The threat matrix: a qualitative study of an instructional design process

Robert Oren Kelly
Iowa State University

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The threat matrix: A qualitative study of an instructional design process

Kelly, Robert Oren, Ph.D.

Iowa State University, 1994

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The threat matrix: A qualitative study of an instructional design process

by

Robert Oren Kelly

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DOCTOR OF PHILOSOPHY

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In Charge of Major Work

Signature was redacted for privacy.

For the Department and Education Major

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa
1994

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DEDICATION

This dissertation is dedicated to my son, Ryan Robert Kelly. Ryan, as you recall this experience, may it remind you of the importance of choosing a goal, working towards it, and at last achieving it.
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CHAPTER 1: INTRODUCTION TO THE STUDY

Organization of the Dissertation

This dissertation has five chapters. The computer-based lesson developed for this study was created for the Surface Warfare Officers School (SWOS) of the United States Navy. A substantial orientation to SWOS and its mission is included. The first chapter orients the reader to the subject of the study and then to the study itself as it identifies research questions and the significance of the study. The second chapter describes the foundations of the study. Chapter 3 describes the methodology and Chapter 4 explains the study's findings. Chapter 5 is a summary of the study.

Chapter 1 begins with a general introduction to the Threat Matrix, which is the content focus of the computer-based lesson designed for this study. The Combat Information Center, which is the control center for all the strategic activities of the ship, is described. Background discussion about SWOS is provided to orient the reader to its purpose, schools of study, and training sequence.

To place the content of the computer-based lesson in perspective, a scenario entitled “The Uninvited Birthday Guest” is presented. The scenario gives the reader insights into the strategic importance of the Threat Matrix training. Another section explains the Threat Matrix in detail and describes a time frame in which the computer-based lesson was developed. The chapter then continues with a statement of the problem, research questions, significance of the study, and summary.

Chapter 2 describes the foundations of the study. It examines constructivism, cognitive theory, schema, advance organizers, mnemonics, and hypertext/hypermedia.

Chapter 3 describes the methodology used throughout the study. It states the problem, describes the research questions, and identifies the significance of the study.
In the description of research methodology used, sections included are explorations of the single case study method, qualitative methods, triangulation, and participant observation.

Chapter 4 discusses the six kinds of data collected in the study. The data include course evaluation and prototype assessment, attitude assessment, personal interviews, chronological logs, and participant observer field notes.

Chapter 5 provides a summary, discussion, recommendations, and conclusions for the study. The findings are summarized and the chapter concludes with recommendations for further research.

**Introduction**

Computer-based instruction has emerged as a frequent tool used in industry, education, and government. This study described a solution that was used to solve an authentic “real world” problem for the United States Navy. The Surface Warfare Officers School (SWOS) located at the Naval Educational Training Center in Newport, Rhode Island, wanted to explore alternative methods for officers to use while studying the Threat Matrix (TM), one of the key curriculum components of their officer instruction program. The TM is a large collection of strategic facts on all the navies of the world. The data it contains about Naval capabilities from any country are essential for an appropriate U. S. Navy response to any potentially hostile situation. Using sophisticated data gathering equipment, officers on board ship assess any observed threat and appropriately determine a response to it. The TM curriculum, which teaches these strategic facts to the Naval officers, was the focal point for the instructional design for this study. SWOS senior officers wanted to explore new ways of presenting the TM data that would assist students to learn it more efficiently and accurately.
The Combat Information Center (CIC) is the nerve center of a Navy ship. In this centralized location are dozens of control consoles staffed by officers who are monitoring all the sensing capabilities of the ship. When radar, sonar, or other electronic signals from surface, sub-surface, or air are detected, the officers in this control room spring into action. They quickly identify and classify the signal as friend or foe and assess the "threat component" it represents. To make these critical decisions requires a thorough knowledge and understanding of the thousands of elements, called data points, that describe the weapons and sensing systems on surface warships, submarines, fixed wing aircraft, and helicopters, sensors, and weapons systems used by the navies of the world. The high technology equipment in the CIC assists with these tasks, but in the final analysis the decision to treat the signal as a threat, and indeed "fire weapons," is a personal decision made by the Commanding Officer (CO), with recommendations from the officers in the CIC.

The Surface Warfare Officers School (SWOS) of the United States Navy had established a record of frequently incorporating instructional technologies into their curricula. This study created another component to assist in the mission of SWOS.

This research discusses the design, construction, and installation of a prototype computer-based learning system developed for the United States Navy to assist students with learning thousands of facts about the navies of the world. Specifically, the study focuses on the instructional design process used to create a computer-based lesson for this study. Significant elements of the instructional design process are identified and verified.

Background

The computer learning system discussed in this study was developed for use at Surface Warfare Officers School (SWOS), one of many schools located at the Naval
Education Training Center (NETC) in Newport, Rhode Island. NETC is adjacent to Narragansett Bay and home to the Naval War College, as well as dozens of other schools that provide training in all aspects of Navy life. The Naval complex at Newport utilizes the services of more than 5,200 active duty military personnel. Each year more than 9,000 Naval personnel receive training here.

The mission of SWOS is to provide the Naval surface warfare force with officers professionally qualified to serve as effective Naval leaders on surface warfare ships. The ultimate goal is to have the qualified officers trained to take command-at-sea.

SWOS has six permanent buildings and five temporary buildings, which serve as classrooms, offices, and laboratories. In 1991, over 2,800 students attended the various training courses at SWOS. The school maintained a teaching and administrative staff to serve its instructional needs. There are five schools at SWOS:

1. **The Division Officer Training School**: This school prepares prospective Surface Warfare Officers for their first assignments by providing fundamental instruction in basic fleet training. This training emphasizes the knowledge and skills required to assume duties as Division Officer, Officer of the Deck (in port), Combat Information Center Watch Officer, and Junior Officer of the Deck. Additionally, the course provides a foundation of knowledge in combat systems, propulsion engineering, and damage control.

2. **The Department Head Training School**: This school prepares mid-grade Surface Warfare Officers to execute confidently the department head level duties aboard surface ships. Training addresses shipboard equipment in a systems fashion, stressing equipment interaction and interdependence. It also provides advanced training in managerial, operational, and technical areas needed to support an officer's assignments to a specific department in a given type of ship.

3. **The Prospective Commanding Officer and Prospective Executive Officer (PCO/PXO) Training School**: The PCO course's primary mission is to prepare line officers, eligible for Command-at-Sea, to execute properly that authority in surface ships. The training addresses the professional aspects of taking ships to sea and executing their battle functions as units in the tactical forces of the U.S. Navy. The school also addresses command responsibilities, ship tactics, techniques for evaluation and control of ships systems and equipment, current fleet policies and practices, and specialized information appropriate to the ship type to which students are ordered. The PXO curriculum is designed to provide the Executive Officer with an improved concept of supporting the Commanding Officer in controlling and evaluating the performance of the ship.
4. **The Damage Control Training School:** Courses in this school are to provide training in shipboard damage control procedures. In-depth study is provided in damage control administration and training, divisional administration, damage control equipment systems, and other damage control concepts.

5. **The Engineering Specialty Training School:** This school's courses of study prepare junior, division officer level, Surface Warfare Officers to execute their prospective Engineering Department Division Officer duties aboard surface ships. The training emphasizes technical and equipment details related to the respective propulsion plant systems and their operation. Instruction in the basic principles of electricity is emphasized. The training is developed toward an understanding of proper and safe propulsion plant operation.

Within each SWOS school there are sequential training curricula that officers experience during their careers. For example, one area deals with combat systems. Primary exposure to this curriculum trains students to a point of expertise, where they can be placed aboard ship for a tour of duty. At the end of the tour of duty, the officer is usually assigned to more advanced training in combat systems, and then is cycled through a second tier of the curriculum. The multi-tiered structure of the SWOS curriculum includes a series of activities designed to move the student from the status of an entry level ensign through that of the executive officer who is being screened for major command.

The computer learning system described in this study was designed to meet needs in the combat systems curriculum of SWOS. Specifically, it was designed to assist students to learn about the Threat Matrix (TM). The TM is a large matrix consisting of dozens of rows and columns. Headings on each column identify a comprehensive listing of classes of ships, fixed wing aircraft, helicopters, submarines, weapons systems, radars, and sonars for the navies of the United States, the USSR (now the Commonwealth of Independent States), and other powers of the world. Each of the categorical groupings that heads a column of the TM is called a platform. The
rows of the matrix include specific data regarding size, speed, range, and other
descriptive platform information (Kelly and Simonson, 1990).

Students in the combat systems curriculum must learn this material and be
able to pass a Threat Matrix exam at the end of the six week course. After graduating
from SWOS the officers are placed aboard ship to assume the duties of Tactical Action
Officer (TAO) and CIC Watch Officer inside the shipboard Combat Information Center
(CIC).

It is the duty of the CIC Watch Officer to inform the TAO of all events related to
safety and well-being of the ship. The TAO must be able to respond quickly to radar and
sonar information indicating an approaching target or "threat." Within a matter of
seconds the TAO must recall the TM, identify proper response action of the vessel, and
relay this information to the Commanding Officer (CO). Rapid and accurate recall of
the TM is crucial to the survival of the ship and its crew.

The charge for this research was to design and create a prototype interactive
computer-based learning system that could assist in the teaching and learning of the
facts of the TM. To place the TM and its importance in perspective, a brief scenario is
provided.

The Uninvited Birthday Guest

The Samuel B. Roberts (FFG 58), one of many guided missile frigates of
the United States Navy, was maneuvering routinely on its regular patrol
mission in the Gulf of Hormuz. The sleek Naval craft measured nearly 450
feet in length and carried a fearsome assortment of missiles, guns, and
torpedoes.

On this particular warm, sunny afternoon the Samuel B. Roberts was
moving through calm seas at a speed of 12 knots. The ship's 219 personnel,
including airmen and officers, were at their posts performing their normal
duties. There was an air of frivolity as the ship's cooks and more than a
hundred sailors gathered at the ship's stern just in front of the two helicopter
bays to celebrate the Captain's birthday. They began a loud celebration of the
event, complete with a decorated birthday cake and "Happy Birthday" chorus
for the Captain. Crew members rotated through the afternoon's festivities, so
that before nightfall, all would have some of the chef's concoction.

The officers on the bridge scanned the horizon with binoculars, only to
see empty water and empty sky. Sailors in the engine room were at their posts
watching the many controls necessary to keep the 40,000 horsepower gas
turbine engines running at peak efficiency.

Located behind the bridge and one deck down, sailors and officers were
poised at their posts in the Combat Information Center (CIC). The 20 by 40 feet
room was a technical marvel filled with state-of-the-art electronic consoles that
monitored dozens of radio and radar signals originating in and near the
vicinity of the ship. Because of the heat from the electronic consoles, the CIC
was air-conditioned. Yet, in spite of the comfortable surroundings there
existed the awesome potential for firepower. It would be from these consoles
that orders to fire guns, torpedoes, or missiles would be received and carried
out. At first the CIC appeared to be a totally darkened room, with only the
phosphorescence glow of radar monitors and display screens providing
illumination. However, the space was illuminated in strategic areas by blue
fluorescent lights, and it was possible to maneuver through the traffic areas.
The subdued ambiance allowed the radar and monitoring consoles to be viewed
efficiently. At the back of the room a large, elevated swivel chair was bolted to
the deck and placed adjacent to a vast array of communication equipment.
This was the Captain's chair, used only when the Commanding Officer (CO)
was in the room.

Directly under the Captain's command was a small group of Tactical
Action Officers (TAO's) who commanded the CIC on regular six hour shifts.
It was the duty of the TAO to receive all input data from CIC personnel, and
when necessary, make critical decisions regarding potential threats. The
TAO under normal circumstances would advise the Captain of any threat, and
then the CO would make a decision on how to proceed. When working in the
CIC and performing TAO watch, the TAO officer is accountable to only one
other person on the ship -- the Captain. Fortunately, the TAO had a sizable
compliment of personnel to assist in the collection of incoming data, so correct
decisions could be made.

The following CIC personnel were at their posts on this warm afternoon
in the Gulf of Hormuz:

**TAO:** Tactical Action Officer; the Captain's representative who ran the operation of the CIC team

**CIC Watch** The watch officer of the Combat Information Center who provided communication and organization management for the TAO

**ASMD/EW:** The Anti-Ship Missile Defense Electronic Warfare specialist; this team member operated a console that detected electromagnetic signals, classified them as to possible source, and alerted the operator and Electronic Warfare specialist as to their existence

**WCCs:** Fire Control technicians who tracked targets and fired at them on command, and operated the Weapons Control Consoles

**WCO:** Weapons Control Officer who supervised both WCCs

**TRACK SUP:** Track Supervisor who was an operations specialist and kept track of radar contacts
On this afternoon there was the normal activity in the CIC, just as there had been every afternoon for the last week. Other U.S. vessels and aircraft were detected by the ASMD/EW and properly logged. As the TAO looked across the CIC, he could see the consoles where each of the ten men assigned to the CIC was posted. The TAO was well aware that if a contact should be made the ASMD/EW would be alerted first and would track its activities. Eventually the TAO would have to make a determination as to whether this radar datum was a threat or not. Possibly he reflected back to his training experiences at the Surface Warfare Officers School (SWOS) in Newport, Rhode Island. Perhaps those classes, lectures, and homemade flash cards seemed like a long time ago and on the other side of the world. At SWOS he had memorized thousands of facts so that if the ASMD/EW ever reported a threatening signal, he would have a basis on which to respond.

"TAO...EW," (this meant the Electronic Warfare specialist in the CIC was calling the TAO. On ship the message recipient is announced first and the sender second.)... The short letters echoed through the CIC phone system to the TAO. "I have an unidentified E band radar at Bearing 028 degrees."

"Continue to advise," the TAO responded.

At this point the TAO knew they had "something" of potential concern out there. He was not yet certain if it was a plane, ship, or submarine, and he did not know whether it was friend or foe. At this early stage he only knew it was approaching them at Bearing 028.

"ADT, SDT, ASWO...TAO" (Air Detector Tracker, Surface Detector Tracker, and Anti-Submarine Warfare Officer) "...be alert for an unidentified E band radar at Bearing 028 and advise."

Abruptly the TAO heard through his headset, "ADT...TAO, I have the target at Bearing 028." When the TAO queried the SDT and ASWO, he determined they had seen nothing at their consoles, thus meaning that the target was an aircraft, which was continuing to approach them on Bearing 028.

"ADT, EW...TAO, continue to track and give me vitals," the TAO ordered.

"TAO...EW, I have a confirmed search radar on the target. The platform may be a Forger."

"OK," the TAO affirmed, "advise me of platform confirmation."

"TAO...ADT, I have locked on the target and it is continuing towards us on Bearing 028 at 10,000 feet. Range is approximately 200 miles."

At this point the TAO now was able to make a much clearer appraisal of the situation. He knew the aircraft was about 200 miles out and continuing towards them. He knew it may well have been a Forger A, a Soviet made Vertical/Short Take Off and Landing (V/STOL) jet fighter, which meant it came from a Kiev class aircraft carrier. From his threat matrix training at SWOS the TAO was acutely aware of the weapons systems on board the Forger and the threat they would represent to his ship.
"TAO...EW, platform confirmed. It is a Forger," the EW advised.
"Affirmative, EW. Continue tracking," replied the TAO.
"ADT...TAO, stay locked on and advise of any changes in altitude, bearing, or range."
While it had been only a few minutes from the time the EW first observed the unidentified E band radar, the TAO felt that he had been observing this one for an hour. The next step for the TAO was very procedural. He flipped his phone switch for the bridge.
"Bridge Watch...TAO, advise the CO we have a confirmed Forger approaching at 10,000 on Bearing 028."
"Confirmed Forger at 10,000, Bearing 028. The CO advises he is in route to CIC," replied the Bridge Watch.
In a few seconds the CO arrived in the CIC and took position near the entrance in the command chair. From this position the CO could see all CIC consoles and receive a visual feel of the CIC. All his dialogue was directed to the TAO, who was in turn receiving his information from the CIC Watch Officer and the CIC specialists seated at their consoles.
"Current status?" queried the CO to the TAO.
"Sir, the platform is a confirmed Forger A, V/STOL, continuing on Bearing 028 at 10,000 about 200 miles out."
"Very well," the CO replied. "Let's keep our eyes and ears open and see what he does."
By now the officers in the CIC had reached a high state of readiness regarding this particular target. They were using the same procedures they had trained for in the FFG 7 - CIC trainer at SWOS in Newport. This time, however, it was not practice.
"ADT...TAO, can you still confirm search radar only?"
"Confirmed TAO. There is no fire control, only search. He's sitting up there looking at us look at him."
The ADT was telling the TAO some good news, for now. When fire control radar was sensed, that meant the radar for a missile or gun had been turned on, which of course would dictate a rapid sequence of emergency procedures. For now there was nothing for the CIC crew to do but watch things very carefully.
The TAO knew the approaching target, the Forger, was a Soviet jet fighter dispatched from a Kev class aircraft carrier. This particular jet was able to take off and land in a vertical manner, in much the same way a helicopter maneuvers. More importantly, the TAO was focusing on the armaments aboard the Forger and the implications they held for the Samuel B. Roberts and its crew.
The Forger carried solid fuel missiles identified as AS-7 Kerry. The Kerry hit a range of six nautical miles, carries a 100 kilogram warhead, and is capable of traveling at Mach 1.0 (about 740 miles per hour). The TAO knew that when the Forger began to approach his optimum range for use of the AS-7 missiles, his ship would indeed be in a threatened situation.
The missiles on board the Samuel B. Roberts to be used in this encounter were SM-1’s, a surface-to-air missile with a threatening list of attributes. This missile was nearly 15 feet long, weighed more than 1000 pounds and could travel at Mach 2 (about 1480 miles per hour). Its range was 25 nautical miles, which meant that the Roberts would have the Forger within its range first, before the Forger could threaten the Roberts. However, the Forger could achieve a maximum speed of 540 knots, which would allow it to move in quickly, fire missiles, and rapidly turn away.
Since the Roberts was outside the United States waters and currently in a previously hostile area, the ship’s alertness standing was condition 3, which meant it was ready to fire all guns and missiles, short of actually loading them into place. The SM-1 surface-to-air missiles on the Roberts were stored vertically below deck and directly beneath the launcher rail on which they were mounted prior to launch. They were clustered below deck in groups of
six on a "lazy Susan type" turntable, which would quickly rotate to place a
missile within the hydraulic mechanism to mount it on the launcher for use.
This process could occur in about five seconds, so normally a missile was not
mounted until immediately prior to its launch.

The Air Detector Tracker (ADT) announced to the TAO that the Forger
was now within 100 miles.

"SWC...TAO, advise status of all weapons systems."

"Bridge Watch...TAO, stand by to move off condition 3."

"Affirmative, TAO," replied the Bridge Watch. The Bridge Watch was a
watch station staffed on the bridge of the ship by a rotating shift of officers
much like the watch stations in the CIC. The TAO was advising Bridge Watch
because the ship might have to maneuver quickly in the water prior to
launching its missiles. By advising Bridge Watch of that potential, proper
adjustments could be made in advance of an order to maneuver.

"SWC...TAO," the voice reported a few seconds later on the CIC phone
head set. "All weapons systems are standing by and at the ready, sir."

"Confirmed, SWC," replied the TAO. The stage was now set, the CIC
crew of the Roberts was ready, and now the outcome would be up to the
approaching Forger aircraft.

"TAO...ADT, target is now approaching 50 miles out and continuing to
use only search radar."

The TAO realized the moment of truth would come in a few more
seconds. As long as the ADT was only showing use of search radar, it meant
the Forger was just looking at them. As the Forger began to close within
range of the surface to air missiles on board the Roberts, the tension in the CIC
mounted. The CO sat stoically in his chair, carefully listening to all
communications and observing the operation of all members of the CIC. He
occasionally asked the TAO to confirm some previous communications, but he
did nothing to interfere with the TAO and his team of experts. The CO would
be responsible for giving the order to fire the SM-1 missiles, should that be
necessary. Until that time he sat watching and waiting.

