retrieve multiple cases, mindset modeling videos, and viewing modes. In order to fight conceptual oversimplification of complex concepts, EASE History theme searches return all cases that have been coded on a particular thematic concept. This is designed to enable users to see how the application of concepts varies from case to case. For example, a search on 'freedom' retrieves sixty-eight cases from multiple decades. The conceptual variability effect in the "Bandwagon" mindset modeling video is designed to show learners how the final stage of the bandwagon effect is used and tailored to contexts. The physical arrangement of cases in the Compare and Weave viewing modes is designed to support across case comparisons in EASE History, for the modes assume some of the cognitive load and increase the number of possible connections that can be more easily noticed, facilitating the development of more advanced understanding of thematic concepts and cases.

Lessons Learned Designing EASE and EASE History

Design goals and pedagogical goals converged in this project. The ability to adapt to new situations, tolerate uncertainty, compare and contrast multiple programs, place programs in context, compensate for an individual program's weaknesses by taking

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advantage of the strengths of other programs, and apply learning theory, a mindset which is used to support learning in the program also supported the design of the EASE programs. This section describes lessons that I learned designing EASE and EASE History. These lessons include the need for designers to:

Adapt to new situations. EASE program designers were challenged to constantly adapt to the changing design landscape. Their ability to adapt to new situations might have supported the design of the EASE programs. As examples, an awareness that technology changes over time led the team to budget for purchase of future software updates; the design team had to adapt to software updates (e.g., Flash, Final Cut Pro, Sorenson Squeeze) over the course of the project. Updated software enabled the designers to work with content in new ways, but required that EASE designers develop new skills to use the updated software; as the programmer's skills grew, the design team was able to explore more possible design options, which led to the development of features, such as the Search History, the timeline, sub-themes in the main menus, and more advanced theme searches. The inclusion of new features often required the team to make changes to the interface (i.e., rearrange elements, delete elements). The design team was given the task of creating a program that could be easily adapted to support learning across ill-structured domains, so the team created elements, such as icons that appeared atop of the videos, that could be renamed and hold different kinds of content. The ability to upload general video content to the database was intended to enable future EASE applications to incorporate advances in digital video editing. The addition of the four-window viewing mode to EASE History, which placed demands on space, led the design

group to create a two-columned timeline and information drop down boxes in the four-window viewing mode.

The following are examples of how I adapted to meet the challenges of new situations when designing EASE History: after failing to secure rights to licensed videos I discussed options with the MSU Library's copyright team, explored other kinds of content that might be featured in EASE History, including pre-20th century topics, and decided that EASE History would feature campaign advertisements and public domain content from U.S. government agencies; the inclusion of new cases required me to think adaptively, for new cases required the generation of new themes, since theme-coding categories emerged from the cases themselves; and after the launch of an updated Living Room Candidate website in July of 2004 I was forced to reevaluate EASE History's goal of gaining a large, global audience, since the Living Room Candidate site featured high quality videos and content that overlapped with EASE History.

Tolerate uncertainty. Often in design there is not a clear right answer, but a decision must be made. A toleration of uncertainty is necessary if a team is to approach each situation with an open mindset, explore multiple design possibilities, examine costs and benefits, and balance multiple project goals. The following examples demonstrate the need to act in the face of uncertainty in the design of the EASE programs. The team wrestled with the costs and benefits of Flash as the program interface, including the benefit of having a Flash video player that could be embedded in an interface and the cost of how content inside Flash could not be found by search engines; the team had to weigh the costs and benefits of having online and offline programs; and the difficult decision to develop programs using Flash was made after exploring the costs and benefits of content

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delivery platforms, including how users would be accessing the program, an examination of current computer usage, and expectations of more powerful computers and increased bandwidth; the decision to have boxes on top of thumbnail images in the two and four viewing mode timeline was made after exploring a drag and drop option.

The following demonstrate the need to act in the face of uncertainty in the design of EASE History: the decision to feature campaign advertisements and public domain materials was made after exploring other content options, including pre-20th century U.S. topics; decisions to apply less straightforward themes, such as freedom and consensus, to cases was an interpretive process, so judgments had to be made on a case by case basis; and the difficult decision to feature the two-window viewing mode as the default viewing mode in EASE History was an attempt to balance the goal of making CFT principles visible, for users could switch to the four-window viewing mode from the two-window viewing mode, with the goal of increasing traffic to the site, which I thought the two-window viewing mode could better support because users might find the mode more cognitively manageable.

Compare and contrast multiple programs. The examination of multiple programs can be argued to have helped EASE designers develop a deeper understanding of how concepts, like "new media" and "content organization", are used in similar and different ways across multiple programs, and then reassemble ideas obtained from this research to design features that fit the needs of specific projects. The EASE timeline was designed after examining timelines from multiple online programs and then adapting them to fit the needs of the EASE system. The examination of CFH systems, including KANE, provided a road map for the development of EASE features and the how content is

organized in the site. The need to connect Flash to the database led the team to compare multiple programs (e.g., Flash, ASP, JAVA) to see how the technologies might complement one another.

After I examined multiple sites, including the BBC, ESPN, CNN, and the Living Room Candidate from the new media perspective, I had a heightened awareness of the need to feature clear, well-edited videos in EASE History, because low quality, poorly edited videos did not reflect how video was being used on the web. After the launch of an updated Living Room Candidate website in July 2004, I compared and contrasted EASE History with Living Room Candidate and determined that were clear differences between the two programs and that I should place more emphasis on EASE History being a hypermedia system that is supported by learning theory. The similarities and differences of the two programs are discussed in greater detail in Chapter 7.

Place programs in context. An argument can be made that placing programs in context supported the design process, for it enabled the team to think about how and where the program would be used. As mentioned before, the decision to produce online and offline EASE applications was made after considering the limitations of current bandwidth and computer and the expectations of more powerful computers and higher bandwidth in the future that might enable more programs to be placed online without limiting program use. In the case of EASE History, the examination of context enabled me to think more deeply about user characteristics, including where the program would be used (e.g., inside and outside classrooms), how the program might be used (e.g., in large groups, small groups, by individuals), and who would be using the program (e.g. novice and more advanced learners). Since campaign advertisements are not often

featured in social studies classrooms, I designed EASE History resources that might be used to support classroom teaching (e.g., learning activities, candidate biographies, and mindset modeling videos).

Compensate for an individual program's weaknesses by taking advantage of the strengths of other programs. Because of constraints on time and financial resources, EASE and EASE History could not do everything. Therefore an attempt was made to integrate multiple programs in order to compensate for an individual program's weaknesses by taking advantage of the strengths of other programs. For example, EASE does not include video editing and compression tools but instead takes advantage of professional tools, like Final Cut Pro and Sorenson Squeeze. EASE does not include blogs or forums. I thought that again, because of constraints on time and financial resources, it would be better to link EASE applications to blogging and forum tools.

EASE History is not comprehensive in terms of content. The program does not include all major events that might appear in a 20th century to present U.S. social studies textbook. Instead of attempting to build a comprehensive program, I linked EASE History cases to related information featured in sites, like BBC, CNN, and NPR, so that EASE History users might develop a deeper understanding of cases and an awareness of how knowledge is connected.

Apply learning theory to program design. The deliberate effort to apply learning theory to the design of the EASE programs can be argued to have supported the overall design of the EASE programs in the following ways. The adoption of an open mindset (e.g. tolerance for uncertainty, comparing and contrasting programs), which CFT advocates, may have supported the design team's ability to adapt to new situations. The

theory, and other previously built CFH systems, provided a road map for understanding

how knowledge is organized in a CFH system. Overall, design was supported by the

application of learning theory, but the learning theory may have negatively impacted

gains of overall users. For example, the four-window viewing mode, a mode supported

by CFT, might have negatively affected the number of site users, since the mode might

have introduced too much complexity and meant that features that might have expanded

the program's audience had to be resized or deleted.

CHAPTER 6

AN EXAMINATION OF THE EASE PROGRAMS
FROM THE DISCIPLINE OF DESIGN

The previous chapters have examined the design of the EASE and EASE History

systems through multiple lenses, including: the Cognitive Flexibility Theory (CFT)

perspective, the theory that supports the two systems; previously built Cognitive

Flexibility Hypermedia (CFH) systems; the contesting of CFT; narratives concerning the

design of the two systems; the examination of features from different learning

perspectives; an overview of EASE History, a full-fledged, working system; specific

worked examples of how EASE History might support learning in history and civics

learning; the perspectives of multiple, contemporary learning programs. Chapter 6 adds

another conceptual lens, from the field of design itself, in order to develop a deeper

understanding of the design of the EASE programs.

There are many different design frameworks that I could have used to examine

the two EASE systems (e.g., TPACK (Mishra & Koehler, 2006); Principle-based

Instructional Design Model (Hong, Scardamalia, Messina, & Teo, 2008); Cultural-

oriented Instructional Design Model (Lin & Kinzer, 2003); the Problem-based

instructional Design Model (Hmelo-Silver, 2004). I decided not to examine the EASE

systems through the TPACK (Mishra & Koehler, 2006) lens, because I thought that its

categories, including the need to identify ill-structured domains and use real world cases

to support the teaching of design, were too similar to the CFT lens that I had previously

applied to the design of the two systems. For example, Mishra & Koehler write that when

teaching design "students should engage in challenging problems that reflect real-world

complexity. The problems should be authentic and ill-structured; that is, they should not have one predetermined, foregone solution but rather be open to multiple interpretations and multiple right answers" (Mishra & Koehler, 2006, p. 33).

For this analysis I selected a design framework outlined in *The Design Way,* a book authored by Nelson and Stolterman (Nelson & Stolterman, 2003). The authors argue that design is a human activity, something that people are continually doing. In the prelude to *"The Design Way"*, the authors state, "To come up with an idea, and to give form, structure and function to the idea, is at the core of design as human activity" (Nelson & Stolterman, 2003, p. 1). The authors advocate the use of a "rich set of rigorous and disciplined design methods and techniques" (Stolterman, 2008, pp. 55-65) to support the examination of program design from multiple perspectives (Nelson & Stolterman, 2003, p. 108). The authors argue that this kind of approach might support innovation in the complex world.

There are three reasons why I decided to use a design framework proposed in *The Design Way*. First, the authors treat design as complex, arguing that in order to understand a system one needs to examine the relationships of elements within the system and the system's relationship with other systems. Second, the authors feature coherent subsets of design principles. Third, and perhaps most importantly, the approach of the authors is becoming one of the more favored approaches in the learning sciences. For example, John Bransford, one of the most important learning theorists in the past thirty years, endorses and makes use of the approach to design that is presented in *The Design Way* (Bransford, Slowinski, Vye, & Mosborg, 2008).

The authors propose multiple design frameworks in *The Design Way*. The framework that I have chosen for this exercise is one that examines how the complex nature of systems, the ability of designers to adapt to new situations, the establishment of a project as a purposeful activity, and limits on time and financial resources shape design decisions. Nelson and Stolterman (2003) advocate the examination of systems through combined categories (e.g., one might examine the tensions between limits on resources and the ability of designers to think in adaptive, creative ways when designing features for a complex system) for these combinations might enable one to draw out relationships, identify patterns (Nelson & Stolterman, 2003, p. 108), and see "how design situations are complex, rich and replete with tensions and contradictions" (Nelson & Stolterman, 2003, p. 102).

In this analysis I will use the following categories, sometimes in combination, to describe tensions and contradictions involved the design decisions related to the EASE programs. These categories are: the complex nature of the EASE systems which have multiple, interconnected elements; the ability of designers to adapt to changing situations; how limits on time and financial resources impacted design decisions; the design of the EASE projects as purposeful activities which used design to solve problems.

EASE systems are complex. Complexity is "a distinctive attribute arising as a consequence of the dynamic interactivity of relationships" (Nelson & Stolterman, 2003, p. 73). The EASE systems are complex, because they have multiple, interconnected elements. In EASE systems, for example, the retrieval of cases and case resources depend on the integration of four tools: ASP, SQL, Javascript, and Flash. In EASE History users can search on themes from across the domains of history, political ads, and core

democratic values. For example, users can search on cases that have been coded on 'freedom,' a core democratic value theme, and 'economy', a history theme.

Designing complex systems means that designers must consider how to "explore, extract, recognize, and chose useful information from all of these potential sources" (e.g., new information, wants and needs, limitations, opportunities) (Stolterman, 2008, pp. 35-55), or in other words, think adaptively when making design decisions. EASE and EASE History designers faced design complexity. Its designers had to approach each design decision with an open mindset, examine trade-offs, and balance multiple project goals in a constantly changing environment. Trade-offs involving the EASE system were discussed in detail in Chapter 5. Those trade-offs included: the EASE design team's decision to create online and offline programs; the decision to include a four-window viewing mode, which supported CFT goals but required changes to other parts of the system, and the decision to use a Flash interface. Trade-offs involving the EASE History program were discussed in Chapter 5 of this dissertation. There were trade-offs involving the decision to use Flash in EASE History, a decision which meant that video content could not be downloaded, satisfying the requests of copyright holders, but also meaning that cases would not appear in Google searches, thus meaning that site usage might be negatively impacted. There were trade-offs with the decision to not build a comprehensive system. The decision to not build a comprehensive site, one that did not include more cases and case resources and resources related to all strands as identified by the National Center for History in the Schools, involved trade-offs. The inclusion of more cases, case resources, and resources related to the history strands might have supported a

*deep*er understanding of content, but these benefits were outweighed by the need to meet deadlines and develop features such as mindset modeling videos and the timeline feature.