A few seconds later the Forger entered the range of the SM-1's and the
ADT announced, "Target is within range, but I am continuing to see search
radar only. No fire control radar is evident." That meant he was still only
looking and had not sent out fire control radar which could guide his AS-7
Kerry missile to the deck of the Roberts.

Since he was not maneuvering in a threatening manner, and since his
radar continued to be search only, the TAO advised, "Continue to stand by."

"TAO...ADT. He's turned, sir, and is leaving us."

Looking very intent, the TAO replied, "Keep on him to be sure that's the
case. Watch closely to be sure that he does not fire a passive missile before he
turns away." In a short time the Forger was well past 100 miles, and there
was no evidence of any missile coming towards them.

"TAO...all CIC. "The target has left us. Discontinue tracking."

"SWC...TAO, the target has left us. Maintain condition 3."

"Affirmative, TAO," the SWC advised.

A collective sign of relief echoed within the metallic walls of the CIC.
Everyone, including the CO, was glad this one was over. As body postures
relaxed at the CIC watch stations, the TAO checked the time and was shocked
to realize the entire chain of events had taken less than ten minutes.

The CO rose from his chair, thanked the TAO and the CIC crew for a
job well done, and reminded them of the leftover birthday cake waiting for
them at the end of their shift. He left without flourish and ascended the steps
to resume his post at the bridge as the Samuel R. Roberts safely continued its
patrol.
In the preceding scenario the ability of the TAO and the CIC crew to recall the facts of the TM and interpret them within the context of this particular target, was demonstrated. The scenario is typical of what occurs in a CIC, and dozens of variations of this chain of events are duplicated daily on hundreds of Navy ships. Sometimes missiles are fired at the target, or the ship is fired upon by the approaching enemy. Regardless of the outcome of the encounter, the ship's safety depends on a relatively small crew of sailors to make the right decisions at the right time. Training received by the TAO and CIC Watch Officer is very important.

The Threat Matrix

The command at SWOS wanted to make the Threat Matrix (TM) training as relevant and meaningful as possible, and still insure rapid and accurate factual recall of essential data. It was for that reason that Iowa State University was contacted for participation in this challenging instructional design project.

A critical part of the SWOS curriculum for its Division Officers Training School is the study and mastery of the TM. The TM is a complex and highly organized collection of thousands of facts describing surface warships, submarines, fixed wing aircraft, helicopters, sensors (radars and sonars), and weapons systems in dozens of classes for all the major navies of the world. It could be visualized as a large chart comprised of rows of classes and columns of data. The officers who completed the TM training and passed the TM examination were considered to be prepared to assume duties in the CIC (Combat Information Center) aboard ship. When presented with data in the CIC, these officers must determine if it represents a threat for their ship. If a threat is confirmed, the officer must know the threat platform's weapons and sensors capability, as well as knowledge of its speed, range, and maneuverability.
The TM has been studied by thousands of officers in numerous ways. Most traditional methods have involved use of a series of flash cards, sketches, or diagrams which helped in the recall of facts. Reference books, such as *Command Fleets of the World*, provided basic information, line drawings, and photographs that were also helpful study aids.

Prior to 1991, SWOS and Iowa State University had worked together on several projects. In 1988, a prototypic high-tech classroom was designed, created, and installed at SWOS. It included an array of equipment and facilities for video, computers, motion and still photos, and transparency projection. ISU also designed, created, and installed a media production center at SWOS, which consisted of several work stations where students and instructors could produce a variety of instructional materials. In 1990, ISU assisted SWOS in the training of its instructors to utilize more instructional technology in their classes.

In 1989, Iowa State University and this researcher became involved in assisting SWOS to incorporate instructional technology in the teaching of the TM. During 1989 through 1991, the planning for a computer-based lesson to teach the TM evolved. Several meetings were held at Iowa State University and at Newport, Rhode Island, to identify components of the system and the lesson's content, approach, and design. On January 16, 1991, an operational prototype was delivered and installed at SWOS and put into use. That evening was a memorable one, because the Persian Gulf War began on this date.

The operational prototype was used and evaluated by many SWOS staff members. A SWOS instructor worked with data contained in the prototype to confirm, change, or add information to bring it up to "classified" status. SWOS liked the prototype and wanted to complete it, so the project was expanded. This phase was
finished by other ISU researchers, who completed the operational prototype and turned it into a fully functioning system.

**Statement of the Problem**

The problem addressed by this study was to identify and verify the key decisions made during the instructional design process for *The Threat Matrix: A Computer-Based Lesson* (TMCBL). The instructional designer determines and implements design factors such as screen design, use of color, text readability, and logical flow of lesson.

Qualitative data collected during the design of the prototype, as well as quantitative data collected from the lessons' users, were used to validate the key decisions. This study identified not only the key instructional design elements, but described the manner in which their importance was verified through the qualitative analysis technique of triangulation.

**Research Questions**

This study concentrated on the instructional design decisions used to create the TMCBL. In addition to the analysis of the instructional design process, data describing the efficacy of the TMCBL were collected.

The questions examined in this study focused on the process of instructional design used in the creation of the prototype computer-based lesson.

- Which design elements were important and considered as potential key decisions?
- Can the instructional design elements be grouped to create a list of key decisions for any instructional design for a hypermedia, computer-based lesson?
Significance of the Study

The research literature contains a variety of methods by which the process of instructional design is evaluated formatively and summatively. A major question facing instructional designers centers on the reasons and manner in which individual design components become a part of the final instructional product.

This study shows how individual decisions made during the creation of this lesson were valid ones, as verified by the process of the triangulation. The manner in which these key decision points are qualitatively confirmed will also be explained.

Summary

This chapter provided background about the organizational structure within which this study occurred. It described the Naval Education Training Center (NETC) in Newport, Rhode Island, and specifically the Surface Warfare Officers School (SWOS) and its curricula.

A scenario was presented showing the importance of the TM training from SWOS to the critical functioning of officers in the Combat Information Center (CIC) of a ship at sea. This chapter explained how the instructional prototype of a computer-based lesson described and evaluated in this study was an integral curriculum need identified by the SWOS command.

This chapter identified the need for the development of a prototypic model of a computer-based learning system to teach the desired facts of the Threat Matrix. The identification of key decisions made during the instructional design process of the TMCBL were described as the basis of this study.
CHAPTER 2: FOUNDATIONS FOR THE STUDY

This chapter examines the foundations in literature on which this study is based. It begins with an overview of constructivism and concludes with the cognitive theory of learning and its elements of schema, advance organizers, and mnemonics.

Constructivism

This section describes the constructivism approach to education and places it in an historical perspective from Vico in the 1700's to Piaget and Papert of the current time period. Elements of Piaget's genetic epistemology are identified and reviewed.

Constructivism takes the position that learners are constructors of whatever they do. That is, knowledge is constructed, and is more or less helpful depending upon the context in which it is experienced and how it is used. Problems are not so much solved as dissolved. As actions and meanings are changed, events are reformulated, and a new set of issues to be addressed, is generated. This is an ongoing and an unending process (Delia, 1977).

Constructivism proposes that learners are substantially authors of their own destinies, but this is always in relation to others as a mutually constructed process. Personal responsibility becomes paramount. Learners experience change, flow, and divergent thinking (Fisher, 1991).

Fisher explained that acceptance of constructivism means accepting the fact that simple solutions to human problems are seldom available. He suggested learners cannot rely upon the promises of politicians, teachers, and religious leaders, because persons occupying these roles offer reformulations of ongoing experience, rather than solutions in any final sense. This means that learners participate in creating an ongoing drama, and how they experience that drama and what they contribute to it depends first of all, on the meanings they give to the events, and second, how they
impose those meanings upon one another or negotiate differences between them. Constructivism provides a way of understanding and working with these processes. Fisher asserted that this makes individuals active agents in constructing their own lives. This view is in contrast to both the psycho dynamic view, in which we are creatures driven by the dark unconscious, and the behaviorist view, which maintains that what we are is determined by our environment.

Fisher reminded us that people sometimes find themselves torn between the objectivist and constructivist position. That is, in one moment everything is solid and real, and in the next moment change, movement, and process predominate. As Fisher described the objectivist position, he commented, “Objectivist epistemology encourages us to believe that there are correct ways of knowing, that there are, in some final sense, solutions to our problems, and that there is an ultimate reality that we are gradually discovering” (p. 8). Fisher has commented that the constructivist process of knowing is based on an awareness of differences and their relationships. The learner uses defined parameters to construct and reconstruct that knowledge.

Pieters and de Bruijn (1992) reflected that constructivists assume knowledge to be neither an exact copy nor a mirror of reality, but the forms and content of it are constructed by the one who experiences it. The interaction between the individual and the environment is mediated by the cognitive structures of the individual. The authors suggested that learning depends on the structuring of the learning experiences. An important purpose of education is to allow people to reconstruct events and ideas in ways that lead to more functional outcomes for the learners.

Candy (1989) linked the following assumptions to constructivism.

- People participate in the construction of reality.
- Construction occurs within a context which influences people.
• Construction is a constant activity which focuses on change and novelty rather than fixed conditions.

• Locus of control resides within the subject themselves and complex behavior is constructed purposely.

Tinker and Thornton (1992) discussed the construction of student knowledge in science:

A constructivist perspective posits that students learn best through active engagement in their own studies in an environment that encourages them to construct and communicate their own knowledge and understandings. Students who are thoroughly engaged in original projects, having selected the topic, decided on the approach, performed the research, drawn the conclusions, and communicated the results are doing science. They are seeing science not as a noun, an object consisting of facts and formulas, but as a verb, a process, a set of activities, a way of proceeding and thinking. A constructivist framework is not only good pedagogy, but good science. (p. 155)

The concept of constructivism is not new. The Italian, Giambattista Vico (1668-1744), is sometimes credited as being the first constructivist. The essence of Vico's work was that people have a mixed nature of good and evil. Through acts of conscience they are able to avert the disasters of materialism and ignoble motivation (Fisher, 1991). Vico's ideas of people's choice represented a challenge to the prevailing dominant thought.

More recent advocates of constructivism include Piaget and Papert. Piaget conceived the term "genetic epistemology" to express his idea that intellectual development (how we come to know) is firmly rooted in the development of the individual, as expressed by the term genetic (Pulaski, 1971).

Piaget's work is based on a central idea that all knowledge is constructed. Wadsworth (1984) said it this way, "For Piagetians, learning always involves construction and comprehension" (p. 185). Piaget (1970) has said, "Knowledge is derived from action...To know an object is to act upon it and to transform it...To know is therefore to assimilate reality into structures of transformation, and these are the structures that intelligence constructs as a direct extension of our actions" (p. 28-29).
Thus, learning which involved action and manipulation led to more learner constructed knowledge.

Pulaski (1971) identified four periods of Piaget's genetic epistemology:

- **Period 1: Sensory Motor Period (first two years of life)**
- **Period 2: Preoperational Period (2-7 years)**
- **Period 3: Concrete Operational Period (7-11 years)**
- **Period 4: Formal Operational Period (11 years - adult)**

Howard (1987) described Piaget's four stages. In Period 1, the Sensory Motor Period, the child has no concepts of space, time, causality or object. The concept of object develops slowly. When an object disappears from view, the child sees it as gone forever and cannot think about it. In Period 2, the Preoperational Period, the child can readily represent the world, but is still bound to perceptual features taking appearance for reality. The child has great trouble seeing things from other perspectives and great difficulty in relating ideas in meaningful ways. In Period 3, the Concrete Operational Period, the child is no longer dominated by the way things look and can think more abstractly. In Period 4, the Formal Operational Period, the individual can think and reason abstractly, make inferences from hypothetical situations, and behave like, or is, an adult.

Each of Piaget's four stages is divided into sub-stages from one month or more for the Sensory Motor Period to a span of several years for the later periods. Within each of the identified stages, Piaget has identified specific kinds of intellectual development that can be expected at that particular age. Edwards (1986) corresponds the periods of Piaget to infancy, childhood, adolescence, and adulthood. Piaget believed that these stages of cognitive development were made possible by spurts in neurological development, that is, the physical maturation of the brain.

Piaget said that knowledge is constructed as learners observe and act upon objects, communicate and interact with people, and try to make sense of discrepancies
in their experience. The knowledge that is constructed bears a relationship or resemblance to that of other people or objects around them. While knowledge is not received passively, the process of constructing knowledge is best described as guided reinvention (Fisher & Bullock, 1984).

A more recent enthusiastic supporter of constructivism is Seymour Papert. Papert's philosophical approach to educational computing is rooted firmly in the work of Piaget. This relationship is stated in *Mindstorms* (Papert, 1980) and is based on Piaget's view of the growth of knowledge as "genetic epistemology." Papert said, "I strive to uncover a more revolutionary Piaget, one whose epistemological ideas might expand known bounds of the human mind. For all these years they could not do so for lack of a means of implementation, a technology which the computer now begins to make available" (p. 157). Papert (1993) described constructivism further in his latest book, *The Children's Machine*:

...the goal is to teach in such a way as to produce the most learning for the least teaching. The principal...parallels an African proverb: If a man is hungry you can give him a fish, but it is better to give him a line and teach him to catch a fish for himself. Constructionism is built on the assumption that children will do best by finding (fishing) for themselves the specific knowledge they need; organized or informal education can help most by making sure they are supported morally, psychologically, materially, and intellectually in their efforts. The kind of knowledge children most need is the knowledge that will help them get more knowledge" (p. 139).

Simon (1987) suggested that Papert claimed because children are fed information in educational establishments, rather than being active in the process, they are being denied the opportunity to learn the natural way which the Piagetian theory of development described. Papert advocated the learning-by-doing or self-discovery approach to learning where children are allowed to discover knowledge for themselves, at their own pace, and in ways suited to their own individual style of thinking. In this manner Papert predicted learning will become a self-generating
process where existing knowledge creates new discoveries merely by the process of activity.

The ideas of Papert are demonstrated in the usage of LOGO computer programming language and the subsequent exploration of LOGO strategies in problem solving applications. Papert called these environments "micro worlds" where learners can immerse themselves into the learning framework and actively participate and utilize the principles of constructivism in learning.

The implications of constructivism to this study can be found in the hypermedia components of the computer-based lesson that was developed. Because of the multi-branching attributes of the hypermedia instruction, learners can organize their learning experiences in a manner appropriate to their needs. The computer-based lesson that was developed for this study functioned similarly to a "micro world" as described by Papert, and served as an arena in which the learner explored and interacted with the materials in a more relevant way.

Cognitive Theory

This section on cognitive theory identifies its essential components. It reviews the work of Bruner, Dale, Papert, and others.

Cognitive theories of learning concentrate on the internal processes that occur during instruction. Cognitive theory attempts to explain how students conceptualize the learning process by focusing on the way information is received, organized, retained, and used by the brain. This approach suggests there are various cognitive structures that should be accounted for when instruction is designed. Cognitive theorists believe that instruction is based on a student's state of mental organization, or schema. This "road map" of how and why a learner thinks, learns, assimilates, and remembers, makes the learning process different for each student.
Bruner (1960) focused on several concepts: the structure and organization of knowledge; readiness for learning; motivation or desire to learn; and intuition. Bruner related intuition as the process of arriving at a plausible but tentative conclusion without going through a series of analytical steps. The instruction needed motivation and structure to get learning started and keep it focused. Bruner called this series of events activation, maintenance, and direction.

Dale (1946) believed the structure and form of knowledge must be considered. Dale’s Cone of Experience visualized a series of twelve levels of increasing abstraction. Dale’s levels are used to explain a series of sequential experiences for all learners: understanding of concrete operations, graphic symbols of reality, and abstract verbal and numerical symbols. Cognitive theory is partially based on the importance of sequencing of instructional materials and focuses on the conceptualization of the learning process, the way information is received, organized, and retained. This conceptualization is different for each learner and must take into account the varied information processing abilities of the learner. Pacing and reinforcement must be considered. One learns general concepts before progressing to the more involved or complex. For example, identifying the prime factors of a given number would not be taught until students had gained an understanding of basic multiplication facts.

Discovery learning implies that learners, with minimal help from teachers, are capable of finding important ideas based on their own exploration. These are the “micro worlds” or educational situations, which Papert (1980) suggested as places where students could probe, try a variety of experiences, and gain new knowledge and understanding. Papert believed students could learn much by discovering the lesson found within the instruction.
Simonson and Thompson (1994) related the application of techniques to learning theories, including cognitive theory. Some general considerations for the design of instruction emerged:

1. a clear statement of level of competence needed by the student to begin the lesson successfully;
2. feedback that is timely, individualized, and positive;
3. instructional outcomes that are clearly stated;
4. lessons that are individualized as to the rate and route of learning;
5. instruction that is motivating, informative, and interesting;
6. learner involvement that is active;
7. accurate assessment of progress as the lesson is experienced;
8. sequence of lessons that is logical and based on learner needs, with some direction from the teacher, and
9. opportunities for students to demonstrate their intuitive abilities.

Cognitive theory concentrates on the manner in which the learner experiences, processes, and interprets the structure of learning. Calfee (1976) believed that an understanding of cognitive structure provides a set of tools for analyzing the mind of the student, the mind of the teacher, and the mind of the administrator.

Greeno (1976) suggested that better and more precise descriptions of student assessment are possible through observations of students within an activity framework. Awareness of cognitive strategies while students are involved in meaningful tasks, can lead to more effective procedures for testing of students with typical and special abilities.

In summary, an awareness of the elements of cognitive theory can assist the educator by focusing on the learning processes of the student. An awareness that there are various "road maps" for learners will allow the educator to design more appropriate instruction which includes various learning opportunities within each lesson.
This study qualitatively analyzed the use and importance of cognitive theory for the design of a lesson. Elements of cognitive theory examined by this study included the following:

- Importance of branching and linking of the lesson to develop user schemata
- Individualized lessons that let the user determine the rate and route of learning
- Instruction that is motivating, informative, and interesting
- Logical sequence of lessons
- Opportunities for the user to implement and demonstrate intuitive abilities
- Cognitive mapping to assist the student in understanding how a given specific body of content relates to the overall lesson
- User control and navigational options to direct the lesson as appropriate and to assist the user in reaching a desired section of the program without difficulty

Incorporating these cognitive components into a hypermedia computer-based lesson provided the learners with multiple learning paths appropriate for their abilities, needs, or interests.

**Schema**

In this section schema structure is identified and discussed. Schema theory has been studied and described by many (Gallini, 1989; Anderson, 1975; Phye and Andre, 1986; and Bourne, et. al., 1986). Schallert's (1982) schema themes of organization, meaningfulness, and context effects are described, as are Howard's (1987) kinds of schema: scenes, events, actions, persons, and stories.

Schema theory is basically a theory about knowledge. It is a theory about how knowledge is represented and how that representation facilitates the use of knowledge in particular ways. According to schema theory, all knowledge is packaged into units. These units are the schemata. Embedded in these packets of knowledge is, in addition
to the knowledge itself, information about how this knowledge is to be used (Rumelhart, 1980).

Kintsch (1978) described one of the chief functions of a schema as providing an answer to an unknown question. The schema functions as a set of learner expectations which facilitate a convenient starting point for organizing unknown or new material. The schema provides hypotheses about incoming stimuli, which include plans for interpreting and gathering schema-related information.

Bartlett (1932) has been credited as introducing schema as a basic idea that accounted for the changes in memory over time. Bartlett said experience was mediated by the effects of organization derived from the experience, which acted to organize further experiences. Bartlett also said that cognitive structures (schema) are cumulative, holistic, assimilative blends of information. Bartlett believed that recall was more than mere passive reproduction of stored memories since the memories no longer existed in their original form.

Dresher (1991) focused on schema by stating it was a mechanism in general learning and concept building intended to replicate key aspects of cognitive development during infancy. Rumelhart and Ortony (1977) described schema as an organized body of knowledge, a mental structure that represented some part of one's experience. Like a concept, a schema is a representation abstracted from experience, which is used to understand the world and deal with it.