Adapting. Designers need to be able to think adaptively when designing complex systems because project demands are constantly shifting. There were multiple examples of how the designers of EASE and EASE History adapted to meet the changing demands of the project. These adaptations were examined in fuller detail in the previous section on the design of complex systems and in Chapter 5. The following are examples of adaptation related to the design of program features: the addition of the four-window viewing mode, the need to adapt previously built CFH programs to reflect changes in "new media", including more powerful computers, higher bandwidth, and the ability to play videos online; my decision to alter the focus of the EASE History project to one that would feature public domain images and presidential campaign commercials due to my inability to secure rights to historical documentaries; the application of thematic perspectives to EASE History cases.

Purposeful activity. The EASE projects were purposeful activities, since they were established to solve problems. These problems included: how to design a CFH program that would support learning in multiple, ill-structured domains; how to create a database that would enable the system to support advanced searches and be easily updateable; how to develop an interface that would feature videos.

Sometimes design activities complemented one another. For example, the decision to create a database supported the goal of creating a nonlinear learning environment, for it offered users another way to work with content (i.e., the ability to search on multiple themes and see how themes are connected). The inclusion of a video

presentation tool enabled the project to present short dense videos online, including mindset modeling videos, which are designed to support the CFT goals of using new media to make complexity more manageable. The addition of a video presentation tool, which enabled the presentation of different content, and the construction of a database, which accommodated different kinds of content, both supported the creation of an open learning environment that was not domain specific.

But oftentimes there were tensions between the activities. For example, because of limits on time and financial resources, EASE project goals were not given equal weight. This meant that features were, in a way, competing against each other. For example, the creation of an online video presentation tool and a database, two goals established by program designers, were given a higher priority, as compared to the creation of a feature that would enable the public to edit and upload new content. This feature was given a low priority because I felt that its costs, in terms of time and financial resources, were too high. Another example of how limits on resources impacted design was the decision to give the database and the development of a video presentation tool a higher priority than the development of a site map. A site map would have provided EASE users with an overview of how site content was organized, but like the user content editing feature, the site map feature was given a lower priority because of limits on time and financial resources.

The EASE and EASE History systems shared many of the same goals: make complexity manageable, support nonlinear movement through the environment, present online videos, and employ a database to support advanced searches and make content more easily updateable. EASE History had an additional goal, to capture a large, global

audience. The inclusion of the four-window viewing mode is an example of the tensions between CFT goals and overall site usage goals. The four-window viewing mode is designed to increase the number of case comparisons exponentially, a goal supported by CFT, but the decision to include this feature might have negatively impacted gains of overall users, because the feature introduces too much complexity and might overwhelm users. I decided to include the one-window viewing mode in the program, because I thought that it would prove to be more popular than either the two or the four-window viewing mode, even though I understood that from the CFT perspective multiple viewing modes might better support across case comparisons.

Limits. According to Stolterman, designers need to address "the desires and needs at hand, while taking into account the limited time and resources at hand" (Stolterman, 2008, pp. 35-55). Limits on time and resources impacted the creative explorations of EASE and EASE History designers. I was encouraged by the project's Principal Investigator to be expansive in my approach to the design of the EASE program but also recognize that time and resources were limited, so priorities had to be set and creative explorations had to be limited in duration. The development of an online video presentation tool and theme searches were given a high priority, while the development of features like a site map and the ability for the public to upload and edit content were given a low priority, and would not be included in the EASE system.

Limited time and resources might have negatively impacted the design of certain features. For example, because of limits on time and resources the designers were given a short period of time to design the icons that appear on top of cases in the viewing windows. The icons do not do enough to alert users to the types of case resources

available through the cases, and this is perhaps due to the fact that design decisions related to this feature were hurried. More time on the design of icons might have produced icons that would have better supported nonlinear movement through the environment.

Because of limits on time and resources, priorities were established in the design of EASE History. For example, the design of the timeline was given a high priority. I spent about a week exploring different options regarding the construction of a timeline, examined other online programs that featured timelines, sketched out multiple design options and decided, since there were limits in terms of time and resources, to add a two-columned timeline to the interface. I argued that the decision was justified, since the timeline fit within the interface and supported the project goal of making complexity more manageable for it returned searched cases in chronological order. The development of EASE History case descriptions, case resources, and the video editing were given a lower priority, as compared to the design of the database, timeline, and video presentation tool. For example, I would have liked to have linked more cases, included more cases related to energy and environmental topics, created more mindset modeling videos, and developed more resources, such as artifacts and learning activities, but because of time and financial constraints I was unable to do so, even though more detailed case descriptions and more resources might have better supported the CFT goal of making learning more manageable.

Many of the categories from the Nelson and Stolterman framework, (e.g., complex systems, adaptivity, and limits) were redundant with categories that were described at the end of Chapter 5. For example, the ability to analyze the costs and

benefits of decisions related to online and offline program presentations, the ability to adapt previous CFH environments to fit the "new media" landscape and change the focus of EASE History content, are examples that I had written about earlier in this dissertation. Limits on design, in terms of time and resources, including the prioritizing of design features and content and the decision to integrate other programs rather than build a comprehensive program, were described in Chapters 4 and 5.

There was some value added of *The Design Way* framework, however. The application of the purposeful activity lens was a perspective that I had not thought to use to examine the EASE programs. This lens enabled me to look more closely at the prioritization of design activities and see how project goals complemented each other, like how the database and the presentation of online video supported the creation of an open, non-domain specific learning environment. Most importantly, there was value added when the themes were combined and the framework's focus on the tensions and contradictions between the categories. For example, *The Design Way* framework illuminated the tensions between elements, such as limits and creativity, in terms of how hurried decisions related to the design of icons might have negatively impacted access to case resources and impeded nonlinear movement in the system. The inclusion of the one and four-window viewing modes illustrated the contradictions between EASE History goals of making CFT principles visible and gaining a large audience. The use of Flash is an example of how EASE History goals stood in contradiction, for the inability of external search engines to locate information in Flash might have diminished the goal of increasing site usage. There was much that was non-redundant with my earlier treatment

of design, so I believe this validates the application of the Nelson and Stolterman

framework to the design of the EASE programs.

CHAPTER 7

A HYPOTHETICAL EXPLORATION OF FREEDOM

In order to see how EASE History might deepen understanding about how 'freedom' is applied across multiple cases, this hypothetical exploration examines how the concept unfolds through work with historical events and campaign advertisements cases.

Describing a complex hypermedia system on paper is a challenge because to really experience the system would require the reader to access and spend time exploring the system. In order to convey some of the potentialities of the system, in this chapter I will invite the reader on a hypothetical exploration, or a kind of "thought experiment", to examine the system through the lens of a more sophisticated understanding of freedom. This exploration does not prove the validity of the system but is designed to illustrate possibilities.

One of the goals of learning in ill-structured domains, and thus of Cognitive Flexibility Theory (CFT) and EASE History, is to convey complexity -to show how concepts vary across contexts, how concepts are interdependent, and how knowledge is web-like. So in order to understand a complex, ill-structured concept like 'freedom' one must look at a number of cases where it has been applied because the idea of freedom changes over time and an individual's meaning of the concept is recalibrated with each case.

Most U.S. citizens think about freedom in abstract terms. For example, they might say that they live in a free country where they are allowed to express their opinions in

public. This hypothetical exploration of EASE History will attempt to demonstrate the different kinds of understandings of freedom, a concept that is featured in EASE History, and one that was previously discussed in this dissertation.

One definition of liberty includes personal freedom, political freedom, and economic freedom as sub-themes (Classroom Help, n.d.):

- Personal Freedom - the right to think and act without government control.

- Political Freedom - the right to participate in the political process.

- Economic Freedom - the right to buy, sell, and trade private property and the right to employment without government interference.

For this hypothetical exploration I imagine that I am a student named Cris, someone who has viewed EASE History mindset videos and has developed a critical mindset of opening perception. Cris will work with a large number of cases coded on freedom, place the cases in context, and see how the same concept is applied in different ways across multiple cases. Whatever Cris notices in this traversal of 'freedom' and whatever this system helps to illuminate, someone will analyze it in a different way but that is the point. There is nothing in this system that is definitive. The point is to see how concepts can be viewed from different perspectives, so learners can gain a more expansive use of concepts and a greater awareness of subtlety and nuance. One could find more sophisticated treatments of 'freedom' (including from Eric Foner's "Story of Freedom" and George Lakoff's "Whose Freedom", for example), but EASE History offers illustrations in context and practice in the tailoring of meaning across historical events and campaign advertisement cases.

The purpose of this detailed hypothetical exploration is designed as a thought experiment to simulate what a student might do when working with cases coded on freedom in the EASE History system and demonstrate the face validity of the system, so that an argument can be made that descriptions of program use match what is done when the program is actually used -that users work with multiple, interconnected cases in an online hypermedia environment that is designed to support a deeper understanding of concepts by showing how the application of concepts vary across cases.

The next eleven pages will take the reader on one path through the system that would take about approximately forty-five minutes in practice.

The Hypothetical Exploration of 'Freedom' by "Cris"

To begin this exercise, Cris rolled over the "Core Democratic Values" theme in the Core Democratic Values theme menu. This action revealed seventeen themes. Cris clicked on the "freedom" theme button, an action that retrieved sixty-eight cases, drawn from the historical events and campaign advertisements topics, coded on the theme. The cases appeared in the two-columned timeline in chronological order. Cris placed "Inked", an historical event, denoted by the green title bar visible on the thumbnail image, in window "'1" and "Across", a Democratic campaign commercial, signified by the blue title bar visible on the thumbnail image that appears in the timeline, in window "2" of the Compare viewing mode.

The "Inked" case featured an image of a group of Iraqi citizens holding up their inked fingers after voting in the January 2005 election. After examining the photograph and reading the case description, Cris observed:

From the case description I learned that the Shia Party won the majority of assembly seats, Kurdish parties came in second, and most Sunnis did not participate in the election. In the example of "Inked", free elections are an example of political freedom, but in this case Sunnis did not participate in the election, and perhaps their non-participation was due to fears of violence or done to protest the elections.

The "Across" case was a thirty-second Senator John Kerry advertisement from the 2004 election. In the ad Senator Kerry talked about how strong military alliances can help people live free from the fear of terror. After viewing the commercial, Cris commented:

> Senator Kerry argued, in the "Across" case that freedom must be defended and can be weakened with fragile alliances. Freedom from fear is addressed in both "Inked" and "Across" cases. In "Inked" the Sunnis might not have participated in the election because they feared violence. In "Across" Senator Kerry addressed the fears of terrorism in the U.S. and said that measures needed to be taken to help U.S. citizens live free from fear. Both cases also addressed the political dimensions of freedom. The "Inked" case linked freedom to voting, while the "Across" case connected the protection of freedom to strong military alliances. In both cases freedom had to be earned- through active participation in elections in the case of "Inked" and the defeat of terrorists in the case of "Across".

Cris rolled over the Related Cases icon atop "Across" and clicked on a link to "Complicate", a thirty-second President George W. Bush advertisement from the 2004 election. In the commercial viewers are warned that Senator Kerry wanted to mandate national health insurance, an initiative that President Bush opposed. In order to find out more information about President Bush and Senator Kerry's stands on the issue, Cris rolled over the Artifacts icon on top of "Complicate" and clicked on the first link, titled "Election 2004 issues from CNN". The CNN website opened up in a new window. At the CNN site, Cris clicked on the "Health Care" button, spent a few minutes reading the information, and said:

> President Bush argued for the maintenance of the current system rather than the creation of a new government-based system, while Senator Kerry supported a

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program that enabled people to participate in a national health insurance system. Both President Bush and Senator Kerry connected freedom and health care but did so in different ways. In "Complicate", President Bush argued against a government-supported health care system because it would mean that higher taxes and government mandates would curtail economic and personal freedoms. In "Across", Senator Kerry argued for national health care from economic and personal freedoms perspectives, the same concepts President Bush used to argue against the program. Senator Kerry argued that a national health care program was needed, because it would increase the quality of life for people and enable people to live free from wants, as they would be able to seek out treatment for illnesses without suffering financial collapse. According to Senator Kerry, the trade off between limits on economic and political freedoms (higher taxes and government interference) and expansion of personal and economic freedoms (national health care system) was worth doing. To President Bush it was not. In these two cases political, economic, and personal freedoms intersect with other conceptual themes, including poverty, quality of life, taxes, government mandates, limited government, and health care plans.

EASE History enabled Cris to search on themes, such as poverty, life, common good, taxes, government, economy, and health, and explore how they are interrelated, but for the purposes of this exercise, seeing how freedom varies across multiple cases, Cris did not pursue these paths at the time.

Cris returned to the "Across" case, rolled over its Related Cases icon, and clicked on "Patriot Act", a case that featured an image of President Bush signing the Patriot Act into law on October 26, 2001. The "Patriot Act" case featured only a brief description of the event, so Cris sought out more information about the case by rolling over the case's Artifacts icon and clicking on a link to an NPR story about how the 2004 candidates talked about the Patriot Act. Cris listened to the NPR story and commented:

> From the NPR story I learned that the two candidates had different reactions to the Patriot Act, but both candidates used freedom to argue their different positions. Both candidates agreed that freedom and national security should be protected. President Bush argued that the Patriot Act was a necessary and effective tool to combat terrorism and protect freedoms, such as personal freedoms, like life, freedom from fear, and the pursuit of happiness. Bush argued that the act curtailed some civil liberties but was a necessary trade-off since the country was at war. Senator Kerry argued that some parts of the Patriot Act had

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created an imbalance between the protection of civil liberties and national security, so the act needed to be amended in order to restore balance.

Cris switched to the Weave viewing mode and brought "Tested", a thirty-second President Bush advertisement from the 2004 election, into window "3". After watching the advertisement, Cris said:

> In "Tested" President Bush argued that freedom, faith, families, and sacrifice have held the U.S. together since 9/11. By connecting freedom to faith, families, and sacrifice, President Bush argued that freedom is a core value, not just a core democratic value, and one that requires protection.

Next Cris placed "Not Tell", a one-minute twenty second video from January 27, 1993, in window "4" of the Weave viewing mode. In the video, newly elected U.S. President Clinton announced his "Don't Ask, Don't Tell" policy, which stated that as long as military personnel hide their sexual orientation they can serve in the military. A complete ban on homosexuals serving in the military had preceded the new policy, so "Don't Ask, Don't Tell" was seen by many as an action that redefined freedom, for the policy's goal was to end discrimination based on sexual orientation in the military. After watching the video, Cris observed:

> In this case freedom was gained but it was partial freedom, because the new military policy did not allow military personnel to discuss their private lives. This violated freedom of speech and freedom of expression. From this case I learned that executive actions can expand freedom and that freedom is not a fixed idea, for the definition of freedom and its application changes over time.

Cris placed "CORE", a fifteen second video case from the spring of 1964, in window "1". The case featured students from civil rights organizations during the Freedom Summer, a civil rights campaign to register black voters. The narrator described the goal of the freedom movement--to end segregation and racism through non-violent actions. After viewing the video, Cris commented:

From this case, I learned that social action is sometimes required to protect and secure freedoms, such as voting rights that are national law. In "CORE", like in the "Not Tell" case, there was an expansion of the definition of freedom and its application, but in the case of "Not Tell" it concerned sexual orientation and an executive order, and in "CORE" it concerned race and social action. In both cases there was resistance to the expansion of freedom.

Cris placed "Jackson", a twenty-one second video from 1964, in window "2". The video showed the Jackson, Mississippi police being outfitted with gas masks and shotguns in preparation for the arrival of civil rights protesters arrived. After watching the video clip, Cris said, "From this case I learned that freedom of speech, freedom of assembly, and voting rights, could be challenged by the state, in this case with violence".

Cris placed "Dream", a forty-four second video excerpt from Martin Luther King Jr.'s "I Have a Dream" speech, delivered in Washington DC on August 28, 1963, in window "3". In the clip, Reverend King described a time when children would be judged by their character not the color of their skin and invoked an "old Negro hymnal" about freedom. In order to place the event in context, Cris rolled over the Artifacts icon and clicked on the link to a BBC article about Reverend King's speech. After reading the BBC article, Cris said:

> From the BBC article I learned that King, a reverend, addressed civil rights protesters at the Lincoln Memorial in Washington DC, as part of the movement to fight for racial equality. I also learned that Reverend King led the Montgomery Bus Boycott of 1955 and had been arrested numerous times, suffered harassment, and had violence directed towards him.
>
> Freedom, in the "Dream" case, is an example of how the concept is chameleon-like, for the case takes on the colors of the specific context. "Dream", for example, included freedom of speech for Reverend King delivered his speech to an audience, freedom of assembly for about 250,000 people gathered in Washington D.C. and listened to the speech, and freedom of religion, because Reverend King, a pastor, was able to speak to the crowd. In the speech, Reverend King used multiple examples to describe the long struggle for freedom, including an old hymnal, inequalities in 1963, and a future when children will be not be judged by the color of their skin but by their character. Reverend King described

the struggle for freedom as a collective struggle, a struggle that has expanded over the years and one that requires religions to work together in order to achieve freedom, equality (of the races), and common good (freedom for one group means freedom for all groups).

Next Cris clicked on "DC March" and placed the case in window "4". The case featured a photograph of civil rights protesters at the march on Washington D.C, where Reverend King delivered his "I Have a Dream" speech. After looking at the image, Cris observed, "The image reinforces the idea that the civil rights movement was a collective struggle. People of different ages and races are visible in the photograph".

Cris rolled over the Related Cases icon situated atop the "DC March" case and clicked on "Poverty", a 1964 President Johnson campaign commercial. In the nineteen-second commercial the narrator described the President's war on poverty and creation of the Great Society, a set of government programs to end poverty and racial inequalities. After watching the "Poverty" advertisement, Cris commented:

> Freedom has social, economic, and political dimensions in the "Poverty" case. In terms of the social dimensions, the case called for the expansion of freedoms for groups who were discriminated against. In terms of economics, the case argued that people should live free from wants. The political dimension of freedom in this commercial was that President Johnson argued that government could break the cycle of poverty through the creation of civil rights, education, jobs, and health care programs.

Cris placed "Pills", a 1963 case about the approval of the birth control pill by the FDA, in window "2". After looking at the image and reading the case description, Cris rolled over the Artifacts icon, clicked on "Pills", and then clicked on the link to a PBS website about the history of the pill. After spending time reading content on the PBS site, Cris said:

> From the PBS website I learned that thirty U.S. states had anti-birth control laws which prohibited or restricted the sale, advertisement, and clinical studies of contraceptive devices in the 1950s. I also learned that the supporters of the pill

argued that restrictions on the pill was an example of government interference for it limited economic freedoms, as pregnancies limited time in the workplace, and personal freedoms, as it restricted the pursuit of happiness. Pharmaceutical companies lobbied (which is a political freedom) the government to have the economic freedom to produce, market, and test the product. The expansion of freedom through a political act was similar to cases that I viewed before, like the passage of the Civil Rights Act of 1964, and the implementation of the "Don't Ask, Don't Tell" policy. It's also like the 19th Amendment, which gave women the right to vote, and was something that we studied last year in my social studies class.

Cris placed "Berlin 89", a fifteen-second video case from November 9, 1989, in window "1". The case was about the fall of the Berlin Wall, a wall that had been erected by the East German government in 1961 to prevent its citizens from leaving the country. After watching the video, Cris observed:

> To many the wall represented oppression, a negative instantiation of political, economic, and personal freedom, for it prevented movement back and forth between East and West Germany. After the destruction of the Berlin Wall, it became a symbol of freedom, for Berlin was once again unified.

Cris placed "Hirano 45", an historical events case from 1945, in window "4". This case featured a photograph of the Hirano family at the Colorado River Relocation Center in Poston, Arizona. During WWII, President Roosevelt's Civilian Executive Order 9066 forced Japanese-Americans to relocate to internment camps because of national security concerns. The order was enacted after Pearl Harbor. In the photo a mother held a framed photo of her son, a member of the U.S. military. After examining the photo, Cris commented:

> Men in the internment camps gained freedom from the camps when they joined the U.S. military. Like "Dream", "CORE", and "Inked", the expansion of freedom often requires sacrifice. The Civilian Executive Order 9066, featured in the "Hirano 45" case, is similar to the "Patriot Act" case, in that both were enacted after the U.S. was attacked. The Civilian Executive Order 9066 was enacted after the bombing of Pearl Harbor, while the Patriot Act was enacted after the attacks on the Twin Towers. In both cases the U.S. government argued that it was necessary to restrict civil liberties freedoms so national security and lives could be

protected during wartime. "Hirano 45" and "Patriot Act" are two examples of how freedoms may ebb. In the case of "Hirano 45" the family enjoyed personal, political, and economic freedoms before the executive order and saw these rights diminished after the order was implemented. The "Patriot Act" curtailed freedoms, too. The two cases are different. Executive Order 9066, for example, targeted specific communities, while the Patriot Act targeted the general population.

Cris placed "Four Freedoms", a case about the four freedoms addressed by President Roosevelt in his annual address to the U.S. Congress on January 6, 1941, in window "3". The Four Freedoms described by President Roosevelt were freedom of speech and expression, freedom of worship, freedom from fear, and freedom from want. After looking at the photo, Cris commented:

> Freedom from want resonated with the public in 1941 because the Great Depression had affected a large portion of the general public. January 1941 was also a time when many countries in the world were at war. Roosevelt's call to defend the core freedoms might have been an attempt to prepare the country for war. Freedom is often used to argue for government action and inaction. In the cases about the war on terror and from what I've learned about WWI, freedom is often invoked at times of war to gain support for government actions. The "Four Freedoms" case, like "Poverty" and "Across", argued that government actions benefited the public good. "Complicated" and advertisements from Ronald Reagan in 1980 and 1984, countered that economic security and personal freedoms could be gained (or maintained) by government non-interference in the free market.

Note: Not all the cases of 'freedom' retrieved in the theme search were useful in this particular exploration. For example, Cris glided over many of the cases, including "At Stake", "Autonomy", and "Transition" because they did not seem relevant for this exploration.

Cris placed "Autos 58", a thirteen-second video case about car culture in the U.S., in window "1". The video illustrated U.S. car culture with images of automobiles on open roads and in traffic. After watching the video, Cris said:

From this case I learned that cars, and the roads they traveled, supported freedom of movement, which in turn supported a more flexible economic workforce and national security. Road networks and cars enabled workers to move from areas of low employment to areas of high employment. President Eisenhower argued that the National Interstate and Defense Highways Act of 1956 was an important component of a national defense system, for it enabled weapons to be transported across the country and supported the evacuation of cities in case of attacks.

Cris placed "Suffrage", a case about suffragettes picketing the White House in January 1917, in window "1". After examining the photo, Cris commented:

> The U.S. suffragettes were active in securing women's right to vote through non-violent protests, similar in nature to the civil rights movement cases, like "CORE", "Dream", and "DC March".

Interpretation of "Cris's" Exploration of 'Freedom'

This hypothetical exploration was designed to demonstrate the potential of EASE History, including moving from everyday freedom to more sophisticated understandings of the concept through work with twenty-seven cases, from the domains of historical events and campaign advertisements, across eight decades. (This example was a traversal of the freedom landscape but with EASE History one is able to do this with other concepts.) This section describes how EASE History might have helped Cris go beyond a more simple definition and perhaps supported a deeper, more complex understanding of freedom, including how freedom has been redefined over the years, the examination of trade-offs, connections with other themes, and how the dimensions of freedom are intertwined.

The following examples describe how Cris might have moved from an everyday understanding of freedom to a more sophisticated understanding of 'freedom' through work with twenty-seven cases coded on the concept. Dimensions of freedom described by Cris in the hypothetical exploration are:

The definition of freedom changes across uses. Freedoms (economic, personal, political) have been gained ("Don't Tell", "Berlin 89", "Pills", "Suffrage", "CORE") through elections ("Suffrage" and "Inked"), protests ("CORE", "Dream", "DC March", "Suffrage"), legislative acts (Civil Rights Act of 1964, "Patriot Act"), executive orders ("Don't Tell" and "Hirano 45"), and have receded during times of war ("Patriot Act" and "Hirano 45").

Freedoms have been contested. The expansions of personal, economic, political freedoms have often been contested ("CORE", "Dream", and "DC March", "Don't Tell", "Jackson", "Pills", and "Suffrage").

There are competing definitions of freedom. For example, in "Complicate", President Bush argued against a government-supported health care system because it would mean that higher taxes and government mandates would curtail economic and personal freedoms. In "Across", Senator Kerry argued for national health care from economic and personal freedoms perspectives.

Freedoms often involve trade-offs with other core democratic values. For example, the two presidential candidates in the 2004 election agreed that there were tradeoffs involved in the Patriot Act between national security and personal freedoms but argued over what was gained and lost. A similar debate, in regards to trade offs, about a national health care system occurred in the 2004 campaign.

Elements of freedom, including political, personal, and economic freedoms, are not independent, but are intertwined. In "Dream", for example, Martin Luther King Jr. argued that economic, political, and personal gains for African-Americans was the

correct moral action and would support the common good. "Pill", for example, demonstrated how the dimensions of freedom are intertwined. Pharmaceutical companies successfully lobbied (political freedom) the government to not restrict the production, testing, and marketing of the pill (economic freedom). The government's policy reversal expanded the personal freedoms of women.

Freedoms are connected to multiple themes. For example, in the case of "Dream" freedom was connected to themes like common good, the pursuit of happiness, equality, economic and social mobility, and poverty.

Going Beyond the System

Work in EASE History is designed to prepare users to go beyond the system. An example of this is "freedom sightings", an activation of new concepts applied to a case after examination of family resemblances across the features of past cases. For example, EASE History users might view cases that have not been coded on freedom and start to notice that the cases could be coded on the concept. Examples of freedom sightings related to EASE History cases that are currently not coded on freedom, include:

"Ingenuity": This Senator Kerry advertisement from the 2004 campaign argued that ending the country's reliance on oil would increase economic freedom and protect national security.