Miller (1965) introduced the concept of chunking, which represented a process dependent on the human propensity to impose organization upon input. Rumelhart (1980) continued to describe a schema as a data structure for representing the generic concepts stored in memory. Rumelhart said that there were schemata representing our knowledge about all concepts: those underlying objects, situations, events,
sequences of events, actions, and sequences of actions. A schema also contains the network of interrelations that are believed to hold the components of the concept in question.

Kintsch (1978) felt a schema was a representation of a situation or an event, and, as such, was a prototype or a norm, specifying the usual sequence of events to be expected. A part of a schema can re-integrate the whole schema. Once the schema is activated, its components are available and need not be specified separately.

Phye and Andre (1986) asserted that usage of a cognitive approach suggested the goals of the educator were to make changes in a learner's cognitive structures or schema. Anderson (1977) and Rumelhart (1980) identified schema as an information based structure that determines how a learner will view, approach, and interpret instructional content. Anderson, Pichert, and Shirley (1983) believed the schema generated by instruction had a great deal to do with what new information the student entered into an internal coding system.

Schallert (1982) identified three themes reflected in the schema theories of knowledge. The first, organization, pertained to the manner in which the learned material was stored and available for recall. The chunking ideas expressed by Miller (1965) and Kintsch (1978) were utilized in this theme.

The second theme identified by Schallert was meaningfulness. Schallert said that material that was understood was much more likely to be remembered than material that was not understood. Schallert suggested that the work of Ausubel (1961) was an inherent part of the theme of meaningfulness, in that Ausubel believed that acquiring new meanings was the product of two factors: (a) the learner adopting a meaningful learning set and an intention to relate new information to existing
cognitive structures, and (b) the material to be learned must be potentially meaningful, that is, relatable to the learner's own cognitive structures.

The third theme was called context effects. Context influences how much is remembered as well as specifically what is remembered. Thus, context affects the kind, as well as the amount, of information recalled.

Howard (1987) called schemata mental representations of a set of categories. Howard suggested that the schemata were elicited in a top-down or bottom-up fashion; however, the basic problem people had in life was selecting the right schema to cover a certain situation. Schemata are used in perception, comprehension, memory, and learning, and accordingly are very important in education. Failure to comprehend may result from not knowing which schema to apply, or from selecting the wrong one or one different from that intended. Howard cautioned that using a schema can have drawbacks. Considerable useful data may be filtered out, to keep the schema manageable. He suggested that an inadequate schema is not easily given up, and the wrong schema may be used in a given situation.

Howard identified five important kinds of schemata: scenes, events, actions, persons, and stories. Scene schemata pertained to the arrangement of objects in space. They encapsulate knowledge and expectations that objects should be arranged in certain ways. The schemata for landscape contains elements that are arranged certain ways to incorporate mountains, lakes, rivers, and the sky. Mandler (1984) believed the scene schemata organization was hierarchical in that smaller schemata were embedded within larger ones.

Howard's events schemata pertain to abstract knowledge about sequences of events. An example would be eating at a restaurant. Some general slots or components of events schemata in the restaurant would include being seated, having
one's order taken, eating the food, paying the bill, and leaving. This series of slots or events of this particular schemata is called the script. Mandler (1984) in discussing event schemata, suggested the items are connected horizontally (serially) as well as vertically (to the whole of which they are a part), and hence become a tightly interconnected organization. For example, a face will almost surely have a pair of eyes, and a child's birthday party will typically have a birthday cake. The cake may well be related to a particular color, shape, taste, or a unique emotional feeling associated with eating a cake at a special occasion. Thus, in an events schemata Mandler would suggest there are serial connections among the items in a given unit, as well as links between them and the larger unit of which they are a part.

Actions are similar to an events schemata, except they involve physical action as an essential part of the recalled task. Bartlett (1932) suggested that there are schemata for routine things such as playing tennis. Another example of an actions schemata is shooting a basketball through a hoop. This schemata consists of slots such as grasping the ball, steadying it to the toss by tensing muscles, judging the distance and force needed for that shot, and then actually throwing the ball.

Howard identified persons schemata as ones used to help understand and predict the behavior of others. General person schemata are developed with slots for motivations, interests, and personality traits.

The last type of schemata Howard enumerated was that of stories. All cultures have stories, and schemata are very important in remembering them. For example, there is a story schema for understanding murder mysteries. It has slots for the killer, the victim, the motive, the detective, and the suspects. To understand a detective story this schema is represented with additional details.
Rumelhart (1980) believed a schema is like a sorting device which places some objects in one category and the rest in another. Rumelhart also suggested that a schema is like a play, in that the slots of the schema can be filled with many different stimuli, just as roles in a play can be filled by many different people. Rumelhart commented that a schema is also like a filter because it allows some, but not all, information in. The mass of data coming through one's senses needs to be filtered, analyzed, and interpreted, which, in turn, assists perception.

Rumelhart believed that to understand something is to select a schema that provides a plausible account of it, and thus assimilate it to something already known and understood. Schemata are very important in memory and learning because they are used to reconstruct the original interpretation of an event from fragments in memory. Having a well-developed schemata for a domain allows one to take in and recall much more information.

Hastie (1981) identified three types of schemata: central tendency, template, and procedural. Central tendency schemata refer to that which is a member of a stimulus set that is located at the statistical center of the distribution of items in the set. An example of a central tendency schema is one used to anticipate the length of a hot dog or the size of an apple. The size expectation would be based on one's central tendency schema, which is essentially the statistical center of a distribution depicting one's experiences with hot dogs or apples.

Hastie described a template schema as a filing system for classifying, retaining, and coordinating incoming sensory data. Template schemata have some elementary types of processing capacities that can add default information to a schematic structure when the anticipated information is not supplied. In the template schematic structure input can be modified within acceptable constraints better to fit an
existing framework, and tests can be used on subsets of information to verify inferences about its proper classification.

The third type of schemata identified by Hastie is procedural schemata, which can be characterized as the active organization of past actions or experiences. This parallels ideas of Bartlett (1932). Procedural schemata can be identified as not only the pattern of action, but also the pattern for action, as well. In referring to schema, Bartlett (1932) summarized:

Schema refers to an active organization of past reactions, or of past experiences, which must always be supposed to be operating in any well adapted organic response. That is, whenever there is any order or regularity of behavior, a particular response is possible only because it is related to other similar responses which have been serially organized, yet which operate, not simply as individual members coming one after the other, but as a unitary mass. (p. 201)

Bartlett also said, “Remembering is...an imaginative reconstruction, or construction, built out of the relation of our attitude towards a whole active mass of organized past reactions or experience...” (p. 213).

In summary, schemata are cognitive structures used as mechanisms for general learning and concept building. Schemata are representations generated from experiences and applied to a new set of circumstances. The awareness of schema and its cognitive impact on learning helps the instructional designer to identify and incorporate important characteristics into a computer-based lesson. The designer should be aware of schema structures that allow the learner to build networks or links between and among lesson components.

In the computer-based lesson for this study, users applied their internal schemata as information based structures to assist in learning the interrelationships of the Threat Matrix (TM). The schema for facts contained in this computer-based lesson is comprised of a set of attributes, which merge and give the learner a composite understanding of the lesson being studied.
Advance Organizers

This section examines the cognitive structure of advance organizers in the context presented by Ausubel (1968). Two overviews of advance organizer studies which reached different conclusions are presented. One is by Barnes and Clawson (1975) and provided an analysis of thirty-two studies examining advance organizers. The second summary was by Mayer (1979 b), who surveyed twenty years of advance organizers research. A concluding section by Mayer (1989) included a list of characteristics and a check list for advance organizers to assist in their implementation.

Ausubel (1968) related the advance organizer to ideational scaffolding for the incorporation and retention of the learning materials. He suggested that advance organizers explicitly draw upon and mobilize relevant anchoring concepts that are already a part of the learner's cognitive structure. Thus, the new material was not only rendered in a more familiar and more meaningful way, but in a manner most relevant for the learner. Ausubel (1968) in discussing the function of organizers suggested, "The principal function of the organizer is to bridge the gap between what the learner already knows and what he needs to know before he can successfully learn the task at hand" (p. 148).

Ausubel asserted that advanced organizers facilitate the incorporability and longevity of meaningfully learned material. They draw upon and mobilize relevant anchoring concepts within the learner's cognitive structure and render unnecessary much of the rote memorization to which students often resort to learn the details of an unfamiliar discipline. Ausubel stated that the advantage of deliberately constructing special organizers is that the learner can achieve a general overview of the more unfamiliar material in advance of its presentation, and also that the organizing
elements presented provide the learner with a structural method of understanding the organizing elements in the material to be learned. Ausubel commented, "Organizers also undoubtedly facilitate the learning of factual material more than they do the learning of abstract material, since abstractions, in a sense, contain their own built-in organizers—both for themselves and related detailed items" (p. 149).

Barnes and Clawson (1975) reported on an analysis of thirty-two studies that were based on the use of advance organizers to determine if they facilitated learning. Barnes and Clawson concluded the efficacy of advance organizers had not been established. Of the thirty-two studies reviewed twelve reported that advance organizers facilitated learning, and twenty reported that they did not. Since no clear pattern emerged regarding the facilitative effects of advance organizers, Barnes and Clawson concluded that they did not facilitate learning.

On the other hand, Groller, Kender, and Honeyman (1991) conducted a study to determine if instruction on metacognitive strategies helped high school students use advance organizers. The authors questioned why the use of advance organizers, which made considerable sense conceptually, had failed. The results of the study affirmed that students needed to be taught how to use, monitor, and evaluate their application of advance organizers in order to utilize them to their best advantage. Groller, Kender, and Honeyman suggested that use of an advance organizer in conjunction with metacognitive strategies could be a good tool for secondary school teachers. The combined strategy clearly had a facilitative effect on learning content area material. It was observed that students tended to use the advance organizers in metacognitive strategies more effectively with practice, so Groller, Kender, and Honeyman concluded that teachers needed to repeat metacognitive strategy training and encourage use of advance organizers to give students the optimum benefit from this procedure.
Glover, Bullock, and Dietzer (1990) studied the effect of inserting a time delay between the presentation of the advance organizer and the reading of the text. Glover, Bullock, and Dietzer found the group that experienced the delay achieved significantly greater levels of recall than those subjects who read an organizer and then moved immediately to the text. The findings fit with a growing body of literature that suggested various encoding manipulations were most effective if a delay was imposed between successive encounters with to-be-learned materials.

Mayer (1979 b) surveyed twenty years of research on advance organizers and found a mass of data and many conflicting claims. Mayer used an analysis of the specific qualifications and predictions of an assimilation theory that he referred to as, "The idea that learning involves relating new, potentially meaningful material to an assimilative context of existing knowledge" (p. 134). Mayer found that the use of advance organizers can result in more effective learning when the material is conceptual, but is unfamiliar to the learner. Mayer concluded, "Twenty years of research on advance organizers has clearly shown that advance organizers can affect learning, and the conditions under which organizers are most likely to affect learning can be specified" (p. 161).

Snapp and Glover (1990) conducted studies with middle school and college students to determine how the careful reading of advance organizers affected the answers that students constructed for study questions. The results were consistent with findings of previous studies that reported the beneficial effects of advance organizers on readers' comprehension of text material. The results showed that advance organizers had a distinctly facilitative effect on the quality of answers that students constructed for study questions. Snapp and Glover observed that the increased reading efficiency of those who had encountered advance organizers
apparently benefited from the question answering process. As reading becomes more efficient, students should have more resources available to help them answer questions, thus improving the quality of their responses. In their concluding remarks, Snapp and Glover stated, “If a reasonable academic goal is to improve the quality of answers that students construct for study questions, we recommend that one method of aiding students is through the use of advance organizers” (p. 270).

Williams and Butterfield (1992) pointed out that since the concept of advance organizers was originally introduced, there has been a steady stream of research to test the efficacy of advance organizers in a variety of situations, and also to test the theoretical underpinnings that might explain their effects. Williams and Butterfield asserted that nearly thirty years of inquiry have reasonably well demonstrated that advance organizers increased the comprehension of those learners for whom textual material was unfamiliar or exceptionally difficult. The advance organizers partially compensated for the learner's lack of relevant prior knowledge. Advance organizers have been shown to be effective for both low-ability and high-ability learners and for children as well as adults.

Advance organizers indicate how previously learned ideas in cognitive structure are basically similar or different from the new information in the learning task. This is possible if the presentation of more detailed or specific information is preceded by a more general principle to which this information can be related. Williams and Butterfield concluded that advance organizers constituted a new appropriate, cognitive structure which could be provided to the reader in advance of new learning materials for which it was assumed the reader would not have the appropriate prior knowledge.
Mayer (1979 a) said that advance organizers seemed to have their strongest positive effects on measures of transfer and that organizers were relative to the particular learner and subject matter. A passage that served as an advance organizer for one learner might not be needed for another learner. Mayer pointed out that an advance organizer generally is characterized as follows (p. 382):

1. has short set of verbal or visual information,
2. is presented prior to learning a larger body of to-be-learned information,
3. contains no specific content from the to-be-learned information,
4. provides a means of generating logical relationships among the elements in to-be-learned information, and
5. influences the learner's encoding process.

Mayer (1979 a) identified a four point check list to consider when using an organizer. First, the educator must ensure that the organizer allows the learner to see the important relationships between concepts and the new material. Second, the instructor must ensure the organizer bridges between the familiar and unfamiliar. Third, the instructor must make certain the organizer is easy to learn and use. Fourth, the instructor should use an organizer only when learners would not normally use their own framework.

In summary, this section has examined the cognitive structure of advance organizers and identified the advantages they provide to learners. Ideas of Ausubel (1968) were presented and described, several studies were discussed that described the pros and cons of the advance organizer, and an organizer's check list and a list of characteristics by Mayer (1989) was presented.

The advance organizers used in this computer-based lesson designed for this study can be found in the design of the screens themselves. Every lesson screen that depicts a warship, weapons system, or sensor has a cognitive map located in its upper
left corner that functions as an advance organizer. That is, it identifies a hierarchical method of how the lesson on the computer screen relates to the other lessons in that chapter, as well as the entire data base upon which the TM lesson was built. An inherent component in most of the screen images was to prepare the user for the information it contains, before the user actually interacts with it.

**Mnemonics**

This section places the cognitive structure of mnemonics within a historical perspective going back to the period of the ancient Greeks. The thoughts of Cermak (1975), Paivio (1971), and Bellezza (1987) are discussed. The mnemonic system of the link, loci, peg, and phonetics as described by Highbee (1977) is presented and interpreted.

The word mnemonics is derived from the word Mnemosyne, the Greek goddess of memory. Yates (1966) pointed out that the Greeks, who invented many art forms, also are credited with an art of memory, which like their other arts, was passed on to Rome. This art seeks to memorize, through a technique of impressing places and images on memory. It was classed as mnemotechnics, which in modern times seems an unimportant activity; however, in the days before printing a trained memory was vitally important.

Bellezza (1987) reminded us that even if one were literate, during this period of ancient history there was no paper for taking notes on lectures, speeches, sermons, or other events. Before the invention of the moveable type printing press, books were rare and highly valued. Some books were so esteemed that scholars memorized their contents. This was especially true of religious books.

Brown (1977) admitted the word mnemonics seemed a particularly inappropriate word to describe memory systems, as the word itself is difficult to
remember. Brown said an easy way to remember it is to knock off the "m", leaving "nemonics", and then add an "m" at the beginning for memory. Brown said one of the first records of the Greek system of memory involved Simonides, a Greek poet who was living during the period of 500 BC. Simonides was invited to a large banquet hall to provide entertainment after the meal. After his recitation Simonides left the banquet hall. He had been gone a short time when the roof of the banquet hall collapsed, crushing the occupants beyond recognition. Simonides was able later to identify the corpses by remembering where each person sat. He had linked the location of the people with their seating positions (Brown, 1977; Higbee, 1977).

A good memory was used by orators to enable them to recall epic stories. Such systems were developed through the Middle Ages and used by Aristotle, Cicero, and St. Thomas Aquinas. Today they are recognized as a highly effective way of memorizing and are used for remembering anything from telephone numbers to the cards played in a game of bridge.

Mnemonics seek to impose order on material a person may want to remember rather than seeking order within the material itself. Mnemonics use schema or plans of organization that have been devised and practiced even before the specific material to be memorized is ever seen. A mnemonic is analogous to a pegboard tool organizer in a workshop. Anything can be placed on this pegboard to help organize tools (Cermak, 1975).

Cermak contended there were basically two types of mnemonics, receptacle and double transposition. Receptacle mnemonics are the type that have slots to be filled, similar to the pegboard example. Cermak suggested a strategy using receptacle mnemonics for memorizing a list of words. Suppose one wanted to remember the following items: elephant, tree, river, automobile, kangaroo, and church. The house
method could be used in this case, in which one visualizes a room in a house for each of the items. Once appropriate matchings have occurred, one only needs to walk mentally through the house to recall the items in the list. Cermak suggested making the image as bizarre as possible, so it will be easier to remember. One enters the house via the foyer, so imagine a large elephant standing there. The next room entered, the living room, is associated with the item “tree,” and a large tree growing in the living room is visualized. The next room, the bathroom, is linked with water and thus the term “river” is visualized in this room. Cermak encouraged an automobile on a bed for the bedroom, a kangaroo with an apron cooking in the kitchen, and finally an entire church placed within the dining room. As ridiculous as these examples sound, their bizarre quality does encourage recall, and thus, by mentally going through one’s house and recalling the associative word, the required list of items is remembered. Cermak called this technique receptacle mnemonics because one is using a filled receptacle (room in the house) to aid in recall of a specific item.

Cermak also identified the double transposition mnemonic, which uses letters of key words to form a word filled with imagery, thus causing the list of items to be recalled. For example, suppose one needed to go the grocery story and buy peas, lettuce, soda, corn, bread, and napkins. Cermak devised a double transposition using the phrase PALS CABIN to recall the grocery list. The capital letters shown relate to the grocery items: Pa (peas), L (lettuce), S (soda), Ca (corn), Bi (bread), and N (napkins), thus remembering the components in the phrase PaLS CaBiN, could regenerate the list of grocery items.

Cermak believed both the receptacle and double transposition techniques could be used effectively to aid in the retention of everyday information. The receptacle method was thought best to use for lists of information or anything that involved a
series of instructions or steps to be performed in a particular order. The double transposition method was best for recalling pairs of items, such as what goes with what, who belongs where, or where one should be at a given time.

Brown (1977) discussed receptacle mnemonics in a similar way. This linking of facts or names with a familiar object or place, forms the basis of mnemonics. In this way any list of objects can be remembered by linking each object with a specific part of a house and its furniture. To recall the objects one imagines walking through the house, seeing the objects, and then recalling the features to which they are linked.

Paivio (1971) noted three critical assumptions underlying the use of mnemonic systems. (1) Concrete objects are easier to remember than words. (2) Concrete objects are particularly effective as retrieval cues for the associated material. (3) Visual images of concrete objects can serve as effective mediators for verbal material.

Bellezza (1987) identified two main types of mnemonics: organizational and encoding. Organizational mnemonics organize and interrelate new information in memory so that it can be later recalled. Examples of organizational mnemonics are the method of loci, the pegword mnemonic, the story mnemonic, and the link mnemonic. Encoding mnemonics transform low-imagery, abstract material into more memorable form. An abstract word such as “fiscal” could be replaced by some semantic association such as “money” or, instead, by words that are similar in pronunciation such as “fish tail.” The words “money” and “fish tail” are easier to process in memory because these words are familiar and high in imagery. Later when the substitute word “money” or “fish tail” is remembered, it acts as a cue for the related word, “fiscal,” and this latter word is recognized as the word that was to be memorized (Bellezza, Day, and Reddy, 1983).
Higbee (1977) described the link, loci, peg, and phonetic mnemonic systems. The link system could also be called a chain system. To use this system one forms a visual image for each item on the list to be learned. Second, the image for each item is associated with the image for the next item. In this way a visual association is formed between the first two items, then between the second and third, then between the third and fourth items, and so on. The items are linked together to form a chain of associations.

An example of the link system is demonstrated with the words: paper, tire, doctor, rose, and ball. One might remember the first link, paper, by recalling the delivery of a local newspaper. Next, paper was linked to tire because the individual remembering had seen an ad for a tire sale in the paper. The next link, doctor, was linked to paper because the individual had read about a recent medical discovery in the evening paper. The fourth word, rose, was linked to paper by recalling a popular song from the 1970's called "Paper Roses." Last, the word ball was remembered by the individual's fondness for planting roses, and in fact he thought "it was a ball" to grow them. The visual association of the links between the words could vary greatly, and there is no correct way to describe the links used. The images could be bizarre or more plausible, but should be vivid and have some interaction. Generally, one uses the first association that comes to mind, as it is the most likely to be remembered when recalling the items. This linking procedure is the same for the entire list of items. The story system is very similar to the link system; it creates a story and weaves or links it through each of the points that needs to be remembered.

The loci system dates back to 500 B.C. and was the principal mnemonic system in use until about the middle of the Seventeenth Century, when other systems such as the peg and phonetic were introduced. The loci system was based on the word loci, the
plural of locus, which means place or location. This system was used by Greek and Roman orators to remember long speeches without using notes. The orators visualized objects that represented the topics to be covered in their speeches, and then mentally placed the objects in different locations, usually in parts of a building. They moved through this building mentally while delivering the speech, retrieving the object images from the location as they came to them. Higbee (1977) suggested this method may be the origin of the expression, “in the first place,” as the phrase implies the starting point on a building tour that would serve as the loci mnemonic for points to be remembered. Some suggested an advantage of the loci system over the link system was that the loci system was not focused on pairs of items to be recalled, so in the loci system one could skip over a forgotten symbol and go on to the next item. The link system worked in a domino fashion, in that one triggered the next, and the next, until the entire list had been recalled. To forget a link might cause the domino effect to malfunction.

The peg system was based on the fact that a person hangs words onto pegs to help remember them. The pegs are named for concrete nouns and are in a specific number sequence such as: one-bun, two-shoe, three-tree, four-door, five-hive, six-sticks, seven-heaven, eight-gate, nine-wine, ten-hen. This system often used rhymes to assist with recall. The classic children’s poem to remember the numbers one through ten is based on this system. “One, two buckle my shoe: three, four shut the door: five, six pick up sticks: seven, eight lay them straight: nine, ten a big fat hen.” In this little rhyme the numbered pegs were grouped in pairs. An advantage of the peg system over the others was that it enabled direct retrieval. That is, if one wanted to remember the eighth item, it was not necessary to proceed sequentially until one reached the eighth location or peg.
The phonetic system as described by Higbee (1977) was the most sophisticated and the most versatile. It was also the most complex and difficult to learn. This system assigned consonant sounds for each of the digits 0-9, and then also assigned key words to go with each number, creating a mental filing system.

The cognitive structure of mnemonics has been a learning tool for centuries. This section described the manner in which mnemonics was first used by the ancient Greeks and how it has been modified for continued usage today. Examples of mnemonics were given, and structural considerations of Cermak (1975), Paivio (1971), and Bellezza (1987) were presented. A detailed mnemonic approach, which enumerated characteristics of the link, loci, peg, and phonetic systems of mnemonics, was described by Higbee (1977).

A mnemonic is a highly personalized learning structure that is created in the mind of the learner. The instructional designer cannot impose a mnemonic structure on the learner. However, the material to be learned can be organized in a way that lends itself to mnemonic techniques more easily. Within this study, the awareness of mnemonics was inherently a part of the instructional design process. The researcher incorporated elements into this computer-based lesson that could be recalled using mnemonic structures if the learner chose to use them.

Hypertext/Hypermedia

The terms hypertext and hypermedia both refer to multi-branching, non-linear methods of moving through a computer-based lesson. Hypertext is printed text viewed on a computer screen that is linked to some other element in the computer-based lesson. Hypermedia works in the same manner, except that it involves not only text, but also graphics, video, and sound components.
Portions of textual material or graphics on the computer screens are linked to other screens within the program by a series of nodes and links. A node is one of the basic information units such as words, graphics, or a video that comprise the basis of the information. A link is the connector between two nodes that enable the user to move from one point in the computer lesson to another in a non-linear manner.

An advantage of the hypertext/hypermedia capability is that the computer-based system which uses it becomes responsive to the needs and goals of the learner. Since it is not linear in its design, the learner selects the sequence of the computer lesson as it is being used.

Wilson and Jonassen (1989) pointed out that much of what we know about hypertext/hypermedia has its origins in the learner control literature. Wilson and Jonassen also commented, "...it seems clear now that hypertext systems can be a valuable component within an overall framework of instruction" (p. 48). Jonassen (1988) identified some criteria by which learners may make hypertext/hypermedia selections from within a computer-based lesson:

- personal relevance
- interest level
- curiosity or fulfillment of the information
- experience level
- information needs
- task demands

Jonassen (1988) cited the immediate access to large collections of information as the major advantage of hypertext/hypermedia. Because the hypertext/hypermedia structure is based on linkage between numerous nodes of information structures, it has the ability to map the structure of the knowledge it is presenting. That is, through its use the learner gains a sense of awareness of the organizational structure of the material itself.
Hypertext and hypermedia are new emerging cognitive structures that have been shown to be valuable contributors to the learning process. The computer-based lesson created for this study made extensive use of hypertext and hypermedia nodes and links. That is, thousands of individual points of information (nodes) were interconnected (links) to provide the learner with multiple paths to explore as the TM lesson was utilized.

Summary

Constructivism is a way of thinking that allows the learner to have more control over the manipulation with and the learning of the environment. Cognitive theory embraces an awareness and understanding of the hows and whys of the learner. Schema, advance organizers, mnemonics, and hypertext/hypermedia are cognitive enhancers. That is, they focus and direct the activities of the learner in such a way that there is greater attention given to the manner in which the learner is experiencing the material.

In this study cognitive enhancers which facilitated a constructivist approach to this instructional design are conspicuous as the computer screens are viewed. The screens themselves, while having information imbedded within them, are not vendors of information unless requested to act as such by the learner. This computer-based lesson allows learners to become constructors of the learning process. The learner becomes personally responsible for the manner in which the material is explored and assimilated.

Schema is a way of building relevant links between bodies of information to facilitate greater understanding and recall. For example, as students study a line drawing of a ship, observe a video image of the same ship, and learn specific data regarding that ship, a series of schematic links is created.
Advance organizers are a variety of information organization structures that assist the learner to understand what needs to be learned before or as they are experiencing it. Within the computer-based lesson created in this study, advance organizers were found in the menu screens which identified content choices and also enumerated the entire content of the lesson. The cognitive map found in the upper left corner of most screens gave the learner a sense of where they were in the lesson and how that particular location related to the total body of knowledge.

Mnemonics are highly personalized learning tools to facilitate recall of facts. While the computer based lesson created for this study did not specifically impose a mnemonic structure on the learner, the researcher was aware of its relevance and organized the material to lend itself to the use of mnemonic devices, should the learner choose to use them.

Hypertext/hypermedia structures are the elements in this computer-based lesson that bring a high sense of relevancy and personalization to the learner. This is accomplished through learner control of the manner in which the lesson components are experienced.
CHAPTER 3: METHODOLOGY FOR THE STUDY

This chapter presents the methodology for the study. It includes an introduction, a statement of the problem, research questions, significance of the study, and discussion of the research methodology used. The research methodology portion begins with an exploration of the research strategies, including the single case study method, which was used in this study, and then continues with discussion of qualitative research methods, the role of the participant observer, and triangulation strategies. The research methodology section concludes with a discussion of the implementation of the research strategies used in this study.

Introduction

In 1988, Iowa State University began its involvement with the Surface Warfare Officers School (SWOS) Command in Newport, Rhode Island. The College of Education and the Media Resources Center at Iowa State had contracted with Oak Ridge Universities in Oak Ridge, Tennessee, to develop a plan to promote increased use of educational technology by instructors and students at SWOS. Previous SWOS-ISU projects completed prior to the implementation of this study included the development, design, and installation of a state-of-the-art media presentation classroom and instructional materials center. Additionally, ISU provided inservice for SWOS staff members to increase their awareness of instructional technology techniques and strategies, and to explore ways of implementing them within existing SWOS curricula.

The computer-based lesson designed for this project was created to teach relevant facts of the Threat Matrix (TM) to Naval personnel. The TM, as described in Chapter one, is a vast collection of thousands of discrete facts about the navies of the world. It provides a structure for categorically grouping descriptive data for surface warships, submarines, fixed wing aircraft, helicopters, sensors, and weapons.
systems. Several years ago the SWOS command contracted with another developer to create a computer game that would help teach the TM facts. After repeated attempts to use it, SWOS determined that the design of the computer game was too complicated and cumbersome for Naval officers and students to use.

SWOS officers studied the TM materials during an intensive six-week period as an integral part of their schooling as a Prospective Commanding Officer and Prospective Executive Officer (PCO/PXO). Upon completion of the TM course, the Naval officers demonstrate mastery by passing a written TM examination. The study technique used by officers during the course was the manipulation of large stacks of homemade note cards that contained the TM information.

After successfully completing several instructional technology projects with Iowa State University, SWOS proposed that ISU develop for them a computer-based lesson to teach the facts contained within the TM. Several potential instructional platforms that could incorporate the flash card approach that the students had used previously were considered. The resulting design was a hypermedia lesson. Hypermedia was designed so that students or instructors could use it differently to meet individual needs. It maintained the appearance of electronic flash cards with line drawings and factual data as well as incorporating video stills and motion sequences from an interactive video disc created especially for the lesson.

This computer-based lesson was designed around the metaphor of a textbook. This lesson, like a textbook, had a cover, a preface, and contents divided into sections and chapters. Each chapter was divided into a series of lessons and was illustrated. Like a textbook, the lesson contained an index of its content and also utilized self-test quizzes to provide users an assessment of their level of understanding. The quizzes addressed three areas: line drawings, factual data, and visual images. The MS-DOS
based computer lesson was created using *Linkway*, an authoring system marketed by IBM.

The lesson was created for the learner to link line drawings, specific data contained in hypertext, and images from a video disc with their mental images of the TM components. The lessons were designed as pages of a chapter in a book. For this prototype three chapters were created. The chapter on surface warships contained the following lessons:

- Carriers V/STOL
- Carriers CV
- Guided missile cruisers (nuclear)
- Guided missile cruisers (regular)
- Guided missile destroyers
- Destroyers
- Frigates
- Light frigates
- Guided missile patrol boats
- Amphibious warfare ships
- Fleet replenishment
- Intelligence collectors

The chapter on sensors contained the following lessons:

- Long range air search
- Missile tracking and control
- Data link
- Gun fire control
- Sonar

The chapter on weapons systems contained lessons on:

- Surface to surface missiles
- Surface to air missiles
- Air to surface missiles
- Guns
- Antisubmarine missiles
- Antisubmarine rockets
- Antisubmarine torpedoes
- Antisubmarine mines

Each of the chapter lessons contained pages (computer screens) providing specific examples of warships, sensors, and weapons systems.

Lesson pages contained line drawings of the example being studied, pop-up hypertext buttons that displayed factual data, and video icons that linked each example.
to a specific still or motion sequence from the video disc. The lesson pages also contained a cognitive map and numerous navigation aides. The cognitive map illustrated how the lesson examples being displayed related to the entire contents of this computer-based lesson. The navigation aides allowed the user to return to a variety of locations within the lesson. One navigational choice directed the user to one of three self-test quizzes that assessed line drawing identification, factual recall, and video recognition.

The lesson was created to allow linkage and connections to facilitate learning. The lesson was easy to use and developed within a program shell to allow for modifications by SWOS personnel.

This qualitative study focused on key decisions that were made during the formulation and implementation of an instructional design process. This instructional design process resulted in the creation, development, and installation of The Threat Matrix: A Computer-Based Lesson (TMCBL) at SWOS.

Statement of the Problem

The problem addressed by this study was to describe the manner in which key decisions were made during the instructional design process for this computer-based lesson. The instructional designer determines and implements design factors such as screen design, use of color, text readability, and logical flow of lesson. This study identified not only the key instructional design elements, but described the manner in which their importance was verified through the qualitative analysis technique of triangulation.
Research Questions

Two major research questions are addressed in this study. First, was it possible to identify what features made the lesson effective and verify these features as key decisions made during an instructional design process? A second research question was related to the list of key decisions made in this lesson. Was it possible to group the instructional design elements to create a list of key decisions for any instructional design for a hypermedia, computer-based lesson?

Significance of the Study

Prototypic instructional designs may be difficult to evaluate since they usually exist in small numbers. This prototype was installed on a single work station, so access by large numbers of learners was not possible. Also, literature that describes the qualitative analysis of the instructional design process is meager. Limited research is available to guide and assist an instructional designer through this developmental, evaluative phase of the design process. Often designs are modeled after other successful implementations. The significance of this study will be its potential to generalize the key design experiences gained through this computer-based lesson to other instructional design efforts.

Research Methodology Used

This section identifies research strategies and describes their implementation. The research strategies are discussed within the context of relevant professional literature. The section on implementation explains the process by which instructional design components were identified and verified as key decisions. The last part of this section describes how the key decisions were grouped to suggest their use within the instructional design process.
Research Strategies

This section examines the single case study method. Several definitions of the case study are given and the rationale for its use is described. Qualitative analysis techniques and reasons for their inclusion are also presented. The use of triangulation as a qualitative technique is examined. The role of the participant observer is discussed. The section concludes with a summary of the research strategies used in this study.

Single Case Study Method

Yin (1989) described the case study as an empirical inquiry that "...investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (p. 23).

Bromley (1986) suggested that the case study is an account of a person in a situation. Bromley said the account can take many different forms, such as a detailed technical report containing scientific and professional concepts and data, a judicial or quasi-judicial report, a computerized catalog of information, or a documentary film. A case study usually deals with a relatively short self-contained episode in a person's life, and can be regarded as a close view of one important life event. Bromley applied the term "case-study" to any singular case, example, or incident, the description and analysis of which is thought to contribute to our understanding of an area of inquiry.

Orem, Feagin, and Sjöberg (1991) provided a straightforward definition: "A case study is an in-depth, multifaceted investigation, using qualitative research methods, of a single social phenomenon. The study was conducted in great detail and often relied on the use of several data sources" (p. 2). Some cases make use of both qualitative and quantitative methods.
Merriam (1988) stated that case studies are not new, and they have been part of the disciplines of medicine and law for many years. They have also been important in the development of other fields such as anthropology, psychology, sociology, management, social work, and political science. Merriam pointed out that recently case study research has been more widely used in education and identified federally funded government studies of the 1960's and 1970's that investigated math, school integration, and innovative science curricula. Merriam said investigators used a case study design in order to gain an in-depth understanding of the situation and its meaning for those involved. Merriam added, "The interest is in process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation" (p. xii). Merriam also reported that case study research, and in particular the qualitative case study, is an ideal design for understanding and interpreting observations of educational phenomena. Merriam asserted that because of its strengths, case study is an appealing design for education innovations, as the processes, problems, and programs can be examined to bring about understanding that can affect and, perhaps, improve practice.

Qualitative Methods

A small sample size in the evaluation of an experimental design creates problems when attempting to analyze data quantitatively. Miles and Huberman (1990) produced an extensive reference that guided the researcher through the elements of the qualitative process. Miles and Huberman reminded researchers that qualitative data in the form of words rather than numbers have long been a staple in areas of social science, notably anthropology, history, and political science. In the last decade more and more researchers in fields that typically had a quantitative emphasis
(psychology, sociology, educational research, program evaluation) have shifted to the paradigm of qualitative analysis.

Miles and Huberman cautioned about the importance of a systematic method for drawing conclusions and testing them carefully. Miles and Huberman asserted that if data were collected in accordance with procedures they recommended, the study could be replicated by other researchers. They encouraged the sharing of more qualitative research and encouraged researchers to describe concretely and specifically how they went about their work and what they learned. Miles and Huberman suggested that researchers should be as vivid and rich in describing their own work as they are in describing the inner and outer lives of the people being studied.

Marshall and Rossman (1989) identified some of the criteria of soundness to be considered when defending the value and logic of qualitative research. Marshall and Rossman asked these questions of the researcher:

1. How truthful are the particular findings of the study? By what criteria can we judge them?
2. How applicable are these findings to another setting or group of people?
3. How can we be reasonably sure that the findings would be replicated if the study were conducted with the same participants in the same context?
4. How can we be sure that the findings are reflective of the subjects and the inquiry itself rather than the product of the researcher's biases or prejudices?

Strauss and Corbin (1990) explained that qualitative research can give the intricate details of a phenomena that are difficult to convey with quantitative methods. Strauss and Corbin suggested there were three major components of qualitative research. First were the data, which come from various sources such as interviews and observations. The second component is analytic or interpretative procedures used to arrive at findings. These include techniques for conceptualizing or coding the data.
and may also include non-statistical sampling, writing of memos, and diagramming of conceptual relationships. The third component of qualitative research is written and verbal reports which summarize the findings.

Patton (1990) quoted Halcom’s Evaluation Laws when stating, “Qualitative inquiry cultivates the most useful of all human capacities -- the capacity to learn from others.” Halcom went on to equate the qualitative researcher to a participant observer when he said, “Statisticians try to measure it. Experimentalists try to control it. Evaluators value it. Interviewers ask questions about it. Observers watch it. Participant observers do it” (p. 7).

Triangulation

Triangulation was used as a term to confirm navigational findings long before it became associated with qualitative analysis. It is a way to use multiple sources to verify the accuracy of findings. Saxe’s (1887) Hindu fable about six blind men encountering an elephant demonstrates the need for triangulation, as each of them identified the object based only on his own observations (Appendix A). Saxe ends these observations by saying, “And so these men of Indostan disputed loud and long, each his own opinion exceedingly stiff and strong. Though each was partly in the right, and all were in the wrong” (p. 112).

Denzin (1989), when referring to triangulation, said the usage of multiple measures and methods to overcome inherent weaknesses of single measurements has a long history in the physical sciences. The concept of triangulation can be traced to the Greeks and the origins of modern mathematics.

Triangulation is the technique of seeking evidence of some occurrence from two or more sources as a means of confirming findings. Benoit (1988) identified four kinds of triangulation: data, investigator, theoretical, and methodological. Data
triangulation involves the use of multiple sources of data, while investigator triangulation utilizes multiple investigators. Theoretical triangulation uses multiple theoretical perspectives for the analysis of the same set of data. Researchers explicitly search for as many different data sources that bear upon the events under analysis as possible.

Methodological triangulation utilizes multiple methods directed towards an understanding of the same phenomena. This type of triangulation is divided into the within-method and the between-method. The within-method takes one of the research elements, the survey, and employs multiple strategies within that element to examine data. The between-method, or the across-method as it is also called, uses two or more different research strategies in the study of a given design element. Thus, if a basic design element of participant observation was used, researchers would employ survey interviews with field experiments, unobtrusive methods, and films or videos to triangulate further the purported findings. Benoit felt that the between-method type of methodological triangulation can accrue a more substantial advantage.

Jick (1979) believed that triangulation provided researchers with several important opportunities. It allows the researcher to be more confident of the results, and it can stimulate the creation of inventive methods of capturing a problem to balance with conventional data collection methods. Jick said that triangulation demands creativity from its user, ingenuity in collecting data, and insightful interpretation of the data. Phillips (1971) affirmed why triangulation is important: “We simply cannot afford to continue to engage in the same kinds of sterile, unproductive, unimaginative investigations which have long characterized most...research” (p. 175).
Denzin (1977) asserted that "...triangulation as a technique forces the observer to combine multiple data sources, research methods, and theoretical schemes in the inspection and analysis of behavioral schemes. It forces the observer to situationally check the validity of his causal propositions and to temporarily specify the character of his hypothesis" (p. 177).

Mathison (1988) felt that it was a good research practice to triangulate, and to use multiple methods, data sources, or researchers to enhance the validity of research findings. Baker, Grubbs, and Ahern (1990) identified the term of convergence as that which occurs when triangulated findings from different sources gathered in different ways indicate the same or similar meaning of the construct being studied.