"Departs": Political freedoms enabled the press to pursue the Watergate story. This pursuit, and subsequent hearings, led to President Nixon's resignation.

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"Press 58": This video case, which features a President Eisenhower news conference, illustrates political freedom as the media is able to ask the president questions.

In a future EASE system I would like to enable users to generate their own theme-codings and cases, so the system might be tailored to fit the needs of individual learners.

CHAPTER 8

SITUATING EASE HISTORY IN THE CONTEXT OF
SIX LEARNING PROGRAMS

In order to examine the design of a working learning environment from multiple

perspectives, which is the goal of this dissertation, Chapter 8 examines EASE History

from the perspective of KANE, a previously built Cognitive Flexibility Hypermedia

(CFH) system, and from the perspectives of five contemporary programs: Living Room

Candidate, The Valley of the Shadow, MediaMatrix, Scratch, and Google Search.

Comparing Two Systems Based on Cognitive Flexibility Theory: KANE and EASE History

This section compares EASE History with KANE, instead of a program like

Flexible Learning in the Periodic System (FLiPS), because FLiPS is designed for a well-

structured domain, chemistry (Mishra & Yadav, 2006). The FLiPS program presents

alternative versions of the periodic table of the elements. This program emphasizes the

Cognitive Flexibility (CFT) principle of multiple conceptual representations. The FLiPS

system also teaches the context in which each of those possible representations is most

useful, because each representational schema puts elements next to each other on a

different principled basis. However, regardless of the way the elements are represented

their properties stay the same. For example, hydrogen will always have the same number

of electrons in the different representations. In ill-structured domains, on the other hand,

like literary interpretation (KANE) and civics and history (EASE History) individual

concepts have far less of a determinant meaning so one consequence of that, is that a

learning environment to teach ill-structured domain concepts has to present a far larger

number of examples to demonstrate a greater conceptual variability. Building a system to accommodate this greater reliance on coordinating a large number of examples leads to substantial differences in design requirements from those of well-structured domains, like chemistry (FLiPS).

KANE and EASE History, two CFH systems, are designed to promote more open and flexible knowledge structures through nonlinear work with content from ill-structured domains. The two programs are designed to help learners see how concepts are applied differently across multiple and interconnected real world cases. KANE themes are drawn from the literary criticism domain, while EASE History's themes are drawn from the historical, political advertising, and core democratic values domains. Both projects feature short video cases that are designed to make complexity more manageable.

KANE, a stand-alone program, was launched in 1987. EASE History developers, as compared to their KANE counterparts, had more powerful computers, video-editing software, and powerful bandwidth to work with. EASE History used these technology advances to build on KANE features and to develop new features that are designed to support the traversal of knowledge in ill-structured domains. EASE History improves upon KANE because it is online, offers multiple ways to search on cases, has multiple viewing modes, features mindset modeling videos, and organizes searched cases in a timeline. These advances are described in this section and further elaborated on in sections devoted to EASE History and the general EASE system. EASE History improves upon KANE in the following aspects:

1. Online program. KANE is a stand-alone program while EASE History is online. More powerful computers, widespread Internet use, and increased bandwidth meant that EASE History, a program that features hundreds of videos, could be placed online. This advance meant that EASE History could reach a global audience, link to other content on the web, and be more easily updatable.

2. Dense, short videos. KANE uses videos that are thirty to ninety seconds in length. EASE History features videos that are shorter, sometimes seven seconds in length. Short, dense clips enable users to work with more cases and better reflects how video is used in contemporary film, television, and advertising.

3. Multiple ways to search on cases. KANE enables users to search on single themes, while EASE History enables users to search on single and multiple themes. Combination theme searches are designed to help users see how themes are connected in context of use. Other EASE History theme searches enable users to search on keywords, case titles, and topics.

4. Multiple viewing modes. EASE History has multiple viewing modes as compared to KANE's single viewing mode. EASE History's two-window viewing mode and four-window viewing modes are designed to support across case comparisons for they enable users to place cases side by side.

5. Mindset modeling videos. EASE History's mindset modeling videos are designed to demonstrate flexible thinking by using innovative video presentation formats, including narration, quick editing, and video effects. User-friendly professional video production tools, like Final Cut Pro, enable EASE History's content developers to apply sound and visual effects to mindset modeling videos.

6. Timeline. EASE History search results are organized in a two-columned timeline. Cases are organized in chronological order with more recent cases at the top of the queue. This arrangement, along with available case information, is designed to support quicker identification of cases, enabling users to move more easily through the nonlinear learning environment.

The Living Room Candidate was chosen because its content overlaps with EASE History's but its main goal, the exhibition of content, is different than EASE History's goal of supporting learning in ill-structured domains. The Valley of the Shadow was chosen because it is a highly praised history website and one that shares many of EASE History's goals. MediaMatrix was chosen because it is designed to help users to gather and organize digital files from the web. Scratch was chosen because it is designed to support the use of multimedia in the production of animations and video. Google Search was chosen because I wanted to think about how EASE History might support the development of strategies and domain knowledge that might support work in Google Search.

<div align="center">The Living Room Candidate</div>

The Living Room Candidate (http://livingroomcandidate.org/index.php) is an online exhibition that features presidential campaign advertisements from 1952 to 2008. The site enables users to search on twenty-six topics related to election year, commercial type, and issues. Many of the commercials are coded on multiple themes. President Johnson's "Daisy" advertisement, for example, is coded on 1964, Fear, and Children, so the commercial appears in three different theme searches. Theme search results, represented by thumbnail images of advertisements, are displayed in columns on the right

side of the page. For searches on election year, the winner's advertisements appear in the column furthest to the left, the advertisements of the candidate who came in second are in a separate column just to the right of the winner's commercials, and advertisements of the candidate who came in third are in the column furthest to the right. Searches on themes that cut across election years, like commercial type and issues, are displayed in chronological order in a single column, with the oldest commercials at the top. When the advertisement's thumbnail image is clicked on, the video is placed in a single video player. Resources, including historical background, commentaries, transcripts, and election results, accompany the videos. Links to related commercials appear in a drop-down menu below each commercial in the video window.

Figure 19. The Living Room Candidate

The Living Room Candidate was created by the American Museum of the Moving Image, a museum dedicated to the study of film, television, and digital media. Originally, the presidential election commercials were presented on eleven television-viewing stations in a gallery exhibit at the museum in Astoria, New York. The museum created the Living Room Candidate online exhibit in 2000 and updated the site before the 2004 and 2008 U.S. presidential elections.

From the CFT perspective, one of the strengths of the Living Room Candidate is that its campaign advertisements are coded on multiple themes. The site recognizes that advertisements are complex and cannot be defined by a single theme. One of the weaknesses of the Living Room Candidate is that it features only twenty-six themes. EASE History has coded its cases on almost three hundred themes. More theme-codings mean that users will have more opportunities to see cases in multiple contexts and develop a deeper understanding of the domain. One of the strengths of the Living Room Candidate is that it places advertisements in context and surrounds them with resources. From this perspective, one of the weaknesses of the Living Room Candidate and EASE History is that they do not explain how cases are related. From the CFT perspective, EASE History's multiple viewing windows better support case comparisons than the Living Room Candidate's single viewing window. One of the weaknesses of the Living Room Candidate, as compared to EASE History, is that the site focuses on a single domain, presidential campaign commercials. EASE History, on the other hand, integrates the presidential campaign advertisements, historical events, and core democratic values domains.

Site features are different because the two projects have different goals. The goal of the Living Room Candidate is to exhibit presidential campaign commercials so a single viewing window and a limited number of themes are sufficient to help users access the content. The goal of EASE History, on the other hand, is to promote the deeper understanding of concepts and concretize CFT principles through features, such as multiple viewing windows, advanced theme searches, case resources, and multiple theme-codings.

From the new media perspective, one of the strengths of the Living Room Candidate is that it displays high quality video. This stands in contrast to many of the advertisements in EASE History that are of a lesser quality. Another strength of the Living Room Candidate from this perspective is that it has a theme called "web ads", which returns commercials that were exclusively shown on the Internet during the 2004 and 2008 presidential campaigns. This is evidence of the project's heightened awareness of new media. From the new media perspective, a weakness of both the Living Room Candidate and EASE History is that they feature small videos. Increased bandwidth now supports the display and viewing of larger videos online. A weakness of the Living Room Candidate is that the videos seem to take on a secondary role in the site, with text, in the form of theme menus and commercial descriptions taking on a co-equal, if not primary role. EASE History's two and four-window viewing modes, on the other hand, place video cases in the forefront, with text, especially in the four-window viewing mode relegated to the background. Another weakness of both the Living Room Candidate and EASE History from the new media perspective is that they do not allow users to download their videos thus preventing users from creating new works from featured

content. The Living Room Candidate has stated that it does not want users to rework the content, while EASE History is not able to make content downloadable because of agreements with rights holders.

From the Cognitive Load perspective, one of the Living Room Candidate's strengths is that it has a limited number of themes and cases, so users are not overwhelmed. For example, a theme search on commercials coded on "Corruption" in the site returns seven advertisements. EASE History, on the other hand, might overwhelm users with too much complexity. For example, a search on "Cold War" in EASE History returns one hundred and eight cases. The way that the Living Room Candidate and EASE History display searched cases, in organized columns, is designed to support work with cases, so learners do not have to hold all relevant cases in their cognitive workspace. Instead users can work with specific cases and cycle new cases into viewing windows. From the Cognitive Theory of Multimedia Learning (CTML) perspective, one of the Living Room Candidate's strengths is that videos and associated text appear next to each other in the middle of the page and in the columns that display searched items. Similarly, this arrangement of video and text might be considered a strength of EASE History's single and two window-viewing modes. One of the weaknesses of EASE History's four-window viewing mode is that videos and their case descriptions are not contiguous. This arrangement places heavy demands on cognitive load.

The Valley of the Shadow

The Valley of the Shadow (http://valley.vcdh.virginia.edu/) is a digital social history project that compares two nearby communities who were on opposite sides during the U.S. Civil War. An extensive digital archive of primary documents, including letters,

diaries, memoirs, census records, church records, battle reports, newspapers, and

speeches, enables users to examine different aspects of lives in the two communities from

multiple perspectives. According to Edward L. Ayers, "the material it [Valley of the

Shadow] presents is common and in isolation from other material, not particularly

meaningful. Put in context, however, newspaper articles take on drama and power;

personal letters and diaries evoke tears and laughter and even census entries and military

records can bring chills" (Ayers, 2004, p. 18). The site has suggestions for paper topics

for middle and high school classrooms.
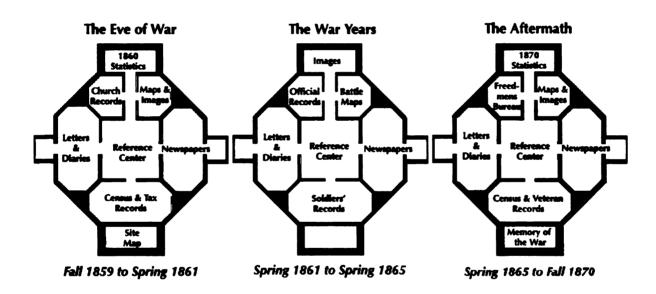
Figure 20. The Valley of the Shadow

Edward L. Ayers, a professor of history at the University of Virginia, proposed

The Valley of the Shadow project in 1991. The project was originally conceived as a

book, and it was thought that text would be used to describe and connect the stories of the

two communities. Ayers soon decided that computers could better support the linking of

resources and more easily reveal historical patterns, as compared to written text. The

project scanned thousands of images and documents. Many items had to be transcribed by hand because they were unable to be scanned. In 1993 Ayers and his team decided that the project should be put online so that it could reach a wider audience, be more easily updated, and feature a large archive. The first online version of The Valley of the Shadow was launched in 1993 and used HTML as its programming language. Because of limited bandwidth many objects in the online version were slow to load, so a CD-ROM version of the project was created for distribution. The Valley of the Shadow has won awards from the American Historical Association, Merlot, and Gettysburg College.

Comparing Valley of the Shadow, Living Room Candidate, and EASE History from multiple perspectives. From the Cognitive Load perspective, all three projects assume some of the user's cognitive load, but they attempt to accomplish this goal in different ways. The Valley of the Shadow and the Living Room Candidate attempt to make content manageable by focusing on specific topics. The Valley of the Shadow focuses on two communities over a twelve-year period, while the Living Room Candidate focuses on television presidential campaign advertisements. EASE History, on the other hand, features content from eleven decades of U.S. history and from multiple domains. The expansive scope of the EASE History project fits with its goal of supporting conceptual understanding by demonstrating how concepts have been applied in similar and different ways across the 20th century to the present.

From the CTML perspective, all three projects make use of two modes of representation for corresponding words and pictures are presented contiguously. For example, an image titled "Fortifications of Manassas" in The Valley of the Shadow is positioned to the left of short descriptive text about the image on the same web page. This

use of short descriptive text associated with an image demonstrates CTML's coherence principle, for relevant words and pictures will support the instructional goal. Examples of how the coherence principle was demonstrated in the Living Room Candidate and EASE History were provided in the previous section.