Miles and Huberman (1984) said that triangulation is supposed to support a finding by showing that independent measures of it agree with it, or at least do not contradict it. Miles and Huberman suggested that the incorporation of triangulation strategies in qualitative studies should become a state of mind in the researcher. If the researcher self-consciously sets out to collect and double-check findings using multiple sources and modes of evidence, the verification process will largely be built into the data-gathering process, and little more needs to be done than to report on one's procedures.

Borg and Gall (1989) identified triangulation and multi-methods as procedures that refer to the strategy of using several different kinds of data-collection instruments to explore a single issue. These instruments could include direct observation, interview, content analysis, or tests. Borg and Gall concluded by saying triangulation is simply a form of replication that contributes greatly to our confidence in the research findings, regardless of whether qualitative or quantitative methodology has been employed.
Participant Observation

Denzin (1970) said that participant observation represents a commitment on the part of the researcher to participate as intimately as possible in the experiences of those studied. The researcher learns the language and terminology and learns to understand the actions surrounding the valued social object of study. The participant observer employs multiple methods of information gathering such as collections of documents, interviews, and personal observations.

Quinn (1990) said the direct personal contact achieved by the participant observer has several advantages. First, by directly observing program and activities, the evaluator is better able to understand the context within which the program operates. Second, firsthand experience allows an evaluator to be open and discovery oriented, with an inductive approach. A third strength is that the evaluator has the opportunity to see things that may routinely escape the consciousness of participants and staff. Quinn said that getting close to a program through firsthand experience allows the evaluator to use personal knowledge and direct experiences as resources to aid in understanding and interpreting the program being studied. Reflections and introspection are important parts of the field research, and the impressions and feelings of the observer become a part of the data to be used in attempting to understand a program and its effects.

Summary of Research Strategies Used

The research methodology described in this study used the single case study method. The study utilized the research strategies of qualitative analysis, triangulation, and participant observation.

Yin (1989) presented the elements of a case study concisely by noting that case studies investigate contemporary phenomenon within a real-life context, that the
boundaries between the phenomenon and context are not clearly evident, and that multiple sources of evidence are used. The single case study method in this study focused on the instructional design process used to create a computer-based lesson. The basis for the study was the key decisions made during the process of instructional design for the lesson that was requested by SWOS. A prototypic lesson was developed to work on a single work station already in existence at SWOS. To examine the process of the instructional design the researcher focused attention on both the key decisions of the instructional design process and the context in which the lesson was used. Following the description by Yin, the researcher selected the single case study method as a viable research strategy.

Qualitative research strategies include gathering data from various sources such as: attitude surveys, classroom experience comments, and personal interviews. Since the computer-based lesson created in this study existed at SWOS, the data collected was from key SWOS personnel involved in the implementation of the computer-based lesson and the Naval students who experienced it in Threat Matrix classes. The purpose of the study was to identify key decisions used in the instructional design process. The awareness, attitudes, opinions, and perceptions of the components of the computer-based lesson were summarized. Data from a Threat Matrix course evaluation were collected from students who used the computer-based lesson for the first time. An attitude assessment instrument was developed which assessed the attitudes of Naval personnel after they had used the *Threat Matrix: A Computer-Based Lesson* (TMCBL). The attitude assessment instrument also contained an open-ended question to which Naval officers responded.

Patton (1990) identified three variations in qualitative interviewing: the informal conversation, the general interview guide approach, and the standardized
open-ended interview. This researcher basically used the standardized open-ended interview approach with some characteristics of the general interview guide approach. Questions were written in advance, as the standardized open-ended interview suggests, but the interviewer was free to establish a conversational style as in the general interview guide approach.

Marshall and Rossman (1989) have identified triangulation as the act of bringing more than one source of data to bear on a single point. "Designing a study in which multiple cases are used, multiple informants or more than one data gathering technique can greatly strengthen the study's usefulness for other settings" (p. 146). The researcher selected triangulation because it could generalize the findings of this study to other applications. Triangulation became the vehicle by which the multiple data sources in this study could be used to achieve convergence of their meaning and assist in the verification of key decisions made during this instructional design process.

Borg and Gall (1989) have said that the participant observer often gains insights that are virtually impossible to achieve through any other method. The researcher's comments were compiled from field notes, recollections, and correspondence. The observations contained the opinions and feelings of the researcher as the study progressed. Chronological logs were compiled by the researcher as a record of the progress of the study. The logs contained records of meetings, presentations, telephone calls, correspondence, and a general sequential listing of events that occurred.

In summary, the research strategies in this chapter included the following: single case study method, qualitative methods, triangulation, and participant observation. The combined qualitative strategies which were employed, yielded a variety of important findings and observations which are summarized in Chapter 4.
Implementation of the Research Strategies

Throughout the design, implementation, and post analysis of this instructional design process, the researcher and Project Director became aware of components which added to the effectiveness of the instructional design. This awareness was based on personal observation from the usage and manipulation of the computer-based lesson as it developed. The awareness was further heightened and substantiated by research literature that was consulted during the instructional design process. Once the computer-based lesson had been developed to a demonstration stage and presented to SWOS, the observations and feedback from SWOS officials and students also confirmed the importance of the design elements.

While the triangulation process became more formalized after the entire lesson had been developed, an informal triangulation process occurred throughout the development of the lesson. Some of the potentially important elements were identified earlier in the process, while others did not become known until after the TMCBL was installed. The order in which some of the design elements were identified and informally triangulated is reflective of the sequence in which this computer-based lesson was conceived and constructed.

A chronology of the identification of potentially important elements of the instructional design is shown in Table 1. Within the context of the TMCBL several key design elements were either predetermined or had been identified by SWOS as elements they wished to include. For example, computer platform dictated the choice for authoring software, which in turn influenced the decisions on screen design. The TMCBL could have been created on either a DOS or a Macintosh platform. However, the HyperCard version for the Macintosh would have lacked color, and, as such, would
Table 1: Chronology of Identification of Important Instructional Design Elements

<table>
<thead>
<tr>
<th>Design Element</th>
<th>When Informally Triangulated</th>
<th>Comments Regarding Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer platform</td>
<td>11-03-89</td>
<td>Identified as important whether it was DOS or Macintosh</td>
</tr>
<tr>
<td>Authoring software</td>
<td>11-03-89</td>
<td>Identified as important whether it was DOS or Macintosh</td>
</tr>
<tr>
<td>Program shell</td>
<td>11-03-89</td>
<td>Identified as important whether it was DOS or Macintosh</td>
</tr>
<tr>
<td>Video disc</td>
<td>11-03-89</td>
<td>Designated from prior SWOS experiences</td>
</tr>
<tr>
<td>Line drawings</td>
<td>11-03-89</td>
<td>Designated from prior SWOS experiences</td>
</tr>
<tr>
<td>Individualized instruction</td>
<td>11-03-89</td>
<td>Designated from prior SWOS experiences</td>
</tr>
<tr>
<td>Hypermedia</td>
<td>11-03-89</td>
<td>Knew if video disc was used within computer-based lesson it would be “hypermedia”</td>
</tr>
<tr>
<td>Advance organizers</td>
<td>11-03-89</td>
<td>Designated from prior SWOS experiences</td>
</tr>
<tr>
<td>Mnemonics</td>
<td>11-03-89</td>
<td>Designated from prior SWOS experiences</td>
</tr>
<tr>
<td>Hypertext</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Metaphor</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Screen design</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Use of color</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
</tbody>
</table>
Table 1: (continued)

<table>
<thead>
<tr>
<th>Design Element</th>
<th>When Informally Triangulated</th>
<th>Comments Regarding Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation aides</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Button placement</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Pop-up information boxes</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Cognitive map</td>
<td>April-May, 1990</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Index of lessons</td>
<td>6-16-90</td>
<td>Evolved as lesson developed</td>
</tr>
<tr>
<td>Use of quizzes</td>
<td>9-19-90</td>
<td>Initiated by researcher and Project Director as check list for self-assessment; used as part of demo in SWOS trip #2</td>
</tr>
<tr>
<td>Objectives of lesson</td>
<td>12-07-90</td>
<td>Purpose of learning; Needed to confirm content presented from <em>Combat Fleets</em> reference book</td>
</tr>
<tr>
<td>Instructional manuals</td>
<td>12-90</td>
<td>Created users' manual as per SWOS specs; created technical reference manual to assist in checking accuracy of lesson</td>
</tr>
<tr>
<td>Logical flow of lesson</td>
<td>7-92</td>
<td>Determined after project finished</td>
</tr>
<tr>
<td>Active learner involvement</td>
<td>7-92</td>
<td>Determined after project finished</td>
</tr>
<tr>
<td>Motivating and informative</td>
<td>7-92</td>
<td>Determined after project finished</td>
</tr>
<tr>
<td>Text readability</td>
<td>7-92</td>
<td>Evolved as lesson developed</td>
</tr>
</tbody>
</table>
have missed essential elements that were built into the DOS Linkway version of the TMCBL.

SWOS knew the computer-based lesson had to be developed within a program shell so their staff could modify it as needed. SWOS also had a video disc and files of scanned line drawings they wanted to use. In preliminary conversations with SWOS, preference had been identified for the lesson to be individualized and to utilize elements of advance organizers and mnemonics.

Many of the other elements evolved in their purpose and importance as the development of the lesson progressed. These elements were hypertext, metaphor, screen design, use of color, navigation aides, button placement, pop-up information boxes, cognitive map, index of lesson, and text readability. Some elements, while important, were not identified until after the lesson was fully developed. These were logical flow of the lesson, active learner involvement, and motivating and informative.

The manner in which the design elements were informally triangulated suggested a chronological relationship between the design element and its place in the development of this computer-based lesson. In general, the design elements that were informally triangulated early in the instructional design process were those related to platform considerations and SWOS prerequisites. Once these elements were put into proper perspective and became an integral part of the instructional design process, several elements relating to screen design and function were developed and were informally triangulated. Other elements were inherently a part of the overall design process and were later informally triangulated after the lesson was finished.

Through the process of triangulation described in this chapter, the twenty-five key elements were triangulated with respect to support from SWOS, from the ISU
experts, and from the research literature. When evidence demonstrated a convergence from all three sources, the key element was then formally identified as a key decision.

Miles and Huberman (1994) discussed the place of clustering the data as an inductive process of forming categories and described it as a process of moving to higher levels of abstraction. Using the processes identified by Miles and Huberman, the twenty-five key decisions were grouped into categories that more effectively described their role and function within the instructional design process. The categorical headings into which the key decisions were grouped included instructional decisions, design decisions, functional decisions, and enhancement decisions. These are illustrated in Figure 1. While SWOS was concerned initially with functional decisions, the researcher was concerned with the instructional decisions and the design decisions, and when these were incorporated into working models of the TMCBL, SWOS was very supportive of their inclusion. The enhancement decisions were ones which came near the end of the instructional design process.

There were some identified design elements that were studied in the literature, considered, and for various reasons not included. These design elements are important in and of themselves, but in this particular computer-based lesson it was appropriate for them to be excluded. A listing of those design elements and a brief discussion of why they were not included is presented in Table 2.

The triangulation data, the opinions and attitudes of Naval officers, interviews with key SWOS personnel, and data collected from the researcher all contributed to an awareness of how the identified key decisions are applicable to a wide range of computer-based applications, regardless of content. The resulting key decisions can be grouped into categories according to their use within the instructional design process.
Figure 1: Identified Key Decisions Organized into Clustered Groupings

**INSTRUCTIONAL DECISIONS**
- Active Learner Inv.
- Advance Organizers
- Cognitive Map
- Hypermedia
- Hypertext
- Indiv. Instruction
- Logical Flow of Lesson
- Metaphor
- Mnemonics
- Motivating and Inform.
- Objectives of Lesson

**DESIGN DECISIONS**
- Button Placement
- Line Drawings
- Navigation Aides
- Pop-Up Info Boxes
- Screen Design
- Text Readability
- Use of Color
- Video Disc

**FUNCTIONAL DECISIONS**
- Authoring Software
- Computer Platform
- Program Shell

**ENHANCEMENT DECISIONS**
- Index of Lessons
- Instruct. Manuals
- Use of Quizzes
This categorization can be a tool for educators to use in other instructional design applications.

The categories of key decisions relate to the instruction, design, function, and enhancement of a computer-based lesson. The identified categories suggest relationships among the key decisions, the groupings, and the instructional design process. This information is presented in Figure 1.

Instructional decisions are elements that guide the pedagogy of the resulting lesson. Key decisions grouped within this category include the cognitive enhancers of hypermedia, hypertext, metaphor, cognitive map, advance organizers, and mnemonics. Also, within the grouping of Instructional Decisions are those additional elements that do not serve as cognitive enhancers, but contribute greatly to the overall educational impact of the lesson. These include the key decisions of individualized instruction, objectives of the lesson, logical flow of the lesson, active learner involvement, and motivating and informative aspects of the lesson.

Design decisions are the visible elements that affect the look and feel of the lesson, as well as enhance the learning. Key decisions grouped within this category include use of video disc, screen design, use of color, line drawings, navigation aides, button placement, pop-up information boxes, and text readability. Text readability refers to the design elements of size, density, and justification on computer screens of lessons.

Functional decisions are those elements that have a substantial effect on many of the other decisions. The selection of computer platform and the authoring software dictate the appearance of the resulting computer-based lesson. For example, if the computer-based lesson developed in this study had used a Macintosh computer platform and if the authoring software HyperCard had been used, the resulting lesson
Table 2: Identified Design Elements Considered but Not Included

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Description of Element</th>
<th>Reasons Design Element Was Not Identified as Key Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of information per screen</td>
<td>Suggestion for amount of instructional screen which contains textual data</td>
<td>Pop-up information boxes allow textual data to be available in scrolling fields on user demand and preserve visual continuity of the lesson page; not a major decision</td>
</tr>
<tr>
<td>Ordering of menu items</td>
<td>Labeling of menu choices by numbers or letters</td>
<td>Not a major decision; covered under screen design, hypertext, button placement, and pop-up info boxes; choice too specific, so selected broader components</td>
</tr>
<tr>
<td>User response time</td>
<td>Length of time to wait for user response to question</td>
<td>Decision will vary with computer lesson; not appropriate in all applications; should be considered as part of objectives of lesson and use of quizzes</td>
</tr>
<tr>
<td>Icons, graphic symbols, or graphic alternatives</td>
<td>Use of graphic or icon devices to guide user through selection options in the lesson</td>
<td>Important decision; not deemed crucial as separate key decision; too specific, covered under screen design</td>
</tr>
<tr>
<td>Alternate command key</td>
<td>Use of keystrokes to invoke lesson choices</td>
<td>Too specific; not applicable to all computer-based lessons; can be too complicated to list and explain; not selected because of extensive use of hypertext buttons and pop-up info boxes</td>
</tr>
<tr>
<td>Methods of help</td>
<td>Selection choice that shows help screens to assist with questions</td>
<td>Should be an integral part of the lesson; built in flow of the lesson should keep user from getting lost in program; navigation aides should allow user to return to a starting point at any time; user manuals can explain how lesson works and identify general help strategies; not selected as major decision</td>
</tr>
<tr>
<td>Sound</td>
<td>Sound files to enhance lesson</td>
<td>May not be available; could be considered under objectives of lesson; may aide in motivation; too specific to be included as a major decision</td>
</tr>
</tbody>
</table>
could have been in black and white. This would have greatly affected the layout and appearance of screen design elements. Thus, computer platform, authoring software, and program shell are functional key decisions.

Enhancement decisions are those elements that assist the efficient operation of the lesson. Key decisions grouped within this category include the index of lesson content, use of quizzes, and the instructional manual. These elements may not be present in all computer-based lessons. However, if used appropriately in the proper context, these enhancement key decisions add to the overall impact and effectiveness of the lesson.

The findings of this study have implications for other computer-based lessons. The instructional design process used to create a computer-based lesson must:

1. Be responsive to the needs of the client.
2. Divide the complex components which make up the instructional process into smaller parts.
3. Use key decisions as a list which guides rather than prioritizes steps to follow.
4. Be aware of the individual components of the instructional design process as single entities and their purposes.
5. Recognize the relationship of the individual components to the total instructional design.

A client is the person implementing and/or using the lesson, and client needs are fundamental to the instructional design of the computer-based lesson. An awareness of client needs guides the instructional designer in the process of incorporating key decisions appropriate for the lesson.

Key decisions guide the instructional designer. Key decisions should not be prioritized nor used as steps to follow. Many key decisions contribute to the instructional design process in similar ways.
The components of the design should be thought of individually and then moved in a modular manner into the lesson. This would happen in much the same manner as a carpenter creates sub-assemblies and combines them to create the finished product. The designer must refine the key decisions individually with an understanding of how these components will merge to create the overall computer-based lesson.
CHAPTER 4: RESULTS OF THE STUDY

Introduction

The results of this study are expressed in the six types of data described in this chapter. They include the following:

• Triangulation data
• Course evaluation and prototype assessment data
• Attitude assessment data
• Personal interviews data
• Chronological log data
• Participant observer field notes data

The chapter section for each of the data types begins with an introduction to the data and the gathering process. This is followed by the data, which is presented and described. The last portion of each data section concludes with a summary of the findings.

Triangulation Process

Introduction

A post analysis of the instructional design process used to develop this computer-based lesson, was completed. Throughout this analysis the researcher asked what were important elements that contributed to the success of the instructional design? Which instructional design elements made positive contributions to the resulting instructional design? Which instructional design elements facilitated learning? A list of factors was compiled with the assistance of the Project Director. This list consisted of twenty-five important components that were identified, verified, and labeled as key decisions.

A process of triangulation as described by Denzin (1989), Borg and Gall (1989), Miles and Huberman (1984), and Jick (1979), was used in this study to verify the
importance of the identified key decisions. The triangulated verification process was based on three elements.

1. The first element was anecdotal evidence that the Surface Warfare Officers School (SWOS) had either suggested as a component for inclusion, or had concurred with the Iowa State University Design Team (ISU Experts) for its implementation.

2. The second element of the triangulation process was anecdotal evidence that the ISU experts had suggested for inclusion of the component.

3. The third element of the triangulation process was the citation of relevant research literature that supported inclusion of that specific component.

When evidence of agreement was observed from all three elements, SWOS, ISU experts, and the research literature, the instructional design component was then labeled by the researcher as a key decision.

The SWOS Team and ISU Experts

The SWOS team of advisers on this project represented the United States Navy, which was the client that reimbursed Iowa State University (ISU) for the development of this computer-based lesson. As the client, SWOS had the final decision on all elements of the instructional design process. Much of the time SWOS agreed with the ISU experts. However, on several occasions SWOS did express different needs and opinions which were discussed, considered, and implemented. The SWOS team was composed of the Commanding Officer of SWOS and a group of SWOS personnel highly involved in the school's curriculum development activities.

In the three years prior to the start of this project, SWOS had worked closely with Iowa State University to develop several state-of-the-art, high-tech classrooms. These classrooms had projection capabilities for film, slides, video, and computer images. Two large screen television monitors were placed in each front corner for maximum viewing effectiveness as well as two television cameras to assist in the
production of instructional activities occurring in the classroom. One of the television cameras was permanently mounted in the back of the room, while another was mounted to focus downward on documents placed on tables in the front of the room. Both of the cameras were remotely controlled, and could be seen on the large screen monitors and/or sent to a video tape recorder for recording purposes. Additionally, the same video recording system could play back video tapes for classroom use. Iowa State University also assisted in the design and installation of a state-of-the-art media center that contained a large variety of multi-media equipment as well as equipment necessary to produce a wide variety of audio-visual materials.

The Commanding Officer (CO) of SWOS worked with principal members of his advisory team, chief of whom was the Specialist in the SWOS Curriculum Standards Office. This specialist served as the primary education liaison coordinator between SWOS and sources with whom educational services were contracted in an effort to be certain that acquired educational materials properly addressed the curriculum standards identified by SWOS. Another essential member of the SWOS team included the Program Manager for Curriculum Development, who worked for a private contractor, but was officed at SWOS. This member's task was to provide leadership in bringing current educational practice and methodology into the teaching of the warfare areas of SWOS. Other key personnel were the Division Director for the teaching of Combat Systems, and instructors who taught the Threat Matrix to classes of Naval officers. All these individuals were professional educators within the schools of SWOS who approached all educational innovations from a pedagogical and Naval perspective.

The ISU experts were comprised of a varying number of individuals closely identified with the practice of, and research about, instructional technology. The Project Director of the ISU team had provided significant leadership on previous
projects that ISU had completed for SWOS. This individual was assisted by the Director and Assistant Director of Media Resources, other professors from the College of Education, and several graduate students. All these individuals were closely involved at the early stages of the project, and as the project's progress became more focused, the team narrowed to the Director of the ISU effort and the researcher of this project. The Director of the project was the researcher's major professor, and this project became the focus of the researcher's Ph. D. dissertation.

The computer-based lesson designed for this project received national recognition on February 7, 1992, when the researcher was honored as the "1992 Award Winner for Outstanding Practice by a Graduate Student in Instructional Development." This prestigious award was presented by the Division for Instructional Development (DID) of the Association for Educational Communications and Technology (AECT) at their national convention in Washington, D. C. The award presented by the AT & T Corporate Training Support Group included a plaque and an honorarium. Press releases and publications are found in Appendix P.

In summary, the SWOS educational team and the ISU Experts were very knowledgeable in their fields. Their individual and collective opinions and expertise represented some of the best ideas in the design and implementation of instructional technology. The research literature cited is from a lengthy list of published articles. This literature became the third link in the triangulation process.

The Triangulation Data

On the pages which follow, each of the twenty-five instructional design components will be discussed within the context of the identified triangulation strategy. Each of the design components will be described as follows:

* Description of key decision
First the key decision will be described. Then data from SWOS, ISU experts, and the literature related to this key decision will be described. Finally, the results of the triangulation will be discussed.

#1. Hypermedia

**Description of key decision**

The terms hypermedia and hypertext are often used synonymously by many authors. The distinction between the two is that hypermedia not only has all the multi-branching, non-linear qualities of hypertext, but also utilizes additional forms of audio or visual media to enhance the instructional lesson. These additional forms of media may be full motion video, animation, graphs, charts, maps, photographs, or audio. For this lesson hypermedia refers to hypertext linked to a program element, graphic line drawings, and still and motion sequences from a video disc.

**SWOS link**

SWOS had no opinion on this key decision and concurred with the ISU experts. SWOS did have a video disc created by the Navy, and they were hoping it could fit into this computer-based lesson in some manner. They had no preconceived idea as to how it might fit, or how it would be utilized within the lesson.

**ISU experts link**

During the period of January 6-9, 1990, a team of experts from ISU visited SWOS headquarters in Newport, Rhode Island. The primary focus of presentations during the three-day period was to explore with SWOS examples of hypermedia that were currently in use. Using the Macintosh computer platform and a video disc
player, several demonstrations were presented showing the non-linear capabilities of
hypermedia and the additional advantages of using a video disc of images to
accompany the hypermedia software. Titles of commercially produced software which
were demonstrated included, HyperCard the First Year, The 88 Vote, BioSci, National
Gallery of Art, and NASA Space Shuttle Images. Additionally, a demonstration
HyperCard stack utilizing principles of hypermedia, that had been created by the
researcher, was presented and discussed.

Literature link

Jonassen (1988) suggested that the use of hypertext and hypermedia provides
defense advantages for learners. First, it provides unconstrained near-immediate
access to large collections of information. Second, it provides a vehicle for the author to
present guided tours which demonstrate elements in a sequence that makes the
information more meaningful. Third, because it is a node-link system based on
semantic structures, it maps fairly directly the structure of knowledge it is presenting.
Jonassen (1991) continued to extol hypertext and hypermedia as "...a flexible
information technology that provides a powerful environment for designing,
developing, and displaying instruction" (p. 91). Jonassen saw this innovation as a tool
that could liberate instructional designs from the constraints of objectivism and
determinism.

Romiszowski (1990) envisioned many large and small scale applications for
hypermedia. Romiszowski saw them as having the potential to promote deep
conceptual learning through enhancement of the schemata in the minds of large
numbers of students and suggested that hypermedia had the social and economic
benefit of delivering the right information to the right person at the right time and
place.
Duchastel (1990) described hypermedia as an emerging technology that had the potential to enhance radically interactions with information. McKnight, Richardson, and Dillon (1990) suggested that there were similarities between hypermedia structures and cognitive structures sufficient to imply that hypermedia was somehow natural and that its use could or would facilitate learning. Slatin (1990) saw the greatest value of hypertext and hypermedia as its ability to link enormous quantities of material that in a conventional text environment would be kept separate.

Lowyck and Elen (1992) identified a hypermedia environment as one which enabled a non-linear presentation of information to enlarge the possibility for discovery during the learning process. The authors pointed out that hypermedia offers an environment by means of which a knowledge field can be explored. By enabling segments of information to be presented and linked in various way, all kinds of information could be displayed and linked to each other.

Collins, et al. (1988) in discussing hypermedia argued for “cognitive apprenticeship” as another important strategy to provide an authentic experience. This approach provided the learner with models of the real use of knowledge, which included not only the concepts but perhaps more importantly, the heuristic, control, and learning strategies. As the student mastered the more basic components of the work, there was increasing complexity and increasing independence. Collins explained there must be a multiple real world experience and a system for aiding the student in his apprenticeship in the use of that knowledge. Delany and Gilbert (1990) provided the concluding support by suggesting that “...in exploring the uses of hypermedia, we may be engaging in the most far-reaching union of technologies since the arrival of motion pictures with sound some fifty years ago” (p. 296).
Discussion:

SWOS was enthusiastic about incorporating hypermedia into their curriculum. They saw how it could immediately meet curriculum presentation needs that instructors desired. On the last day of the visit to SWOS headquarters, the ISU Experts made a presentation to the SWOS command which encouraged SWOS to consider the creation of the desired instructional materials using a Macintosh platform. The decision made by SWOS one month later was definitely to proceed with the instructional design using the element of hypermedia, but on a DOS platform. There were several reasons for their decision. The DOS platform was extremely well established, and there was considerable reluctance to support a new computer platform that was not a standard Navy item. SWOS also expressed concerns about the maintenance of a new computer platform, and they were not certain that the instructors and students would easily make the switch to the Macintosh.

The literature strongly supported the key decision to develop a hypermedia-based lesson. It became the "corner-stone" on which this application was to be created and built.

#2. Use of Video Disc

Description of key decision

A video disc is a Read Only Memory (ROM) storage device. It contains optically encoded data that are created and read by a laser. The video disc is not subject to magnetic fields as is video tape, and it is more durable. It can contain up to 54,000 still images or 30 minutes of motion sequences on each of two sides. The advantages of the video disc are that it is faster accessing images than video tape, it is easy to use, and it is very durable. The video disc player can be controlled by the computer, so within a computer-based lesson one can easily access the video disc to display images.
SWOS link

SWOS command had a video disc made by the U. S. Naval Education and Training Support Center in San Diego, California. This disc depicted hundreds of still and motion sequences of Soviet surface warships, submarines, fixed wing aircraft, helicopters, sensors, and weapons systems. SWOS wanted the computer learning system designed for this study to access those images and use them as part of the resulting learning system.

ISU experts link

Prior to September, 1989, SWOS had been involved with ISU experts in other instructional technology efforts. Following the successful completion of those projects, SWOS had discussed the concept for this body of work with the Project Director, one of the experts from Iowa State University. When this researcher became involved in the project, the potential usage of the video disc was already seriously being considered. The ISU experts were aware of the value of interactive video instruction, as the researcher had been involved in the production and use of a video disc for teacher training in 1988. Since the Navy already had the disk, and since the ISU design team was aware of its enhancement capabilities for the lesson, it was included as one of the essential instructional design elements.

Literature link

Gay (1986) studied the effects of learner control and prior understanding of the content area as they related to usage of interactive video instruction. Gay's results indicated there was an interaction between learner control of the instruction and prior familiarity with the material to be learned. Gay concluded that learners could be given more control if their prior understanding of a topic was relatively high, and conversely
the learners should be provided with more structure if their prior conceptual understanding of a topic was low. The results also suggested that students should be taught how to use the interactive video control options more effectively.

McNeil and Nelson (1991) directed a meta-analysis of sixty-three interactive video studies which had been completed over a period of ten years. Their overall mean effect size for interactive video was .530, which indicated that interactive video can be an effective form of instruction. The effect size that was obtained was similar to that of computer-assisted instruction.

Bosco (1986) analyzed twenty-eight evaluations of interactive video that were used for applications in the military, higher education, K-12 education, industry, and social services. Overwhelmingly, the studies presented were oriented toward skill acquisition.

Discussion

The video disc contained surveillance images obtained from a number of Naval sources. The quality of the images varied, but in general they did provide a "real" look at some of the Threat Matrix (TM) platforms the Naval officers were studying. To utilize more fully the contents of the video disc and include its images into the resulting computer-based lesson, a complete frame-by-frame inventory of the video disc was accomplished. A video disc player has the capability to display any one of the 54,000 frames when directed to do so. Thus, it was vital to know not only the types of TM platforms displayed, but their exact location as well.

The usage of video discs for purposes such as this, is well documented in the military, business and industry, and increasingly so in educational applications. The literature showed this element to be one of great potential, so it was also included as part of this computer-based lesson.
#3. Individualized Instruction

*Description of key decision*

Individualized instruction implies responsibilities for the teacher and advantages for the learner. On the part of the teacher it involves planning and conducting a program of study which can be tailored to fit the learning requirements and characteristics of the student. The student can benefit by working with learning materials and activities that are more personally focused and provide opportunities to be engaged in the learning activities.

*SWOS link*

In conversations prior to September, 1989, SWOS officials expressed interest in developing a computer-based lesson that would be available for students to use at an individual work station. They viewed the work station as an opportunity for the student to study those topics presented in class. Because of the design of the materials, students could explore the learning at their own pace according to their personal learning needs.

*ISU experts link*

During the SWOS visit of January 6-9, 1990, the advantages of individualized instructional strategies were demonstrated when the ISU experts made several presentations of commercially produced hypermedia. During the period of September 19-23, 1990, SWOS officials saw a rough demonstration of the computer-based lesson that was being created. The demonstration, while far from complete, was developed enough so SWOS officials could obtain a basic understanding of what it would look like and how its elements would interact in the final product. During those demonstrations its capability as a stand alone individual work station, as well as a teacher presentation tool, were demonstrated, discussed, and approved.
Keuscher (1970) asserted that individualized instruction was more democratic, taught critical thinking, taught self-direction, nurtured creativity, and developed one's self-concept. Veach (1970) suggested that individualizing was a way to think about managing the classroom, not a method of instruction. Veach explained how individualization could take on many forms, and that what matters is how individualization affects the student. Parker (1970) pointed out that training is skill-getting, while education is skill-using. Parker believed that during the training or skill-getting phase individualized instruction was essential if learning was to take place as effectively as it could. In the education or skill-using phase a combination of group planning, individual study, and group participation was usually most desirable.

Katzenmeyer and Ingison (1980) posed five questions regarding the implementation of individualized instruction. First, they asked, "Does individualization change classrooms?" An almost universal finding was that when individualization was well implemented, the schools were different. The environment became more sensitive to individual differences of students, and both the students and the staff generally were more satisfied. Second, the authors asked, "Is individualized instruction a great deal of effort?" The answer was that it could be, and sometimes was more work than some staff members wished to put forth. It took effort to make it work on a small scale, and even more effort on a department or school-wide scale. Third, they asked, "Does individualization increase the amount of record keeping needed?" Inevitably, individualization required knowing more about the students, regardless of the system being used, and it involved more records. The authors thought that perhaps one day the computer would be able to do much of the record-keeping work. Fourth, they asked, "Do students achieve more under individualized instruction?" This was
difficult to answer, as it was related to what goes on in the classroom and how achievement was measured. Fifth and last, they asked, "Is individualization really worth the effort?" Katzenmeyer and Ingison said the answer to that question could not come from them, but only from the individual school or school district implementing the ideas. The authors concluded by stressing the importance of deciding on the evaluation needs before beginning individualization.

Gagné (1971) discussed several conditions of importance to individualized learning. The student needed to learn as a general principle that learning took place inside his head as a result of his own "thinking" activity. Outlines, indexes, reference lists, and other materials or devices needed to be designed for maximum ease and efficiency of employment by the student in finding the stimuli "learning materials" that were needed. Concepts and principles to be learned must be communicated in a manner which is optimally effective. In addition to textbooks, audio and visual modes of communication also needed attention.

Gagné believed that every stage of learning should begin with a statement that made the objectives of learning clear to the learner. This statement remained readily available to the learner throughout a lesson or other unit to be learned. The learner should be provided with a means of appraisal that has a direct and obvious relationship to the objectives of learning. By this means, the learner could check his own performance and obtain immediate feedback.

Gagné commented that opportunities needed to be provided for two activities of importance to the transfer of learning. The first was discussion of what had been recently learned with other people, whether teachers or students, for the purpose of refining, sharpening, and embellishing the mediational processes that had been
acquired. The second was application of the acquired knowledge in specific practical situations.

Discussion

The computer-based lesson developed for this research study was a prototype of what would become a fully completed program. SWOS officers enrolled in the Threat Matrix (TM) course had a high desire to practice their recall abilities as they studied and mastered the TM data points. The students had previously created large stacks of note cards that contained pertinent data, and they studied them individually or in pairs using a “flash card” style of review. The instructors and students were excited about the opportunity to sit down at a computer work station and individually study those parts of the TM where they needed practice. The hypermedia lesson was designed in such a way that it was totally non-linear. As such, users could interact with the lesson contents in any manner appropriate to their individual interest or educational needs.

#4. Computer Platform

Description of key decision

The computer platform referred to the type of computer that was to be used for the instructional activities being developed. Two of the most widely used computer platforms include the Macintosh and the IBM, or IBM compatible equipment, which uses a different Disk Operating System (DOS). In some situations a platform decision may also include mainframe or UNIX based computer systems. Computer platforms were endorsed or vetoed due to many factors including costs, maintenance, training, and user preference.

SWOS link

During the SWOS visit of January 6-9, 1990, the hypermedia demonstrations that were presented were all based on the Macintosh computer platform. At the time of
this research the Navy had standardized on Zenith, IBM compatible, computers with a 286 micro processor. There were dozens of them being used at the SWOS schools. Some SWOS officials and students owned Macintosh computers privately and used them at home in various ways to assist with their educational activities. During the January 1-6 visit, the ISU experts presented reasons why the Macintosh would be a viable computer platform.

*ISU experts link*

ISU experts favored the Macintosh because of its ease of use and made presentations which demonstrated that attribute. The researcher had no experience with DOS computer-based systems, but was an experienced Macintosh user for many years. Some of the ISU experts favored Macintosh but were experts in DOS, too. The Project Director had installed DOS machines in previous SWOS projects, and ISU had a huge inventory of installed DOS computers.

*Literature link*

Meyrowitz (1989) discussed what it will take for the paradigm of hypertext/hypermedia to become as widely accepted as the paradigm of "cut, copy, and paste." Meyrowitz suggested the hypertext/hypermedia elements must be an inherent part of the standard computing toolbox found on all popular computers. Application developers must be provided with the proper programming tools and access to create applications that will "link up" in a standard manner across several computer platforms.

Palay (1992) believed that computer platforms could no longer be monolithic entities. Instead, computer platforms should be able to utilize a wide variety of components that could be pieced together by a user to create specific visual presentations or documents.
Kemp (1985) described the person in a business or industrial training environment who is responsible for the project as “the client.” The designer must work with the client to implement the instructional design process. Kemp identified three types of relationships: designer directed, client directed, and cooperative.

The research literature did not discuss computer platform selection or usage in any detail. It was assumed that in most situations the platform of choice would be either DOS or Macintosh based, and that the decision may be dictated by a variety of circumstances such as existing equipment, costs of maintenance and training, ease of use, and software availability for desired applications.

Discussion

The impression of the ISU experts after the January, 1990, demonstrations was that SWOS was interested in the Macintosh platform. Because the ISU Experts were well acquainted with the Macintosh, they proposed that SWOS approve its use. However, the ISU experts were aware that SWOS might not select the Macintosh, but instead would continue to use Zenith, IBM compatible platforms with DOS, as they had for other applications. ISU experts understood that as the client, SWOS would have the final decision on this project, and ISU experts recognized the possible need to compromise on the platform choice.

During the period of mid to late January, 1990, the SWOS experts had meetings to discuss this decision. The options were clear. ISU experts could accept the choice of the client (SWOS) or decline. If accepted, the researcher needed to learn DOS and an appropriate authoring software to develop the computer-based lesson. At a meeting of the ISU experts, February 6, 1990, communications from SWOS were presented which indicated their chosen computer platform was the existing Zenith, IBM compatible computer.
Immediately, the researcher began a crash course on DOS and on the IBM authoring software, Linkway. At the request of the researcher, SWOS sent a Zenith computer platform to be used for authoring the computer-based lesson, which remained at the home of the researcher during the creation of this project. Plans were made with local IBM educational support personnel to obtain a copy of Linkway, and also to determine locations for additional Linkway training. The researcher and the Project Director went to Atlanta, Georgia, during the period of March 27-30, 1990, for an intensive course on the use of Linkway.

Although the research literature did not indicate a particular platform of choice, it was important to recognize that the client made the decision based on existing equipment. According to a cooperative client-designer relationship, it was appropriate that the final decision was made by SWOS.

#5. Authoring Software

_Description of key decision_

Authoring software is a generic name for a variety of instructional tools that enables one to create a stand-alone computer application without creating code via a computer programming language. Authoring software allows the creation of the resulting instruction to be more transparent, and, as such, the author can focus on the content to be delivered. Authoring software can be described as a toolbox containing many instructional elements which are implemented and combined as the author feels is appropriate to create the desired instructional materials. Compared to writing original programming code, the elements are easy to use and modify.
SWOS link

SWOS had no opinion on the type of software needed to create the desired instructional materials. As the client, they identified the specifications, but left the selection of authoring software to the ISU experts. They then approved of the decision.

ISU experts link

The Project Director had identified Linkway as an appropriate authoring system for the DOS machines. Because Linkway was an IBM supported product, training by IBM staff was available. The decision to accept the DOS platform, use Linkway, and thus continue with the development of this project, was finalized on February 6, 1990.

Literature link

An authoring tool is a type of computer software that enables the user to create computer-based instructional materials (Myers and Lamb, 1990). Johnson (1988) believed that authoring tools should be a high priority for intelligent tutoring systems used in research and development. Practical applications for these authoring tools would permit researchers to identify problems and new development needs.

Towne and Munro (1988) pointed out that authoring tools provided a way for extracting device-specific knowledge from authors who are neither computer programmers nor training specialists. Dyer (1990) believed that hypertext authoring tools could be helpful to create maps or models which describe a particular aspect of reality, organize information in relation to the development of a particular theory, or create and plot multiple pathways through a knowledge structure.

McKnight, et al. (1989) commented that hypermedia authoring software had been responsible for bringing the notion of hypertext to a wider audience than just the audience of academics who had been discussing it for many years.
Duffy and Knuth (1990) saw authoring tools as a major component in an enriched learning environment. Duffy and Knuth referred to authoring as a critical component of any hypermedia application. Duffy and Knuth continued thus:

There is sufficient research to indicate that learning must be an active process; that the learner must work with the information and come to see it as relevant to his context. Hypermedia systems, with active authoring facilities, are ideally suited to support this active learning. (p. 212)

Discussion

In instructional development the developers must remember they are working for pay to meet the identified needs of the "client." Essentially, what the client wants, the client gets, as long as it is within the capability of the developers and within budget. Linkway was the best authoring software available at the time of this project that could accomplish the objectives identified by the client and be supported by the ISU experts.