From the CFT perspective, all three programs are similar in that they feature conceptual themes from ill-structured domains. The Valley of Shadow features themes from the historical domain. The Living Room candidate themes are from the political advertising domain. EASE History themes are drawn from historical, political advertising, and core democratic values domains. All three programs enable users to see how concepts vary across multiple cases. The Valley of the Shadow is designed to help learners develop a deeper understanding of themes related to occupation, gender, and the U.S. Civil War. In EASE History users see how themes such as freedom and common good are applied in similar and different ways across multiple cases. Similarly, in the Living Room Candidate users see how concepts like fear and corruption vary in how they are applied in multiple examples. From the CFT perspective, the use of non-hierarchical theme organization is a strength of all three systems, for it reflects how knowledge is organized in ill-structured domains and it is intended to support the development of more flexible knowledge structures. For example, The Valley of the Shadow's navigation tool enables users to begin their search on any of the twenty-three themes displayed on the floor plan. In EASE History, themes such as freedom and stability appear in multiple theme menus. Another strength of all three programs from the CFT perspective is that they place events in context. The Valley of the Shadow enables users to examine newspaper articles and editorials from Augusta County and Franklin County in order to

understand the debates about slavery and secession. EASE History and the Living Room Candidate's use of case descriptions are designed to help user's place events in context.

From the content developer's perspective, The Valley of the Shadow project had a more difficult task, as compared to The Living Room Candidate and EASE History, of preparing content for its website. The Valley of the Shadow project developers had to scan thousands of documents, including letters and photographs before they were able to place the content online. EASE History, on the other hand, was able to obtain digitized materials from online archives and from video documentaries. However, EASE History had to seek permission from the rights holders before non-public domain content could be featured online. Many of the rights holders gave EASE History permission to use the videos on the condition that the videos would not be downloadable. These agreements impacted the design of the system. One of the reasons that EASE History uses Flash is so users are unable to download video content. The Valley of the Shadow did not have this problem because they were working with content that was in the public domain.

From the technology developer's perspective, The Valley of the Shadow, the Living Room Candidate, and EASE History use databases to support theme searches and uploading of new content.

These tools launch the appropriate MediaMatrix editor to your browser. Here are directions on how to load them to your browser.

Find Sound   Find Video   Find Image   Add Bookmark   Add Text   View Tree

Figure 21. MediaMatrix

MediaMatrix

MediaMatrix (http://www.matrix.msu.edu/~mmatrix/) is an online learning tool

that enables users to capture online digital content, and edit, annotate, and organize the

segments inside the MediaMatrix program. Users install MediaMatrix tools as bookmarks

before capturing online media content. A feature enables users to annotate text media

segments and then find captured segments by searching on the text. Users can produce

multimedia presentations with the segmented media using templates available at the

MediaMatrix website.

MediaMatrix was launched in 2005 by MATRIX: The Center for Humane Arts,

Letters, and Social Sciences Online (http://matrix.msu.edu), one of the foremost efforts in

using new technologies that are designed to support social science learning. The Center

places emphasis on providing access to well organized, easy to search digital media

archives. MATRIX has produced digital library collections, portals, and networking

websites.

Comparing MediaMatrix, The Valley of the Shadow, Living Room Candidate,

and EASE History from multiple perspectives. From the new media perspective, a

strength of the MediaMatrix program is that it takes advantage of the richness of the web

for its users are able to capture, annotate, and organize online video, audio, and text.

From the new media perspective a weakness of MediaMatrix is that it is unable to capture

Flash videos, which are featured in EASE History.

From the Cognitive Load perspective, a weakness of the MediaMatrix program is

that it enables its users to crisscross the entire web. The ability to access the entire web

might overwhelm most learners, though one of the program's strengths is that it enables

users to create smaller segments from longer text, video, and audio found online. Creating short, dense segments makes complexity more manageable and is similar to the use of short video cases in EASE History.

From the design perspective, MediaMatrix is a shell or an empty container, meaning that users can upload multiple types of media and create different presentations using imported content. For example, users can bring in multiple types of media to create presentations about social justice or climate change. The EASE system is also a shell-like program, for it accommodates multiple types of media and content from multiple domains. EASE History and TTMM, a literacy instruction program, are specific applications of EASE system.

From the learner control perspective, one of the strengths of MediaMatrix is that its users can gather, edit, and organize online content and produce multimedia presentations. The Valley of the Shadow, EASE History, and The Living Room Candidate programs do not allow users to upload content, but a strength of the three programs from the learner control perspective, is that they enable users to choose their own routes through the programs.

<u>Scratch</u>

Scratch (http://scratch.mit.edu/) is a digital toolkit for children. The program enables users to integrate images, sound, and audio and produce animations and video games through the stacking of action blocks. Scratch projects can feature pre-built objects available in Scratch, objects created by the users in the Scratch paint editor, or objects downloaded from the web. Users can share their projects on the Scratch website and e-mail links to others.

Figure 22. Scratch

Scratch was developed in 2007 at MIT's Media Lab. The goals of the project were to support creative and analytical thinking, collaborative work, learning of computational concepts, and raise interest of young people in the Information Technology profession. The project was developed during the explosion in broadband connectivity, rich multimedia, and content online and was inspired by how hip-hop artists mix records to create new sounds, according to Mitch Resnick, a Professor of Learning Research at MIT Development and director of the project. Resnick's previous projects include Building on to Programmable Bricks, a tool that children can use to build and program their own robots and other constructions. LEGO MindStorms and PicoCricket grew out of the Programmable Bricks project.

From the decentralized learning perspective, one of the strengths of Scratch and MediaMatrix is that they place powerful tools into the hands of learners, enabling them to become content producers. Both programs are designed to support work with online content. On the other hand, the producers of EASE History, Living Room Candidate, and The Valley of the Shadow created and organized their site content. But these three sites can also be described as decentralized because they do not organize themes in a

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hierarchical fashion. In EASE History, for example, some themes appear in multiple theme menus and users can enter the program through multiple entry points.

From the new media perspective, Scratch and the other four online programs took advantage of new media at the time of program development. Each project is online. The Valley of the Shadow embraced computer technology in the early 1990's. The Living Room Candidate placed multiple videos online in 2001 and EASE History used Flash to do the same in 2004. MediaMatrix was one of the first programs to create a tool that enables users to harvest online multimedia materials for classroom presentations. Unlike the four other programs, Scratch embraces new media like animations and games, enabling users to create presentations using these formats.

CFT argues that multiple knowledge representations support flexible knowledge application, so it sees the ability of Scratch users to create animations and video games and represent knowledge in different ways as one of the program's strengths. For example, a Scratch project could illustrate a mechanistic approach to historical interpretation by showing billiard balls bouncing off each other.

From the community perspective, one of Scratch's strengths is that its users are able to share their projects on the Scratch website. The Scratch site has classroom forums and advanced topics that are designed to support conversations related to program content. The Valley of the Shadow also is designed to support community building, but does so differently than Scratch. The Valley of the Shadow encourages users to use site resources to create narratives that can be published as journal articles or presented in classrooms. From the content perspective, Scratch and MediaMatrix are similar in that they can accommodate different kinds of user-generated content. For example, Scratch

has been used to create multimedia presentations about a wide variety of topics, including pets, neighborhood, and transportation.

Google Search

Google Search is a web search engine that retrieves and ranks pages in order of the most relevant web pages associated with the search. Ranking the most relevant pages is determined through the analysis of relationships between websites. Google Search has a simple interface, a search box, and is easy to use. Searched web pages, which may include content such as text, audio, images and video, are retrieved quickly. For example, a search on "Citizen Kane", in wrapped quotes, returned almost 3 million results in less than 0.31 seconds. In order to refine searches, Google's Advanced Search offers users additional fields, including language and file type.

Google™

Advanced Search
Preferences
Language Tools

Google Search | I'm Feeling Lucky

Figure 23. Google Search

Google, Inc., the company that owns Google Search, was founded in 1998. The company's rise coincided with the increase in Internet use. The company's share of the Internet search in the U.S. in 2008 is more than 60%. The company earns revenue primarily from advertising related to its Internet search and its suite of cloud computing

tools, like Blogger, Google Earth and Google Pages, which enable users to produce and store content online.

From the CFT perspective, one of Google Search strength's is that its algorithm makes the traversal of the web more manageable for users are able to retrieve relevant cases. But CFT would argue that the development of critical habits of mind and deep understanding of content, which CFH systems are designed to support, could support work with Google Search. For example, work in EASE History might enable users to gain experience working with complex cases in a nonlinear hypermedia environment. Habits of mind, like examining the cases from multiple perspectives, comparing and contrasting cases, seeing how cases are connected, and placing them in context, might support work in Google Search. Deep knowledge about themes related to EASE History content might help users search more efficiently, for they are aware of themes and how they are interconnected, and able to examine the reliability of searched content and sources.

From the content authority perspective, Google Search too often gives precedence to pages that lack authority or coherence. The Valley of the Shadow project, on the other hand, was created by a respected historian and organized around two communities, so it ranks high in terms of authority and coherence.

From the new media perspective, one of Google Search strengths is that it provides access to huge amounts of multimedia content on the web. MediaMatrix is a tool that complements Google Search, for it is designed to help users work with online content and construct narratives.

Collage Programs

A collage of programs might be created from different combinations of programs, taking advantage of each program's strengths and compensating for their weaknesses. This proposal was developed after thinking about the limitations and strengths of each program described earlier in this chapter. For example, EASE History is designed to help people learn difficult subject matter and apply their knowledge flexibly, adapting prior understandings and experiences to fit the needs of new situations through work with multiple, interconnected cases. Scratch and MediaMatrix enable users to create presentations with their own content but do not support learning of specific content. The integration of multiple programs might support learning as compared to work done in a single environment. Developing a deeper understanding of content and a flexible mindset might support the construction of narratives in Scratch and MediaMatrix. Collages might also be designed to promote a flexible, more pragmatic, mindset, for users will work with examples of how the assembly of knowledge from multiple programs are designed to match the multiple goals of the activity. These worked examples might help learners develop a flexible mindset, one that helps them look for connections between programs to satisfy multiple goals. This section provides examples of how collages might be designed.

EASE History and The Valley of the Shadow. An EASE History and The Valley of the Shadow collage might help learners compare and contrast roles of women during the Civil War and WWII. EASE History resources can support work with content related to women and WWII and with the development of critical habits of mind, which overlap with historical understanding goals. The Valley of the Shadow can be used to support

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work with cases about women during the Civil War and with the development of the narrative.

EASE History and MediaMatrix. Learners can use EASE History to compare and contrast U.S. cultural events from the 1930s with U.S. cultural events from the 1950's and then create a narrative related to the topic in MediaMatrix. The rationale for this collage is that EASE History has well-organized content but does not have a presentation tool. MediaMatrix, on the other hand, is an open shell, that is designed to support content presentations but whose users must seek out content.

EASE History and Scratch. Learners can develop an historical interpretation of the impact of the movement from rural to urban areas in 20th Century U.S. in EASE History. Scratch can be used to create an animation or game that explains the interpretation of the event. The rationale for the collage is that EASE History has content related to this topic but does not have a presentation tool. Scratch is an open shell that enables users to construct animation and games, tools that enable users to represent knowledge in different ways, something that CFT advocates.

EASE History and Google Search. Learners can use the two programs to examine developments in transportation brought about by economic and social change in 20th Century U.S. For example, learners can do a single theme search on "transportation" in EASE History and then refine the search in the Advanced Theme Search page. After working with EASE History theme searches and content, learners might search on themes they have worked with in EASE History and apply strategies that they have practiced in the program to do related information searches and work with retrieved cases in Google Search. From the content perspective, EASE History is designed to make complexity

manageable and not be comprehensive. Google Search's expansive reach, in regards to searchable items, may overwhelm novice learners who require strategies in order to work with a large number of cases. A collage might enable learners to develop search strategies and flexible habits of mind in EASE History and then apply them to work with retrieved content in Google Search.

EASE History and Google Search. Learners can compare social protests in the U.S. 20th century to social protests in 20th Century United Kingdom. In EASE History learners can examine cases coded on the "social protests" theme and then seek out more information with a search on "social protests:uk", in Google Search. EASE History is designed to help learners develop critical habits of mind while working with content. These habits of minds can be applied to content from sites with a United Kingdom address found through Google Search, and themes worked with in EASE History can be searched on in Google Search.

EASE History, The Valley of the Shadow, Google Search, MediaMatrix. Learners can examine cases related to themes that are featured in EASE History and The Valley of the Shadow (ex: community, freedom, women, rural areas, war) and create a presentation in MediaMatrix. Google Search can be used to seek additional information related to the concept. The rationale for this collage is that EASE History and The Valley of the Shadow feature content that might support the construction of a narrative related to the topic. Neither EASE History nor The Valley of the Shadow has presentation tools, so MediaMatrix can be used to build and present the narratives. Google Search, with its more expansive reach, can be used to augment work with EASE History and The Valley of the Shadow.

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CHAPTER 9

CRITIQUING EASE HISTORY AND COGNITIVE FLEXIBILITY THEORY

Chapter 9 employs a critical lens to examine EASE History as a finished product and the learning theory that supported the design of the program.