Harrington, Fancer, and Black (1990) authored a third party users' manual on Linkway, and it was used to gain better understanding for the use of the software. The Project Director arranged for specialized training with the use of Linkway. The training for the Project Director and the researcher was held by IBM in Atlanta, Georgia, on March 27-30, 1990. It accomplished exactly what the ISU experts had hoped, that of getting the instructional design effort off and running.

#6. Program Shell

Description of key decision

The concept of a program shell implies that the computer software can be modified or changed with relative ease. The advantage is that the software is not quickly out of date as conditions or information change. For example, the TMCBL could easily be modified if new ships were put into service, or others were no longer of strategic importance. The program shell feature would insure flexibility of use for SWOS.
SWOS knew the ISU experts would be teaching some of their personnel how to modify the resulting computer-based lesson, so the concept of a program shell was of interest to them. In preliminary discussions about this project in September, 1989, SWOS made it known to ISU that they wanted a computer-based lesson they could modify without great difficulty.

The ISU experts supported the concept of a program shell, because it met the expressed needs of SWOS for their internal modifications, and from a practical point of view, it was easier to use. The computer-based lesson was developed in a series of modules, each of which pertained to a different area of study. Each module, as a program shell that contained data, was easily modifiable. During the SWOS visit of September 19-23, 1990, a rough version of this computer-based lesson was demonstrated. Techniques for changing data or screen appearance were also demonstrated.

Edmonds (1981) said it was necessary to develop facilities to enable systems designers to specify ways in which users could modify the interface. Edmonds also suggested that it was important that users have limited access as they modify the interface, so they cannot harm the computer system itself.

Yen, et al. (1991) commented that good programming environments were often marked by close integration of their tools. Yen and colleagues believed the tools of a "user-support environment" should be constructed in an open fashion to allow the user to have more control over modifying the content portions of the computer lesson, as appropriate. Yen suggested usage of a reformulation shell that offered several benefits.
to the system builders. By reusing programming code, it reduced the effort necessary to develop a new application or modify an existing one. The use of a shell facilitated the development of a set of cooperative tools (editor of authoring system) through a shared knowledge base (entire SWOS Threat Matrix). The shell offered a consistent interface across different applications of the data, and these techniques could be applied to different domains. Yen summarized that a general, reusable module (shell) that could capture the user interface paradigm significantly reduced the code size and maintenance problems for the application modules.

**Discussion**

From a practical point of view there was no alternative to using a program shell in the creation of the materials for this research. Ultimately the data contained in the program would be classified for security purposes. Then the researcher would no longer have access to the created materials. The researcher designed a series of modules and screens that could accommodate the data that was identified for input, and still maintain the flexibility for any or all of it to be modified, deleted, or replaced.

Early decisions had to be made regarding the researcher's access to data on the Soviet fleet. SWOS officials could not describe for the ISU experts which attributes of Soviet naval capabilities were critically important to them because information related to U.S. Naval positions and strategies was classified. SWOS recommended that an authoritative source for the data necessary for this computer-based lesson was *Combat Fleets of the World*, a large compendium of photos, line drawings, and data on all the ships of all the navies of the world. The researcher then began the task of inputting the appropriate data points into program shell modules that had been created for this computer-based lesson.
When the final prototype was delivered and installed on January 16-19, 1991, the researcher spent an entire day training SWOS personnel in the modification of the data contained in the computer-based lesson. After the ISU experts returned to Ames, Iowa, SWOS spent two weeks carefully examining the data included in the prototype. During this time incorrect data were corrected, newly acquired data by SWOS were entered, and changes in classes of ships, weapons, or sensors according to the Threat Matrix list were made. When all data were correct and confirmed, this computer-based lesson was labeled "classified" for security purposes.

#7. Metaphor

Description of key decision

A metaphor is a figure of speech that compares the characteristics of a familiar object to a less familiar object. For example, the trash can on the Macintosh screen is a metaphor for throwing away unwanted files. A metaphor in this computer application is described as a way of conceptualization of an environment to aid in its comprehension for the user. This TMCBL was built on the metaphor of a book. Consequently, it had a cover page, preface, table of contents, lessons and examples, quizzes, and an index.

SWOS link

SWOS personnel had no prior opinion regarding the inclusion of this key decision. They concurred with the ISU experts regarding its inclusion and approved subsequent action.

ISU experts link

The concept of a book metaphor was discussed in a preliminary schematic design of the lesson with the ISU experts. The book metaphor was presented by the
Project Director during a visit to SWOS on June 18, 1990. A schematic computer graphic showed how each of the components of the TMCBL fit the book metaphor.

**Literature link**

Patton (1981) commented that metaphors could be extremely useful in stimulating creative thinking and in facilitating communication about concepts, meanings, and processes. Patton believed that metaphors, as well as similes and analogies, could be powerful ways of making connections between seemingly unconnected things. In short, a metaphor was a creative way of seeing and understanding old things in new ways.

Thornburg (1988) believed that using a computer involved working with metaphors. The use of desktops, menus, and windows made computing resemble more of the "real" activities in which one participates. The metaphor was a shared creation of the programmer and the user; in some cases it was obvious, and in others it was not.

McKnight, Dillon, and Richardson (1991) suggested that the metaphor offered a way of conceptualizing an object or environment and was frequently discussed as a means for aiding novices' comprehension of a system or application. Carrol and Thomas (1982) have commented, "If people employ metaphors in learning about computing systems, the designers of those systems should anticipate and support likely metaphorical constructions to increase the ease of learning and the use of the system" (pp. 107-116).

Alfred and Locatis (1988) spoke of scenario-based designs (metaphors) that became the basis for more didactic instruction. The scenarios were realistic or fantasy worlds of video and graphic images. Alfred and Locatis believed designs such as this were more motivating and engaging for the learners, thus making the content more
interesting. A second benefit was that these designs could be more suitable for those who had difficulty learning via more traditional methods. Third, Alfred and Locatis believed designs such as these had the ability to give individuals more control of the learning process.

Sandford (1990) discussed visualization models as ways of assisting the user to gain greater clarity about the learning materials. The logic behind metaphors as explained by McKnight, et. al. (1991) was that they enabled users to draw on existing world knowledge in order to act in the electronic domain. As they assisted in conceptualizing an object or an environment, they aided in the comprehension of a system or learning application.

Baird and Percival (1989) suggested that a metaphor not only helped the non-expert user, but also formed a relatively rigid framework within which the author worked to maintain consistency. Baird and Percival continued, "Comparisons and analogies between the virtual world of the hyper document and the real world of everyday experience allow users to construct a more accurate mental model of what to expect from the hypertext" (p. 82).

Benest (1990) in discussing the value of a book metaphor believed that the metaphor became enhanced when information contained in the book emulator is accessible by simply going through from one end of the book to the other. Norman (1991) commented that the purpose of a metaphor as a literary device was to transfer the reader's concrete knowledge about a familiar thing to an unfamiliar subject being studied. Norman suggested that menu selection itself is a metaphor and similar to the process of ordering from a menu in a restaurant.

Malone (1984) said that one of the reasons the original VisiCalc computer software was so popular was that it was built on the metaphor of a paper spreadsheet.
The Macintosh computer has capitalized on the concept of metaphors since it was first developed. It had folders, trash cans, and other items analogous to a real desktop. Barker (1992) commented that metaphors constituted an extremely useful class of design tools that could be used to facilitate cognitive knowledge from a familiar area of knowledge to a less familiar one.

**Discussion**

The inclusion of the book metaphor provided organizational structure to the TMCBL, not only for SWOS students and personnel, but also for the ISU experts as well. This lesson became complex quickly, and without some structural mechanism to provide a sense of organization and function, it would have been very difficult to develop.

The concept of the book metaphor was carried out in the designs used for each of the screens. A series of textual navigation buttons (hypertext) in the upper right corner of the screen was always present and gave the user options to return to the cover, preface, book contents, chapter contents, index, or see previous screens. The TMCBL contained a screen which listed the book contents as USSR, USA, and Other. Within each category were six chapters: Surface Warships, Submarines, Fixed Aircraft, Helicopters, Sensors, and Weapons Systems. Once a chapter was selected the user was then taken to a screen describing the specific lessons in the chapter. By selecting a specific lesson, the user was then taken to a study page where that particular Threat Matrix platform could be studied in more detail. An illustration of this screen is found in Appendix C.

The metaphor was further emphasized by labeling the upper left corner of the screen. By using different highlighting colors each screen was identified as a particular example from a lesson, which was part of a specified chapter. The chapter
represented a large body of information known as a section. At any time while viewing a screen, a user could determine program location within the concept of the book metaphor and see the structural way in which this individual screen fit into the total concept of the TMCBL. This mapping structure contributed to the cognitive map created within the mind of the learner and was of value in comprehending the total scope of the TMCBL.

#8. Use of Quizzes

*Description of key decision*

A quiz is an assessment or an evaluation that enables the learner to determine what instructional objectives have been learned. At any point in the lesson the user could elect to take a quiz over the area of warships, weapons systems, or sensors. Within each of these categories, three different types of quizzes were available. The choices included factual data, line drawing identification, or video image recognition. The quizzes contained pools of items which were randomly selected and presented to the user.

*SWOS link*

SWOS was interested in some form of student assessment as related to the use of the materials, but had no opinion about the inclusion of this decision. When they learned that the ISU experts were considering a form of computer-based learner assessment, they became very interested in its inclusion. Later, after they saw demonstrations of how the quiz concept could be implemented, they supported its inclusion.

*ISU experts link*

The Project Director and researcher thought the use of quizzes was an important component in this lesson because the quizzes facilitated the goal of the
TMCBL, which was mastery learning of the Threat Matrix. The concept of a series of quizzes as a comprehension check for the user was presented during a preliminary demonstration at SWOS on September 20, 1990.

**Literature link**

Allinson and Hammond (1989) discussed portions of the hypermedia lesson that were not part of the metaphor. Allison and Hammond suggested the most important of these is the provision for multiple choice quizzes. Bork (1991) supported quiz-based mastery of learning strategies and suggested that courses could be organized around tests and quizzes, rather than around lecture materials. Marchionini (1990) explained that the best method for determining the outcome of a learning task was to measure learner performance on tests for that task.

Forrest-Pressley and Gillies (1983) discussed ways the reader was motivated to become an active learner, and that motivation could become enhanced through the use of strategies such as questioning, reciting, reviewing, taking of notes, underlining, summarizing, visualizing, or monitoring of progress. Forrest-Pressley and Gillies argued that this form of metacognition was a necessary component of a flexible learning strategy.

Gagné and Glaser (1987) discussed self-regulatory skills as a set of generalized strategies for approaching problems and monitoring one's performance. The authors recognized these skills as metacognitive in nature because Gagné and Glaser referred to the kind of knowledge that enabled one to reflect upon and observe one's own performance ability. The authors pointed out that to become an expert required a great deal of knowledge and practice in a domain, and that implied facilitating the development of knowledge so that helpful schema and mental modes could be created.
and efficiently accessed to guide performance. Quizzes helped facilitate this development of knowledge.

*Discussion*

Since textbooks often have chapter quizzes to help students assess comprehension of the presented materials, the concept of quizzes was an outgrowth of the book metaphor. The quizzes were never meant to be a form of quantitative assessment of the student's learning, but rather an opportunity to check what was known and what still needed to be learned. The quizzes included factual data, line drawing identification of Threat Matrix (TM) platforms, or video image recognition of TM platforms. The quiz items were chosen randomly from a pool of items. After answering each item, indication was given if the response was correct or not. At the end of the quiz the student was given a score of the items answered correctly.

All quizzes included four multiple choice responses. The quiz on factual data presented a stem and asked the user to select the correct answer. An example follows:

Identify the sensor that is back to back, three dimensional, made of one Top Steer and one Top Plate antenna.

A. Top Pair  
B. Top Steer  
C. Top Plate  
D. Top Sail

The quiz on line drawings of TM platforms presented the user with a line drawing from the drawing files used for the lesson pages. An example of the stem associated with a drawing and its multiple choices was as follows:

Which USSR surface warship class does this drawing represent? Choose your answer and click on button A, B, C, or D below.

A. Sarancha  
B. Kara  
C. Kashin  
D. Modified Kildin
The quiz on video image recognition of a TM platform utilized the images contained on the video disc. The computer monitor screen provided the directions, stem, and choices for the video recognition question. When the user clicked a video button located on the computer screen, the appropriate still or motion sequence was displayed on an adjacent television monitor. An example of this type of item was as follows:

Read the stem of the item. Click on VIDEO to see the video selection. Choose your answer and click on A, B, C, or D at the bottom of the screen.

If you wish not to see the video for an extended period of time, click on the yellow area: TURN OFF VIDEO STILL. If you wish to exit the quiz, please click on the Stop Quiz button. You will be returned to the PREFACE.

Which USSR warship class is shown in this motion segment?

A. Udaloy  
B. Kirov  
C. Slava  
D. Moskva

The creation of the quizzes provided students and instructors with an additional component to assess understanding of the lesson content. Examples of these quiz items and others can be found in Appendix B.

#9. Index of Lessons

Description of key decision

The index of a book contains an alphabetical listing of important terms found in the presented material. The index guides the reader to appropriate pages for desired information. This metaphor was included in the TMCBL to assist the user to locate rapidly any desired lesson content. The index for the TMCBL contained an alphabetical listing of the lesson contents. Index words were hypertext, and when selected, presented the user with a lesson page describing the selected term. An example screen of the TMCBL index is found in Appendix G.
**SWOS link**

In the beginning, SWOS had no opinion about the inclusion of this key decision. However, when SWOS saw the index being demonstrated, they became supportive of its inclusion.

**ISU experts link**

The concept of an index to find quickly a desired TM platform was presented during a SWOS visit that occurred during the period of September 19-23, 1990. The ISU experts discussed the index as an extension of the previously developed book metaphor and recommended to SWOS that this element be included. SWOS approved.

**Literature link**

An index that is dynamically linked within a hypermedia application is called a hyperindex. It is a potentially powerful element of the design. The hyperindex is a series of node pairs connected to each other by a structural link in the hypermedia program. Bruza (1990) called the hyperindex a new means for supporting effective search in hypermedia and characterized it as superior to indexes based on terms or term phrases. Craven (1986) commented that computer indexes should be created to make it possible for the user to browse through the listings and find desired material. Craven saw this functioning in much the same manner one would browse through library shelves surveying the books on a given shelf.

Soulier (1988) explained that building an index was one of the most time-consuming aspects in instructional design, but the long term value of the index could be judged by the quality of the index itself. The index should be designed so the randomly accessible materials could be easily located through the use of key search words. Bolter (1991) remarked than an index transforms information compiled in a linear modality into a network offering many multiple searching capabilities.
Discussion

The index of the TMCBL consisted of 339 entries that filled nearly twelve screens with alphabetized terms, each of which was a hypertext link to the place in the lesson where that particular TM platform could be explored. Since each of the warship classes contained several individually named vessels, the researcher chose to list vessel names as components in the index. To distinguish them from other TM platforms, vessel names were shown in capital letters while other platforms were shown in capitalized lower case displays. Many of the long, complicated, official names of the Soviet vessels had a North Atlantic Treaty Organization (NATO) designation to assist in recall and categorization. Sample index listings are shown below:

KRASNYY KRYM (Red Crimea)
This vessel was a guided missile destroyer of the Kashin class.

PORVIVISTYY (Impetuous)
This vessel was a frigate of the Krivak-I class.

VOZBUZHDENNYY (Excited)
This vessel was a guided missile destroyer of the SAM Kotlin class.

The index proved to be an invaluable aid to the researcher when it was necessary to check and verify all the data contained in the lesson. The index was a hyperindex, as each of the words in it were connected to lesson pages by a structural link. By using the hypertext links found in the index one could very quickly access any portion of the TMCBL.

#10. Cognitive Map

Description of key decision

A cognitive map can be a tangible printed document on paper or a computer screen, or it can be an understanding of a concept that a learner visualizes. The cognitive map discussed in this key decision is the visible one that appeared on the
computer screen. It helped the user to understand the reference points in the lesson with respect to the total lesson content. A cognitive map assists the user by showing how the current computer screen is a part of the entire lesson content. Each of the lesson pages identified its section, chapter, lesson, and example identification.

**SWOS link**

SWOS had no prior opinion about the inclusion of this key decision. They concurred with the ISU experts regarding its inclusion.

**ISU experts link**

During the period of August and September, 1990, the Project Director made several visits to the home of the researcher to see the evolving prototype as it was being created. It was during one of those visits that the idea for a cognitive map evolved. It was refined and simplified to its present form and included in the preview demonstration given to SWOS during the period of September 19-23, 1990.

**Literature link**

The results of a study by Barba (1993) indicated that the use of an embedded instructional map in computer courseware made a significant difference in student achievement on a cognitive assessment instrument. Barba concluded that software designers should embed interactive instructional maps or visual organizers in instructional courseware.

Maddix (1990) believed that anything that could strengthen the user's internal cognitive map of an application would assist in learning and understanding the package. Maddix cited a study by Patrick and Fitzgibbon (1988) which showed that the presence of a structural display enhanced both speed and error performance. Patrick and Fitzgibbon attributed the enhancement to the relevant ideational scaffolding that the display structure provided. Norman (1991) suggested that the cognitive layout of a
menu selection system may be perceived as a mental map, which displayed graphic representations showing the major locations and connectors for the lesson content.

Jeffries, Miller, Wharton, and Uyeda (1991) spoke of a "cognitive walk through," in which users were walked through the interface of the lesson within the context of core tasks a typical user will need to accomplish. Jeffries, Miller, Wharton, and Uyeda noted that the walk through strategy would be of significant value to designers and other members of a development team, since it built upon the knowledge users were assumed to have and also upon the internal states of the system that were relevant to interactions users have with it.

Waller (1985) proposed building a cognitive map of the materials in which headings, illustrations, and other features acted as landmarks. Simpson and McKnight (1990) found in a study of navigation in hypertext that readers using a hierarchical contents list navigated through the text more efficiently and produced more accurate maps of its structure than readers using an alphabetical index. Simpson and McKnight found a correlation between navigation efficiency and accuracy of the construction of a mental cognitive map of the materials.

Discussion

The value of cognitive mapping was well documented and supported in the literature. Cognitive maps are generally perceived in the mind of the learner while individual schema is created to help the learner formulate recall of the lesson content. Any structural device which assisted in this process became a cognitive enhancer. The upper left corners of the computer screens functioned in this manner.

From a practical standpoint the categories shown in the corner of the screen were to assist the learner to understand fully how this particular screen of information fit into the total TMCBL. An analogy would be the signs one finds in shopping malls or
airports that display maps for the entire complex, and have a sign appropriately placed that says, "You are here." This cognitive map capability prevented a user from becoming lost or trapped, and more importantly helped the user build an internal mental cognitive map.

#11. Motivating and Informative

**Description of key decision**

The key decision motivating and informative implies a high level of user interest and the ability to impart knowledge. Computer applications that are relevant to the learner, easy to use, and generate a sense of satisfaction are considered motivating. Applications which assist the learner to gain or reaffirm knowledge are informative.

**SWOS link**

Another source provided SWOS with a computer-based lesson to assist with the Threat Matrix curriculum. The lesson was difficult and troublesome to use so SWOS discontinued its use. From this experience SWOS knew they wanted something that was easy to use as well as motivating and informative for students and instructors. These program needs were discussed prior to September, 1989, before the researcher became actively involved in the project.

During the demonstrations of September 19-23, 1990, it became apparent to SWOS that the TMCBL had the potential to become very motivating and informative. SWOS approved of the manner in which the program moved through the lesson content and the immediate responses from the SWOS personnel who used the material were positive.
ISU experts link

Demonstrations were presented to SWOS on September 19-23, 1990, to illustrate hypermedia computer applications. The ISU experts specifically chose commercial applications which demonstrated the power of hypermedia, including its ease of use and ability to present relevant facts. These were selected because they were readily available and had been used previously in ISU education classes and were found to be motivating and informative.