Problematizing Cognitive Flexibility Theory

Cognitive Flexibility Theory (CFT) is a constructivist learning theory that is designed to foster adaptively flexible use of knowledge, in order to meet changing demands in real-world settings. CFT argues that learning does not proceed in one direction and that new media, computers being one example, might support nonlinear learning.

A number of studies that have found that specific Cognitive Flexibility Hypermedia (CFH) applications support knowledge acquisition (Kraus, Reed, & Fitzgerald, 2001), conceptual understanding (Fitzgerald, Wilson, & Semrau, 1997; Jacobson & Archodidou, 2000), knowledge retention (Jacobson & Archodidou, 2000) and knowledge transfer (Demetriadis & Pombortsis, 1999; Jacobson, Maouri, Mishra, & Kolar, 1996; Jacobson & Spiro, 1995; Li & Jonassen, 1996). CFH systems have been developed in multiple ill-structured domains, including: physics, biology, history, climatology, psychology, film criticism, literature, military strategy, and teacher education. The majority of these systems take advantage of the affordances of computers to support nonlinear work in ill-structured domains.

CFT can be seen as posing certain problems for design and research. The theory claims that its hypermedia programs can support real world practice through work in

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hypermedia environments, but the theory does not stress enough the need for direct experience. For example, a hypermedia system can be created to support literacy instruction and in it users can work with a large number of cases and see how a concept like scaffolding varies across multiple cases. This work may support the development of deeper understanding of concepts and certain habits of mind, but it does not replace real world experience. Rather, it should be argued that CFH systems should complement real world experience. Teachers, for example, might develop a deeper understanding of concepts related to literacy instruction in a CFH system, but they also need to have experiences teaching in the classroom, working with colleagues, and discussing topics with groups.

Another problem with CFT is that the more complicated the programs are, the more difficult it is to study the particular features of the system. There are difficulties testing larger systems, since many variables are interacting making it difficult to generalize from condition to condition, so researchers might be better able to determine learning outcomes tied to specific system features in smaller CFH systems. For example, in a full-fledged CFH system, like EASE History, it would be difficult to see how embedded features, like mindset modeling videos or theme searches, support learning goals.

The use of the term "case" is also problematic because it is often used ambiguously in discussions of CFT and in CFH applications. Cases in CFH systems are actual occurrences in a specific domain. For example, in the domain of campaign advertising on television, a television campaign advertisement is a case in that particular domain. Sometimes cases refer to a collection of resources and at other times cases refer

to events that do not have resources or associated links. In EASE History, for example, the "I Like Ike" case has multiple resources, including links to other EASE History cases, expert interviews, outside links to other websites, artifacts, and descriptive text, while other cases in the system, like "TV 47" and "No Nukes 79", do not have associated resources.

In order to more clearly define "cases" in CFH systems it might be useful to employ new terminology. "Events" might be a better name for cases. Some "events" would have resources while other "events" would not. Events with resources could be called "Resourced Events" and events without resources could be called "Fragments". This change in nomenclature might be useful for the following reasons. First, it may be less confusing because it marks a distinction between CFT cases and how the term is used in other domains, such as education and law. Second, an argument could be made that a CFH system with "Resourced Events" and "Fragments" might support overall learning goals. Fragments are dense objects that are coded on multiple themes so will be returned in conceptual theme searches. The use of fragments might enable users to make their own connections with other cases and this less-structured, or less-directed approach, might support more independent thinking.

Previously built CFH systems have not taken advantage of the strengths of other programs. Since CFH systems are not designed to be comprehensive, exclusive focus on system content may limit understanding of domain knowledge and how knowledge is connected. For a deepening understanding of domain knowledge, CFH systems should connect to other programs. For example, a CFH system might support guided explorations of multiple programs in order take advantage of the strengths of each

program. The integration of CFH systems with cloud computing and social networking tools might support social aspects of learning for users often work alone in CFH systems and do not share their ideas with others. Chapter 8 describes specific examples of how EASE History might be integrated with other programs.

Another concern is that CFH learning environments with their multiple viewing windows, links, and nodes are expansive and complex and may overwhelm more novice learners with high levels of cognitive load thus leading to frustrations that interfere with the learning process. An open hypermedia environment with unguided routes might not be an optimal environment for novice learners to develop a deeper understanding of ill-structured domains. CFT would argue that its hypermedia systems should employ a more structured learning approach, for "unbridled complexity would be confusing and discouraging to the learner" (Spiro et al., 2003) and that guided explorations help novice learners understand how terms have been defined, why themes are applicable, and how arguments and connections have been constructed (Feltovich et. al., 1997; Spiro et al., 2003).

Rationale Behind Design Choices

This section explains the rationale behind certain design choices and discusses why some of those choices are ones that I would decide to do differently today.

Multiple viewing modes. There are benefits to having two-window and four-window viewing modes. The modes are designed to support case comparisons, making one of CFT principles concrete, while the inclusion of multiple viewing modes attracted the attention of design experts. But having multiple viewing windows might have reduced the number of people using the site, because it is different than the more

traditional single-video viewing mode that is more commonly used by other websites. Another negative impact of having multiple window viewing modes is that it limited the amount of space available in EASE History. The lack of space limited the inclusion of features such as an RSS feed that would display Google News articles that are related to EASE History themes and an interactive list of popular EASE History videos. The lack of space also limited accessibility and expansion of current EASE History features. For example, the Search History is now accessible through a button located above window "1". I would have liked to have made the Search History feature more visible and given users the ability to combine search histories into a single search. More space would have enabled icons to be moved off the video and placed above or below the video player, and an expansion of the single window viewer and timeline images.

I think that it was the right decision in 2004 to include multiple window viewing modes in the EASE History program because they are designed to support CFT goals, and they attracted the attention of design experts. The decision to feature the two-window viewing mode as the default viewing mode, rather than the four-window viewing mode, was a compromise between the goals of making CFT principles concrete and gaining a wider audience. I thought that making the four-window viewing mode the default viewing mode would confuse users and reduce traffic.

There are changes to the single viewing mode that I wish that I had made. In order to increase traffic, I would have made the single-video viewing mode the program's default interface, so instead of the two-window viewing mode, which may confuse and overwhelm first time users and possibly dissuade them from returning to the site, users' initial work would be with the more traditional, single-window. With the single viewing

mode as the default, users would be able to switch to the two and four-window viewing modes. I would have made several changes to the single-video viewing mode. These changes would have included increasing the size of the video and still images that appear in the main viewing window, the addition of features like the "Topics in Google News", a list of popular video searches within the site, and the ability to combine search histories into a new single search. I would have also expanded the timeline thumbnail images and made the short descriptions related to each timeline image visible in order to better support program use. These changes to the single-window viewing mode would mean that the viewing modes would not be consistent, but I think that the program, in terms of traffic and usability would have benefited greatly. I also would have designed more scaffolding tools for the two and the four-window viewing modes, since the multiple viewing modes might overwhelm learners.

Icons. Icons enable users to access information related to a case. The use of cases and resources available through icons, and nonlinear work within EASE History, might be hindered because the icons are not intuitive and related titles are too short to alert users of the available content. More time should have been spent on the design of the icons. The icons should have been designed in such a way so that content is immediately identifiable. If this cannot be accomplished, then it might be necessary to switch to text-based menus or create an icon key that is available through the main video players. In order to make content more easily identifiable I would have liked to have included short descriptions with related cases and resource titles available through icons or text-based menus.

<u>Introduction of EASE History and program features</u>. The creation of HTML pages for individual cases might support the goal of gaining a wider audience. The use of HTML in this way would enable search engines to locate EASE History content. A button could be placed on each HTML page that would enable users to work with the case in a flash-based EASE History environment.

There are many features in EASE History that are designed to support learning in ill-structured domains, but EASE History needs to do a better job introducing its features and explaining how they support learning goals. For example, EASE does not do a very good job introducing its theme menus. Instead of having random images and static descriptions on the theme pages, it might have been better to include a more detailed theme menu, perhaps one with descriptions of each theme category, since theme menus are one of the first features that users work with and one that they continually return to do single theme searches. The EASE History tour is another feature that could be better utilized. The current tour offers an overview of the program features. It should be expanded to discuss the theory that supported the development of the features, so users might better understand how knowledge is organized. Another problem is that the tour is in Flash, a program that some users do not have installed on their computers. Being able to learn about the program in HTML based pages, rather than Flash, might have encouraged more users to install Flash and work with EASE History.

EASE History is an open-ended teaching tool. Because the program has no predetermined goals, teachers need help in how to use it. Teachers might benefit from an EASE History manual. A program manual might provide hypothetical explorations and examples of program collages and be used to support classroom teaching.

Shorter videos. Some of the videos in EASE History need to be shortened. Many of the campaign advertisements are between thirty seconds and one minute in length. Dividing the campaign advertisements into smaller cases might make content more manageable and better support the crisscrossing of the domains. For example, instead of showing the entire "I Like Ike" minute long case, it could have been edited down to three ten-second cases. Each case would be coded on multiple themes and have its own case resources. The decision to present the election advertisements in their entirety was one that I made because I thought that the use of only short clips would reduce the number of visitors to the site. This is an example of how I thought the project's goal of making CFT principles concrete and gaining a wider audience conflicted. If I were to do it again, then I would edit the larger advertisements into smaller cases, have users search on the shorter cases, and make the longer cases available through an icon on the video. My thinking changed after seeing how EASE History users could work efficiently and effectively with short videos.

Large, high quality videos. EASE History does not reflect how video is currently being used on the web, for it does not feature large, high quality videos. From the new media perspective, the program seems dated. If I were to go back to the start of development, then I would have increased the size of the video in the single viewing mode. At the time of development in 2004 I was concerned about users having enough bandwidth to play larger videos. As discussed previously, the lack of space in the two and four-window viewing modes prevented the use of larger videos. An option to expand the video featured in the one-window viewing mode was on the list of things to do.

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The videos in EASE History are of mixed quality. The Gerald R. Ford 1976 advertisements and the George W. Bush 2004 commercials are of high quality. These advertisements were obtained from the Gerald R. Ford Presidential Library and from the Bush-Cheney 2004 campaign. Other campaign advertisements featured in EASE History are of lesser quality. Many are from older documentaries, while others were recorded off the television. The interviews that I did were shot in high definition video.

Multiple knowledge representations. EASE History cases are coded on multiple themes. This multi-faceted approach is intended to support case and conceptual understanding. The system could do more to help users understand how historians with different approaches to history (contextualist and mechanistic approaches, for example) have analyzed events in different ways. Content related to multiple representations of knowledge should be added to EASE History. Interviews and mindset modeling videos might be particularly useful to demonstrate different approaches to the interpretation of historical events. For example, mindset modeling videos might show how one interpretation might be useful for the understanding an event while another approach might be better when interpreting another event.

Content. Changes related to cases and to the interconnections of cases, might better support learning and better reflect CFT principles. Longer case descriptions, along with links to resources and related cases, might help more novice learners place events in context, apply multiple knowledge representations to problems, and better understand CFT principles.

Metacognitive support structures. EASE History does not currently have metacognitive support structures that are designed to alert users to where they have been,

how the system is organized, and where they might want to go later on in the system. These supports that might minimize disorientation should be added to the current program.

Three topics. One of EASE History's strengths is that it enables users to see how historical events, campaign advertisements, and core democratic values are interconnected, but featuring only three topics is one of the limitations of the program. I decided to focus on three topics in this version in order to make the project more coherent and place fewer demands on novice learners, but it was always my intention to add more topics to EASE History. In retrospect, the decision to have three main topic buttons in the upper left hand corner of the interface between topics, instead of employing a drop down menu, was shortsighted. A drop down topics list would have enabled content developers to more easily add new topics.

User generated content. EASE History is not designed to allow users to generate content and tailor the system to fit their needs. Enabling users to have control over program content, including the addition, rearrangement, and deletion of themes, the inclusion of new cases and lesson plans to the system, the ability to edit case descriptions and link cases would enable learners to tailor the system to fit their needs.

Connections to other programs. EASE History does not do enough to connect to other websites and online tools. Currently the program provides links to websites that feature articles or videos related to EASE History cases. For example, the "Anti-War" case about the 1969 march on the Pentagon is linked to a BBC article about the protest. "Protecting", a 2004 John Kerry advertisement is linked to CNN and BBC polls from the election. The further integration of other websites and tools with EASE History might

demonstrate how ideas are connected and how the strengths of one program can compensate for the weaknesses of another. For example, one of the weaknesses of the EASE History program is that it is not comprehensive, in terms of content, so linking to other sites supports content learning goals. Another weakness of EASE History is that it does not enable users to rework its content, so programs like MediaMatrix and Scratch, which are designed to enable users to generate content, might complement EASE History.

Early in the development of EASE History I decided that future EASE applications, when appropriate, would be linked. For example, a case like "NAFTA" might be featured in multiple programs, including ones with content related to Canadian history, Mexican history, economy, agriculture, the environment, energy, immigration, and transportation. Like the connections with websites and other programs that were discussed previously, these connected programs would be designed to produce an expansive web-like knowledge base, thus avoiding a provincial mentality that may come from the exclusive attention on a single perspective.

I have begun to incorporate these changes into the design of a new EASE application that integrates multiple topics related to 21st century global challenges. (See Appendix C for a description of the design of a future EASE application.)

CHAPTER 10

CONCLUSION

EASE History and the EASE system are based on Cognitive Flexibility Theory

(CFT) and the approach to the design of hypermedia learning environments articulated in

that theory (e.g., Spiro et al., 1991). The production of a full-fledged, functioning, online

program for all to see might be considered a kind of educational technology data, for it is

a kind of existence proof. The development of EASE History demonstrated that a

proposed set of ideas can be actualized in a full-functioning program that features over

thousand cases related to history and civics topics. It was also argued that while it is easy

to develop conjectures of how a system might be built, the proof is in the demonstration

of the working system. Full-fledged systems are hard to build. The EASE programs took

almost two years to build. The fully functioning program, which is freely available at

http://www.easehistory.org/ was offered as a major component of the dissertation.

Does the Instantiation of the Underlying Theoretical Ideas
Have Clear Fidelity to Those Ideas?

One of the most frequent criticisms of systems in educational technology is that

systems are driven by the power of the technology rather than guided by theory. Since the

field of educational technology does not want systems that are driven by technology,

there is a need for learning theory to support system design.

EASE History features concretized CFT principles in the following ways. Cases

are complex, but designed to be manageable in size. Theme searches return all cases that

have been coded on a particular thematic concept. Representation of knowledge in

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multiple ways is designed to discourage conceptual oversimplification of complex concepts. A timeline is designed to make work with a large number of cases more manageable. Resources, such as interviews and mindset modeling videos, are designed to support the examination of events from multiple perspectives and promote context awareness. Linked cases and topics are designed to form an interconnected knowledge network, enabling users to move in nonlinear fashion through the system. The two and four-window viewing modes are designed to support across case comparisons and increase the number of possible connections that can be more easily noticed.

CFT was chosen to support program design for the following reasons: the theory is designed to support learning in ill-structured domains—civics and history being two examples of ill-structured domains; the theory and previously built hypermedia systems offered a road map for how knowledge is organized in hypermedia systems; and the theory has been used by other designers to develop hypermedia systems. The theory does have its shortcomings and these were discussed in the dissertation. The theory claims that its hypermedia programs can support real world practice through work in hypermedia environments, but the theory does not stress enough the need for direct experience. The more complicated the programs are, the more difficult it is to study the particular features of the system, since many variables are interacting making it difficult to generalize from condition to condition. Researchers might be better able to determine learning outcomes tied to specific system features in smaller CFH systems. The use of the term "case" is problematic because it is often used ambiguously in discussions of CFT and in CFH applications.

With the construction of the system, it becomes possible to evaluate the theory that supported its design. It might be argued that a built system is able to provide feedback to the theory, in terms of what was able to be instantiated and what was not. The construction of the EASE programs might feed back to the theory in the following ways. CFH learning environments with their multiple viewing windows, links, and nodes are expansive and complex and may overwhelm more novice learners. The theory might need to advocate for the overlearning of selected cases and the viewing of mindset modeling videos prior to working inside the general program. This might support the development of a critical mindset and might reduce cognitive load and disorientation. Previously built CFH systems have not taken advantage of the strengths of other programs. Since CFH systems are not designed to be comprehensive, exclusive focus on content housed in a single program may limit understanding of domain knowledge and how knowledge is connected. The theory might place greater emphasis on the need to create program collages to take advantage of other programs and compensate for individual program weaknesses. Integrating multiple programs is straightforward and efficient, something that was not the case in the earlier days of CFT, where it would not have been practical to consider using a collage of programs.

The Design of a Working Computer Learning Environment Is a Kind of Data

This dissertation argued that the design of a working computer learning environment is a kind of data, for it shows that ideas can be built into concrete systems. Two kinds of data were presented in this dissertation, absent the presentation of data on effects of use, the details of system design and development, and the program itself.

The field of educational technology is a relatively new field compared to many disciplines, so paradigms for scholarly work in the area continue to evolve. It could be argued though that the field of educational technology needs data from student learning and the building of learning systems for the field to advance. The following are presented as the possible benefits of designing and developing actualized systems.

It might be argued that the field of educational technology would benefit from knowing details of earlier design and development efforts. The program, the design and development of the EASE system and the instantiation of that general design in EASE History, an EASE application, was examined from multiple perspectives in order to develop a more complete picture of the program, one that might inform similar efforts in the future. Hypermedia systems were examined from the historical perspective, with descriptions of how they have evolved from built hypertext and hypermedia systems and from descriptions of theoretical hypertext and hypermedia systems. CFT, the theory that supports EASE and EASE History, was examined through the lens of another hypermedia learning theory, Cognitive Theory of Multimedia Learning (CTML). CTML was examined in order to develop a deeper understanding of CFT.

The design and development of the EASE programs were examined from multiple perspectives, including the costs, in terms of time and effort, that went into designing the system, the examination of program features from different learning perspectives, an explanation of the theoretical rationale and design of features used across EASE applications, and the comparison of EASE features with other computer learning environments. Multiple narrative lenses were applied to the design, development, and deployment of EASE History. These narratives described the development of program

content, the costs and effort that went into the design of the system, the minor adaptations made to EASE in order for the shell to the fit the needs of EASE History, and a discussion of the deployment of the system. A framework from the discipline of design, outlined in *The Design Way,* was applied to the design of EASE programs. The framework's emphasis on how the intertwining of design categories illuminated the tensions between limits on resources and creativity. For example, limits on time might have negatively impacted the design of icons and impeded nonlinear movement in the system. EASE History was examined through the lens of a more sophisticated understanding of freedom. A detailed hypothetical exploration of EASE History was provided in order to simulate what a student might do when working with cases coded on 'freedom' in EASE History and described how EASE History might set the stage for learning, because the program is designed to help learners get practice working with multiple, interconnected cases in a nonlinear environment and perhaps go beyond the system and activate new concepts in a case by examination of family resemblances across the features of past cases. The examination of EASE History from the perspectives of six programs, including KANE, a previously built CFH system, enabled the EASE History program to be placed in context. It was argued that EASE History and KANE were products of their times, KANE was used to understand how knowledge was organized in CFH environments, and EASE History improved on KANE, because it is online, features videos, multiple theme searches, a timeline, and mindset modeling videos, and multiple viewing modes. The six programs were examined from multiple learning and multimedia perspectives. The creation of program collages, or integrated network of programs, that might compensate for the weaknesses of individual programs and highlight program

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strengths, was described. A critical lens was applied to the EASE History as a finished

product, including a discussion of the rationale behind certain design choices and why

some of those choices are ones that I would decide to do differently today.

<u>Does the Program Offer Compelling Examples of How Its Design</u>
<u>Is Matched to the Achievement of the Design Goals?</u>

The finished program was examined in order to answer the following questions:

Does the instantiation of the underlying theoretical ideas have clear fidelity to those

ideas? Does the program offer compelling examples of how its design is matched to the

achievement of the design goals? What can be learned about computer learning

environment design from a detailed examination of the design process?

Demonstrations of how program use matches what is done when the program is

actually used were presented in this dissertation in order to show how EASE History's

design is matched to the achievement of its goals. First, a descriptive guide was provided

to demonstrate how features, based on learning theory, including cases, icons, timeline,

resources, theme searches, mindset modeling videos, and viewing modes, are showcased

in EASE History. Second, a demonstration of case comparisons related to campaign

advertisement types and presidential leadership attributes using the Weave viewing mode

was provided. In this example, it was argued that music might support different goals by

crisscrossing multiple elections, examining cases from multiple thematic perspectives,

placing cases in context, and making connections with other cases in EASE History.

Third, a hypothetical example of how one might work with cases coded on freedom was

provided. This exercise attempted to demonstrate the potential of the system, including

moving from an understanding of everyday freedom to a more sophisticated

understanding of the concept.

The development of EASE applications that feature content from two very different domains, history and reading comprehension, might say something about the validity of the EASE system, a system that was designed to support learning across other ill-structured domains. EASE History and TTMM required only minor adjustments to fit the needs of the two programs. For EASE History it was the addition of an Image icon and for TTMM it was the renaming of the viewing mode buttons. That two such different domains should require few changes to the EASE learning environment might speak to the intended generality of the EASE approach to learning in ill-structured domains.

What Can Be Learned About Computer Learning Environment Design From a Detailed Examination of the Design Process?

Lessons learned from the design of the EASE programs, include the need to: adapt to new situations, tolerate uncertainty, compare and contrast multiple programs, place programs in context, compensate for an individual program's weaknesses by taking advantage of the strengths of other programs, and apply learning theory to program design. This section briefly describes instantiations from the design of the EASE programs that are intended to support these lessons. For more detailed descriptions of lessons see Chapter 5. Lessons include the need for designers to:

Adapt to new situations. EASE program designers were challenged to constantly adapt to the changing design landscape. Their ability to adapt to new situations might have supported the design of the EASE programs. Two examples demonstrate how EASE and EASE History designers adapted to new situations. First, the addition of the four-window viewing mode to the EASE interface, which placed demands on space, led to the design of new features, including the timeline and the drop down information boxes, and

the rearrangement of elements. The second example occurred during the design of EASE History. After I was unable to secure rights to licensed videos, I explored content options that might be featured in the program.

Tolerate uncertainty. Often in design there is not a clear right answer, but a decision must be made. A tolerance for that uncertainty is necessary if a team is to approach each situation with an open mindset, explore multiple design possibilities, examine costs and benefits, and balance multiple project goals. Three examples, which were presented in Chapter 5, demonstrate the need to act in the face of uncertainty in the design of EASE programs. First, the EASE team wrestled with the costs and benefits of using Flash to develop the program's interface. Second, the team had to weigh the costs and benefits of having EASE applications online and offline. Third, the difficult decision to feature the two-window viewing mode as the default viewing mode in EASE History was an attempt to balance learning and usage goals.

Compare and contrast multiple programs. The examination of multiple programs can be argued to have helped EASE designers to generate ideas. Two examples demonstrate how across program comparisons supported the design of EASE features and EASE History content. First, the EASE timeline was designed after examining timelines featured in multiple online programs. Second, after I examined how other programs, including the BBC, CNN, and ESPN, used online videos, I decided that EASE History would feature clear, well-edited videos.

Place programs in context. An argument can be made that placing programs in context supported the design process for it enabled the team to think about how and where the programs would be used. For example, the decision to produce online and

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offline EASE applications was made after considering current realities of less powerful computers and less bandwidth and long-term expectations of more powerful computers and higher bandwidth. EASE History features learning activities to support teachers, because campaign advertisements are not often featured in social studies classrooms.

Compensate for an individual program's weaknesses by taking advantage of the strengths of other programs. Because of constraints on time and financial resources, EASE and EASE History could not do everything. Therefore an attempt was made to integrate multiple programs in order to compensate for an individual program's weaknesses by taking advantage of the strengths of other programs. The following are presented as examples of how this mindset was incorporated into the design of the EASE programs. EASE does not include video editing and compression tools but instead takes advantage of external video editing tools. EASE History does not include all major events that might appear in a 20th century to present U.S. social studies textbook. Instead, EASE History cases are linked to related information in external websites that might support understanding of events.

Apply learning theory to program design. The deliberate effort to apply learning theory to the design of the EASE programs can be argued to have supported the overall design of EASE programs in the following way. The adoption of a critical mindset (e.g. tolerance of uncertainty, comparing and contrasting programs), a mindset that is advocated by CFT, could well have supported the design team's ability to adapt to new situations. The theory, and previously built Cognitive Flexibility Hypermedia (CFH) systems, provided a road map for understanding how knowledge is organized in CFH systems.

Limitations

This research is limited because it does not present evidence of learning in EASE History, an environment that was designed to concretize CFT principles. A natural next step for the work presented in this study would be to evaluate how individuals learn when they work with EASE History. Since the program includes a large number of resources and is designed to support nonlinear learning, it will be important to think about the number of participants and duration of experience in the program, in order to analyze how the program supports learning.

Bias was unavoidable. It might be argued that the system was biased in the selection of topics, cases, and case resources, the ordering of cases in chronological order in the timeline, and how knowledge was connected. In order to avoid bias, an attempt was made to support openness and multiplicity. The underlying theory that supported the design argues that having more examples, as the program does, lessens the risk of bias. Also, EASE History attempted to limit bias by using multiple thematic codings and the use of counterexamples as much as possible, so not to privilege any of the representations.

Future Directions

Participants in an EASE History study might be randomly assigned to experimental and control conditions. Content, time on task, and assessments would the same for both conditions, but the control condition would work with content in a linear fashion, while the experimental condition worked with content in the nonlinear EASE History environment. A long term study might allow a critical mass of interconnections

to be built up, strengthening positive results, enabling researchers to examine the processes of thought and patterns of interaction with the program at different stages of working with EASE History.

Another natural next step is the continuation of the design process. I have begun to apply lessons learned from designing EASE and EASE History to inform the development of a new EASE application that will be designed to support the learning of topics related to 21st century global challenges, including biodiversity, climate change, energy, health, food, population growth, poverty, transportation, and water. (See Appendix C for a description of the design of a future EASE application.)

In conclusion, this dissertation should be seen as a richly detailed narrative account of how one complex hypermedia system was designed and implemented. I hope this account will be of value to others setting out to design other learning environments.

APPENDIX A

EASE HISTORY THEME CHARTS

Historical Events

Themes	Sub Themes	Sub-Sub Themes
Administration	Bush GW, Clinton, Bush GHW, Reagan, Carter, Ford, Nixon, Johnson, Kennedy, Eisenhower	
Culture	All Culture, Cultural Icons, Counterculture, Fashion, Mass Media, Sports, Youth	Mass Media: All Mass Media, Radio, Television
Decades	2000s Events, 1990s Events, 1980s Events, 1970s Events, 1960s Events, 1950s Events, 1940s Events, 1930s Events, 1920s Events, 1910s Events, 1900s Events,	
Economy	All Economy, Consumerism, Factory Work, Trade	
Environment		
Historical Themes	Consensus, Conflict, Cooperation, Fragmentation, Unity, Freedom, Control, Progress, Destruction, Reform, Stability	Conflict: All Conflict, Terrorism, War Cooperation: All Cooperation, Treaties, UN
Legal Decisions		
Movement	Immigration, Migration	
Political	All Political, Domestic Policy, Foreign Policy, Global Events, Inaugurations, Political Campaigns	Domestic Policy: All Domestic Policy, Legislation, New Deal Foreign Policy: International Agreements, Treaties

Protest Movements	All Protest Movements, Labor Movement, Civil Rights Movement, Anti-war Movement, Women's Movement	
Science/Tech	All Science/Tech, Communications, Government Projects, Household Technology, Military Technology, Science, Space Programs, Transportation	Communications: All Communications, Telephone Transportation: All Transportation, Airplanes, Cars
Social	All Social, Communities, Family, Social Institutions, Social Issues	
Topics	Baby Boomers, Cold War, Great Depression, Great Society, New Deal, The year 1968	
War	All War, Second Gulf War, First Gulf War, Vietnam War, Korean War, WWI, WWII	

Campaign Ads Themes

Themes	*Sub Themes*	*Sub-Sub Themes*
Year	2004, 2000, 1996, 1992, 1988, 1984, 1980, 1976, 1972, 1968, 1964, 1960, 1956, 1952	
Candidate	Bush GHW '88, Bush GW '00 '04, Carter '76, Clinton '93 '96, Dole '96, Dukakis '88, Eisenhower '52 '56, Ford '76, Goldwater '64, Gore '00, Humphrey '68, Johnson '64, Kennedy '60, Kerry '04, McGovern '68, Mondale '84, Nixon '60 '68 '72, Reagan '80 '84, Stevenson '52 '56	
Political party	Democrat, Republican	

Election Winner/Loser	Election Winners, Election Losers	
Challenger/ Incumbent	Challenger/Incumbent	
Issues	Balanced Budget...Welfare	
Positive/Negative	Positive Ads, Negative Ads	
Ad Themes	Attack...Testimonial	
Pres. Leadership Attributes	Positive, Negative	Positive: Accomplishments, Strong Negative: Dishonest, Weak
Hub Cases		

Core Values

Themes	Sub Themes	Sub-Sub Themes
Core Democratic Values	Common Good, Individual Rights, Justice	Common Good: All Common Good, Diversity, Tolerance, Truth Individual Rights: All Individual Rights, Economic Freedom, Life, Liberty, Pursuit of Happiness Justice: All Justice, Equality
US Constitutional Principles	Checks and Balances, First Amendment, National Security, Self Determination	First Amendment: All First Amendment, Free Press, Free Speech, Freedom of Assembly, Religious Tolerance
US Values	Choice, Competition, Democracy Promotion, Freedom, Patriotism, Stability	

APPENDIX B

ADDRESSING GOAL OF USAGE AND EXPERT RECEPTION
OF THE SYSTEM

This section addresses one of the main goals of the EASE History project, that a full-fledged multidimensional working system could demonstrate Cognitive Flexibility Theory (CFT) principles and make the argument to the public that the system is doing what it claims. In a sense the design and execution of a theoretically grounded system is a new kind of data, for it shows that ideas can be built into concrete, working systems. This section argues that a system can be built with face validity that showcases CFT ideas.

EASE History has had over 150,000 unique visitors from all around the world since its launch. Its use in K-16 history, social studies, rhetoric, political science, media studies, advertising, and multimedia classrooms demonstrates the system's flexibility of use. EASE History has received many honors. Macromedia named EASE History one of 2005's top 8 most innovative higher education websites. EASE History has received 'website of the month' awards from Politics Online and the History News Network. It was named 'site of the day' by the U.K.'s Guardian Unlimited. EASE History has been featured on hundreds of sites including Time.com, National Council for Social Studies, Macromedia, the Library of Congress, and Kids.gov. The site has received awards from the American Association Of Webmasters and Awesome Library. In the summer of 2005 EASE History was featured at FlashForward 2005 in New York City. Addressing the goal of expert reception of the system, EASE History has received acknowledgements from Steve Wozniak, David Weinberger, Bernie Dodge, Robert Krulwich, Brooks Jackson, and leaders at the National Archives, Library of Congress, the Smithsonian

American Art Museum, and H-Net. Recognitions are listed in order to show that

outsiders say that the system passes the test, a kind of validation of the success of the

design of the system. Usage and recognition is not the only form of validation but is in

addition to face validity of theory implementation.

APPENDIX C

IMPLICATIONS FOR THE DESIGN OF A FUTURE EASE APPLICATION

Lessons from the design of the EASE and EASE History projects can inform the design, development, and deployment of 21st Century Global Challenges, a program that will be designed to help learners develop a deeper understanding of global challenges through work cases related to biodiversity, climate change, energy, transportation, food, urban areas, poverty, and water.

The application of learning theory to design. The theory, and hypermedia systems supported by the theory, including the EASE and EASE History programs, will provide a road map for the designers of the 21st Century Global Challenges program, for they might enable designers to see how knowledge is organized in CFH systems.

The adoption of a critical mindset. I will ask the 21st Century Global Challenges design team to treat design as an ill-structured domain and adopt a critical mindset, including the need to: examine programs from multiple perspectives, juggle multiple goals, understand that there is often no single right answer in designing a program, be aware that the program is interconnected, understand that the program should not be expected to do everything, and place events in context.

Multiple topics. The 21st Century Global Challenges project will feature more than three topics. The increased number of topics will provide more entry points into the program. This will be intended to show learners the web-like organization of knowledge. 21st Century Global Challenges topics will each have their own set of themes and sub-themes. In order to accommodate more than three topics a change to the current EASE interface is necessary. Instead of having three theme menu icons in the upper left hand

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corner of the interface, it will be necessary to have a drop down list of topics that users can choose from.

Shared cases and themes. The 21st Century Global Challenges program will share cases, themes, and resources with other EASE projects, including EASE History. For example, a case about how climate change negatively affects blueberry production in the U.S. Northeast will be featured in both 21st Century Global Challenges and EASE History. Cases that appear in multiple programs will be highlighted and a button located near the viewing window will enable users to start working with the case in the other program. In the current database projects have their own set of cases and resources meaning that content has to be reentered in the database if it is to be used by multiple projects, so this change will most likely require that the database be modified.

User control. The 21st Century Global Challenges program will enable users to generate content and tailor the system to fit their needs. Users will have control over program content, including the ability to add, rearrange, and delete themes, add new cases to the system, edit case descriptions, add features, and link cases. Control over content production and organization might better support independent thinking and increase time spent in the system.

Connecting to other programs. Besides connecting to other EASE applications, 21st Century Global Challenges will link to online and offline content. This will demonstrate the interconnectedness of knowledge and how online programs and offline content can complement one another, enabling the project to take advantage of rich content across learning platforms. Connections to online tools, like MediaMatrix and Scratch, will enable users to rework content and represent knowledge in different ways.

Offline content such as "An Inconvenient Truth", a DVD and a book by Al Gore, and "The Weather Makers", a book by Tim Flannery, along with online content, will offer supportive resources and serve as worked examples of how narratives can be constructed. The dual roles of online content as resources and worked examples will support the construction of new narratives. Examples of program collages include:

An Inconvenient Truth, 21st Century Global Challenges, MediaMatrix, and Inspiration. After watching "An Inconvenient Truth", learners might work with multiple cases coded on thematic concepts that are featured in the documentary in 21st Century Global Challenges. These concepts include: warming temperatures, biodiversity, CO2 levels, international agreements on climate change, greenhouse gases, glacial melting, water stress, congestion charges, and oil crises. Learners can use MediaMatrix to create a narrative to demonstrate conceptual understanding.

"Zoom: The Global Race to Fuel the Car of the Future", 21st Century Global Challenges, and MediaMatrix. Learners can use a book and three online tools to construct a narrative about how cars and the oil industry wrote the history of 20th Century capitalism. After reading Chapter one of "Zoom: The Global Race to Fuel the Car of the Future", learners can use 21st Century Global Challenges and Google Search to examine cases about automobiles and oil in 20th Century U.S. MediaMatrix can be used to build and present the narrative.

21st Century Global Challenges, Scratch, and MediaMatrix. Learners can select two climate change analogies, illustrate each analogy in a Scratch animation, and examine the strengths and weaknesses of each analogy in a MediaMatrix presentation.

Examples of climate change analogies include: the Earth is a super organism, the Earth's climate is like an angry beast, and ocean acidification is the osteoporosis of the oceans.

21st Century Global Challenges, Google Search, "The Weather Makers". Learners can use 21st Century Global Challenges, Google Search, and "The Weather Makers", a book by Tim Flannery that examines global climate effects over the last one hundred years, to develop a deeper understanding of how climate change has affected the Great Barrier Reef and plant communities in Australia. In 21st Century Global Challenges learners can do an advanced theme search on "climate change effects", "Australia", "20th Century" and then refine the search to focus on "coral bleaching" and "drought", for example. After working with 21st Century Global Challenges, users might develop a deeper understanding of domain knowledge, which might support related information searches and work with retrieved cases in Google Search.

Large, high quality video. 21st Century Global Challenges will feature large, high quality videos, reflecting current use of video on the web.

Viewing modes. A resolution independent system will enable designers to expand the interface, show more of the descriptive text in the one and two-window viewing modes, and increase image size in all three viewing modes. A change to a resolution independent system will require an HTML based redesign to the point where Flash is only used to support video play.

21st Century Global Challenges' single-window viewing mode will feature larger videos and still images, a "Topics in Google News" feature, a list of popular video searches done within the site, and provide users with the ability to combine search histories into a new single search. The single-window viewing mode will be the 21st

Century Global Challenges program's default interface, but users will still be able to switch to the two and four-window viewing modes. I think that these decisions will lead to increased traffic, while enabling users to work with viewing modes specifically designed to support nonlinear juxtapositions.

Timeline. A resolution independent system will enable the size of the thumbnail images in the timeline to be increased and related case information, including title, event date, short descriptions, and video timing to be visible without having to rolling over the thumbnail image. A new timeline feature will enable users to sort on cases in the timeline by name, date, theme, and relevance. I believe that these changes will support more efficient work with cases.

Short, dense videos. Short, dense videos will be used in 21st Century Global Challenges program. Longer videos will be edited down to short, cognitively manageable chunks of information. Users will search on these shorter cases but be able to view longer cases by clicking on an icon located above the video.

Introducing the program, its features, and learning goals. The 21st Century Global Challenges project will place greater emphasis on the introduction of its features and learning goals. Since theme menus are one of the first features that users work with in the program a more detailed theme menu will be created, one with descriptions of each theme category. The 21st Century Global Challenges tour will be built in HTML based pages, rather than Flash, enabling more people, specifically those who have yet to download the Flash player, to get an overview of the environment which might encourage them to install Flash and work with the program. The creation of learning tasks and worked examples will be another way to explain 21st Century Global Challenges features

and the learning theory that is the foundation for the environment. An HTML page will be created for each case. A link to the Flash-based program will appear on each page. This will enable search engines to locate program content and be designed to increase site traffic.

Keyword search. The "Keyword Search" will play a larger role in 21st Century Global Challenges than it presently does in EASE History. It will appear on each page, so users will have easier access to this feature. The "Index Search" will not be included in 21st Century Global Challenges, because it is made redundant by the "Keyword Search", which enables users to search on case titles.

Icons. 21st Century Global Challenges icons and related menus will be redesigned so that available content is immediately identifiable. A switch to text-based menus, for example, will enable short descriptions to accompany related cases and resources titles so that users will be alerted to available content.

Individual differences. Guided explorations will be developed in order to help novice learners understand how terms have been defined, and how cases are connected. Mindset modeling videos will be developed to help more novice learners develop critical habits of mind and develop a deeper understanding of content.

Metacognitive support structures. 21st Century Global Challenges will feature metacognitive support structures that alert users to where they have been, how the system is organized, and where they might want to go later on in the system. These supports will be designed to minimize disorientation.

Multiple content producers. 21st Century Global Challenges will enable users to create their own cases (i.e., upload public domain images, assign related themes and

resources, and add text descriptions to the program's database). Users will be given the option of working with cases developed by 21st Century Global Challenges content producers, and/or by the public.

Deployment. For the deployment of 21st Century Global Challenges I will create a press release that focuses on the content and the learning benefits of the new program. I will e-mail bloggers, reporters, and state educational leaders, many of whom I contacted about the release of EASE History. I will also create a list of organizations and alert them to the launch of the program.

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