Literature link

Keller and Kopp (1987) described their ARCS model (Attention, Relevance, Confidence, and Satisfaction) of motivational design and elaborated on four critical events that needed to be kept in mind. The events were audience analysis, motivational objectives, strategy selection, and evaluation. Keller and Kopp suggested that motivational objectives were an inherent part of an instructional design process, and, as such, should be identified and described by specifying the student behaviors that the instructor wished to observe relative to the motivational factor. The objectives could be cognitive, affective, or psychomotor. A cognitive motivational objective may state that the student will indicate a higher expectancy for success midway through the lesson than at the beginning. An affective objective could be the student will rate the instruction as at least moderately interesting. In the psychomotor objective the instructor might specify a physical activity that demonstrates motivated effort on the part of the students.

Ringsted (1992) described how roles of trainers in corporate classrooms had changed with computer-based lessons for employee training. Ringsted found that the role of the trainer shifted from being a continuous initiator and motivator when using conventional materials to the role of a sporadic expert, motivator, and planner when
using the computer-based materials. Thus, the computer-based system provided much of the necessary motivation for the area of study that had been previously provided by the instructor.

Malone (1984) studied several computer games to determine why the software was so captivating. Malone wanted to know if those same captivating features of the computer game could be used to make other interfaces interesting and enjoyable to use. Malone believed the elements of design incorporated into enjoyable user interfaces were motivators for the user. Malone determined that a successful highly motivating interface contained elements of challenge, fantasy, and curiosity. The element of challenge had a goal that was clearly determined through the interaction with the interface. If performance feedback was given, the user had a better sense of how well the goal was being achieved. Other questions Malone asked of the challenge element included the following: Does the activity have a variable level of difficulty? Are there successive layers of complexity? Does the interface have multiple level goals and include the capability for score keeping? The element of fantasy should embody a premise that is emotionally appealing to the interface situation. Malone suggested that the activity embody metaphors that the user would understand.

While discussing curiosity, Malone asked if the interface used audio or visual effects as decoration, to enhance the fantasy, or as a representation system in itself. Did the interface use the element of randomness that added variety without making the interface tools unreliable? Malone asked if the interface used humor appropriately. Did the interface capitalize on the user's desire to have "well-formed knowledge structures?" Did it introduce new information when users saw that their existing knowledge was incomplete or inconsistent? Malone did not believe that all the features would be useful in all interfaces but did believe that inclusion of features such as
multiple layers of complexity, involvement of metaphors, and useful sound and
graphics, could add important elements that would serve to motivate and encourage
the user to interact with the interface on a more engaged level.

Maddix (1990) has done much work with human-computer interaction (HCI).
Maddix suggested the goal of HCI was simple: "to ensure that the systems produced by
designers for people to use are comprehensible, consistent, and usable." Maddix
inferred that designers needed to take into account the feelings, attitudes, and
motivation of users. Maddix concluded by saying: "Many people sitting in front of a
computer would rather be doing something else. Let's change that" (p. 281).

Discussion

SWOS had a need for this computer-based lesson to teach the Threat Matrix.
Instructors in the TM course hoped the TMCBL would be motivating, as well as
informative. Although the instructional objectives involved the learning of
information, the more motivational the lesson was, the more efficient the TM could be
learned. The TMCBL included multiple levels of learning, individualized use, and the
capability for score keeping. These elements contributed to the motivational
involvement of the learner.

#12. Active Learner Involvement

Description of key decision

Active learner involvement implies a high level of participation on the part of
the learner. Learner involvement can be increased with a higher degree of learner
control. The more a learner can manipulate the learning environment to meet specific
needs, the more involved the learner will become. The "hooks" of this lesson which
created active learner involvement consisted of different elements for different users.
The overall novelty of this new form of instruction was one of them. Others included
the ability to study a SWOS platform via its line drawing, learn its attributes from the pop-up information boxes, and then select appropriate video images for viewing. These elements provided a higher level of learner participation, which caused the learners to be actively involved as the lesson progressed.

SWOS link

In previous conversations with the Project Director, SWOS officials stated that they wanted participation by the students. SWOS approved of elements of the TMCBL which facilitated active learner involvement. Examples included use of color, navigation buttons, specific platform data via the pop-up information boxes, video display icons, and line drawings. Overall active learner involvement was enhanced through the ease of use that learners experienced while using the lesson.

ISU experts link

The ISU experts knew the value of the importance of learner involvement while interacting with computer applications. They incorporated design elements that facilitated this type of reaction into the demonstrations made during September 19-23, 1990. The active learner involvement was obtained by making the lesson intuitive to use and different for each learner each time it was utilized.

Literature link

Carroll and Mack (1984), in discussing human factors of computer systems, argued that "people learn actively, not passively." The researchers studied ten temporary office workers who spent four half-days learning to use one of two possible word processing systems in an educational laboratory. Four of the ten subjects were given a subset of the word processing operations for a general purpose, command based system. The other six subjects were asked to learn basic functions of a commercially available word processor that was menu based. The subjects in the
study were relentless in their desire to learn by trying things out rather than by reading about how to do them. They were reluctant to read long directions or get bogged down following meticulous directions. Carroll and Mack found that the subjects wanted to discover how to do specific things at particular times, and this did not always follow the sequence in which topics were presented in the manual. Carroll and Mack pointed out that future application systems and their training support needed to accommodate the real learner (which they equated with “active” learner). Learners were also active in trying to make sense of their experience with the system and developed hypotheses about why it operated the way it did. This sense of adventure on the part of the learner was triggered by new facts, discrepancies between what was expected and what actually happened, and the learner's personal agenda.

Carroll and Mack found through their study that adapting to using a word processor provided a study of real complex human learning that was fundamentally “active,” driven by the initiatives of the learner. These learner initiatives were in turn based on domain specific knowledge and skill and on reasoning processes. The authors concluded, “Learners do not absorb knowledge: they create, explore, and integrate knowledge. ...the educational technologies that support them, must take this picture of learning seriously” (p. 43).

Vaske and Grantham (1990) suggested that design teams fostered more effective user involvement through interactive exchanges between the product designer and ultimate end-user. The premise here was that the end-users actively assisted the designers in the development and selection of design alternatives. Through this process the resulting design was more likely to engage actively the learners for which it was designed.
Bork (1992) discussed learning with interactive multimedia technology in the Twenty-First Century. Bork asserted that learning should allow for student interaction within the learning process.

**Discussion**

In order to maintain active learner involvement many other attributes of a viable TMCBL need to be inherently a part of the materials being used. Many of the key decisions identified in this research contributed to a sense of active learner involvement by the users. Some examples included the following: hypermedia, video disc, book metaphor, quizzes, index, cognitive map, advance organizers, screen design, use of color, button placement, pop-up information boxes, and line drawings. Within the TMCBL these examples must be manipulated by the learner, and therefore direct the learner toward more active involvement. When instructional design components, such as those listed above, are incorporated into the lesson, then active learner involvement will be more likely to occur. SWOS instructors required students to navigate through the lesson as a part of their TM training. By actively participating with the TMCBL the learners were more involved than they would be if they were passively watching from within the classroom.

### #13. Advance Organizers

**Description of key decision**

An advance organizer is any of a variety of instructional tools that assist the learner to visualize and conceptualize the content to be learned. Advance organizers could be utilized within the design of the lesson or as the lesson is being learned. Advance organizers were found in two areas in the TMCBL. One was the book content page. A second use of advance organizers was with the pop-up buttons designed to assist the learner visually.
SWOS link

Inclusion of this key decision was discussed prior to September, 1989. SWOS wanted to incorporate the elements of advance organizers into this TMCBL.

ISU experts link

The ISU experts incorporated several elements into the instructional design to function as advance organizers. The cognitive map which appeared in the upper left corner of each lesson screen helped learners understand the lesson sequence. Advance organizers assisted learners in gaining understanding of how the lesson portion being viewed on the computer monitor related to the entire body of information contained within the lesson. The element of advance organizers was presented during the demonstrations of September 19-23, 1990.

Literature link

Levine and Loerinc (1985) in summarizing the work of Mayer (1981) concluded, “The use of a graphic advance organizer does have a significant effect on allowing the learner to encode information in a coherent and useful way” (p. 179). Mayer (1979a) said, “Organizers seem to have their strongest positive effects not on measures of retention, but rather on measures of transfer” (p. 382). Mayer (1979b) also has concluded, “Twenty years of research on advance organizers has clearly shown that advance organizers can affect learning, and the conditions under which organizers are most likely to affect learning can be specified” (p. 161).

Snapp and Glover (1990) said advance organizers have distinctly facilitative effects on the quality of student answers. Snapp and Glover also asserted the following:

Advance organizers have their facilitative effect on readers' comprehension by allowing them to more efficiently relate new information to knowledge already existing in their memories. This situation occurs as advance organizers activate schemata relevant to the to-be-learned-material. (p. 270)
In studying the research issues of hypermedia in education, Heller (1990) related Ausubel's (1968) advance organizers to the role of instructional objectives. Heller saw the role of instructional objectives as a way to orient the learner so that the learner decided which material to concentrate on and which to give less attention. Heller concluded, "The use of learning objectives as advance organizers presented before the material, significantly increased intended learning...in some studies incidental learning actually increased" (p. 434).

Williams and Butterfield (1992) said the following with respect to the use of advance organizers: "They constitute a new, appropriate, cognitive structure, provided to the reader in advance of new learning materials, for which it is assumed the reader will not have a cognitive structure appropriate for their meaningful assimilation" (p. 263). Cardinale (1991) used advance organizers in an introductory microcomputer course for pre-service teachers. Cardinale concluded that advance organizers had an important function in the design and implementation of instruction.

While discussing their use, Kurland and Tenney (1988) had the following comment. "Studies on knowledge structures and advance organizers have shown that advance organizers facilitate learning new knowledge and cause students' knowledge structures to more closely resemble those of instructors and the course materials" (p. 158).

Jonassen (1982) said, "Organizers activate the conceptualizing process needed to provide an appropriate context for encoding, retrieving, and applying knowledge" (p. 267). This is accomplished through the integration of new information with the learner's prior knowledge.
The research literature highly validates the importance of advance organizers as a viable instructional design strategy and lends considerable credibility to its inclusion into this TMCBL. Some examples of how advance organizers were implemented within this particular TMCBL follow.

The navigation option of BOOK CONTENTS presented a visual display of sections of a book (USSR, USA, and OTHER), each of which had specific chapters:

- Chapter 1: Surface Warships
- Chapter 2: Submarines
- Chapter 3: Fixed Aircraft (fixed wing aircraft)
- Chapter 4: Helicopters
- Chapter 5: Sensors
- Chapter 6: Weapons Systems

Additionally, the navigation option CHAPTER CONTENTS provided a visual listing of all the classes of warships, sensors, or weapons systems contained in the lesson and placed them within a structural organization. The chart by itself demonstrated a sense of advance organization of the lesson content that was to follow. The hundreds of lesson screens that showed a line drawing of a warship, sensor, or weapons system also contained several hypertext buttons identifying attributes of the particular platform being viewed. When any of these buttons was selected, a small pop-up information box appeared, displaying the specific data for the selected attribute. For example, if one were viewing the example page for the Kirov class of nuclear guided missile cruisers and the red button labeled "Speed" was selected, a pop-up information box would appear to tell the user that the cruising speed of the Kirov was 33 knots. As the learner moved on the Kirov screen and interacted with the numerous pop-up buttons found there, more factual attributes for the Kirov could be learned.
#14. Mnemonics

**Description of key decision**

Mnemonics could be described as any of many learning strategies that allow the learner to create mental filing systems of the contents to be learned. Learners recall terms or phrases that assist them to recall desired factual information. For example, they may relate a body of information to rooms in their house, and as they mentally go on tour of their house, they describe the information they wish to recall. There are many types of mnemonic devices that have been with us for a long time. A full description of several of them can be found in Chapter 2.

**SWOS link**

SWOS wanted students to utilize any memory recall device to assist them in learning the facts of the Threat Matrix. SWOS supported inclusion of any instructional design elements that would facilitate a greater usage of mnemonics on the part of the learner. The inclusion of this specification was discussed prior to September, 1989, before the researcher became actively involved in the project.

**ISU experts link**

The ISU Experts were aware of the SWOS need for utilization of mnemonics by users who interacted with the TMCBL. While the lesson itself could not specifically project a mnemonics strategy on a learner, it could, by way of its design, be easier to use and make its component parts more evident. From the demonstrations given in September, 1990, SWOS was satisfied that the lesson they saw demonstrated, could facilitate the use of mnemonic devices on the part of students who interacted with the lesson. For example, the pop-up information boxes became a mnemonic peg on which to build a memory structure.
Levin and Levin (1990) found that information acquired on the basis of mnemonic instruction was not just remembered better at the rote memory level but was often applied better in a number of thinking contexts. Levin and Levin concluded that mnemonic techniques facilitated users' performance when successful completion depended on accessing relevant factual information.

Higbee (1977) explained how mnemonic systems were viewed quite literally as mental filing systems which helped store information in such a way that it was possible to search memory and find the information when it was wanted. Higbee said that items to be associated were pictured as interacting in some way. The visual images were made vivid through the use of motion, substitution, or exaggeration.

Cermak (1975) suggested that mnemonics seek to impose order on any material a person may want to remember. Mnemonics use schema or organization plans that have been practiced before the specific material to be memorized has ever been seen. Cermak suggested that a mnemonic became a pegboard on which information of any kind can be hung.

Discussion

The use of mnemonics is a highly personal activity. Users must determine if a given mnemonic system or a variation of it will work for them. Many people have remembered the colors of the spectrum by recalling the name Roy G. Biv to remind them of red, orange, yellow, green, blue, indigo, and violet. In the TMCBL the instructional design element of book metaphor, components such as book contents and chapter contents, presented users with an overview of the material contained in the lesson. For example, knowing the integral parts that make up the classes of warships, a user is able to construct a relevant mnemonic. The visuals, such as line drawings
and video disc images, serve as memory pegs. Organizational mnemonics built upon links within the computer based lesson showed the association of parts with one another.

#15. Logical Flow of Lesson

Description of key decision

Logical flow implies that the lesson moves and branches in a predictable way, and, as such, teaches or reinforces semantic structures within the learner. As an instructional design component, logical flow suggests the learner “can always get there, from here.” Likewise, if logical flow is fully implemented, the user would never become stuck in a portion of the computer lesson, having no recourse except to reboot the computer system.

SWOS link

SWOS wanted a program that worked well and was easy to use. Other than that, SWOS had no opinion as to the inclusion of this key decision.

ISU experts link

During the demonstrations of September 19-23, 1990, it became apparent to SWOS that the ISU experts had incorporated structures into the instructional design that facilitated logical flow of the lesson. The ISU experts were aware of the importance of a lesson that moved in a logical manner, and they wanted to incorporate that element into the TMCBL. SWOS approved the result.

Literature link

Tanaka, Eberts, and Salvendy (1991) studied cognitive consistency and displayed consistency with respect to the manner in which subjects in three different treatment groups interacted with computers being used to complete a word processing task. Tanaka, Eberts, and Salvendy found that low cognitive consistency (e.g. lack of logical
flow of the lesson) and low display consistency (e.g. lack of consistent displays from one screen to another) had detrimental effects on performance. Tanaka, Eberts, and Salvendy also found that low cognitive consistency had a larger detrimental effect on task completion time.

Millheim (1990) completed a study to examine the effects of learner control versus program control of pacing and sequence in an interactive video lesson on photography. Millheim's results showed that learner control was a significant factor in terms of achievement and time on task of the learners. Millheim concluded that learner control may be an important variable to be considered when designing effective instructional materials.

Martin (1990) believed the logical structure of a computer application should be compared with the physical structure. The physical structure referred to elements such as page layout, line lengths, typographical styles, margin headings, and other aspects of the document's appearance. Martin continued to say that the logical structure referred to the hierarchical arrangement of program segments and how diagrams linked to text and other devices that gave the program structure. Martin also pointed out the importance of combining linkage to other components such as: table of contents, index, numbering scheme, and cross-references. Martin concluded by saying the challenge was to use the computer screen to add features that a paper version of the document did not have.

Discussion

When learners experience a sense of logical flow, a higher degree of relevance is evident and learners are more on task. Through the hypermedia component in this TMCBL, the learner soon discovered there was no “set way” to progress through the lesson's material, which had dozens of multi-branching paths available for learner
use. The hypermedia capability not only kept the learners more involved, but since it was done logically through the lesson design, the learners could easily interact with the desired lesson components. The strategies of the cognitive mapping screen elements also contributed to a logical movement within the lesson.

#16. Screen Design

*Description of key decision*

Screen design is a critical component of computer-based lessons. It includes attention to instructional space, placement of text, and aesthetic appearance. It is important that an appropriately sized work space be consistently located on all screens displaying lesson information. Other information central to the lesson should be placed around this area. For maximum consistency, repetitive screen information should be located in the same space for all screens. Attention should be given to the placement of screen components to cue appropriate cognitive behavior.

*SWOS link*

SWOS had no prior opinion as to how the screen should look. SWOS responded supportively to the examples which were shown. A series of demonstration screens was presented to SWOS on September 19-23, 1990, and SWOS approved of the manner in which they were designed.

*ISU experts link*

The ISU experts decided that the upper one third of the screen would contain cognitive mapping information in the upper left and navigation movement choices in the upper right. The remaining lower two-thirds of the screen would serve as the functional space where line drawings of TM platforms would be displayed, and a series of pop-up buttons and video disc icons would be placed.
Ziegler (1988) discussed the “gestalt” of the screen as being made of three major components. Similarity referred to the elements which are the same with respect to color or shape and are drawn into groups. Proximity pertained to the placement of similar elements close to each other. Symmetry suggested that elements which are proportionately arranged are drawn together.

Ziegler suggested screen displays contained four types of information which were necessary for interactive communications. First, the display must contain the information directly relevant to the task the user is experiencing. Second, elements of control must be available and evident. Third, the status of the information must be identified. This element helps the user understand location within the software and provides assurance that the application is functioning properly. The last element he calls explanatory information; it includes functions such as error messages, help, and instructions for the user. Ziegler believed there should be distinct areas of the screen that contain the information the learner is utilizing, and other distinct areas that are reserved for informational elements to guide the user through the application.

Norman (1991) cautioned the designer about the quantity of information to be displayed. Norman suggested the more information present, the more difficult and time-consuming it is to search for the target information, read, and process it. Norman also pointed out that readability is affected by the density of text on the screen and suggested that no more than 30% of the available character spaces on the screen should be used. Norman commented that icons clearly provided positive benefits as components of graphic menus which should be carefully selected to depict concrete objects.
Fleming (1987) said, “Lean displays focus attention” (p. 236). Fleming suggested inclusion of only the most relevant information because the display and its elements that appear similar tend to be grouped in perception and associated in memory. Fleming cited Mills (1980) as saying, “Pictures and words can be reciprocally beneficial; words can delimit and interpret pictures, and pictures help define, exemplify, and make memorable words” (p. 242). Fleming also commented that a connection existed between display organization and advance organizers. The more meaningful the display was, the less drill or repetition necessary to memorize it. Fleming summarized by saying that in order to have screen displays that communicated, the designer must attend to learner needs of stimulation, order, and strategy, because the learner seeks stimulation from the material displayed and responds well to a sense of order within the organization of the material. Last, there needs to be some strategy or method the learner can use while interacting with the stimulation and order found in the materials.

Hannafin and Peck (1988) discussed functional zones within the instructional frame of the application. The authors suggested that a given unit of instruction taking place on a series of sequential screens be arranged in such a manner so that the screen images are found in the same location or zone each time they are presented.

Hannafin and Hooper (1989) described the importance of consistent frame design to cue appropriate cognitive behavior. They believed attention to this element of frame protocol helped to establish an anticipatory set which cued the learner as to how the information was to be used. The authors also discussed ways headings and outlines promoted organization. An outline could help to provide a schema useful to the learner, while headings could provide clear relationships between the lesson concepts and content. The element of consistency would help learners become
accustomed to finding the instructional elements more readily. The screen should be
easy to see and interpret and should not be cluttered by excess information.

Discussion

The ISU experts made several screen design decisions which affected the final
appearance of the computer lesson screens. The researcher decided to keep the screen
black so the color elements could be displayed at their optimum chroma levels. The
screen was framed and divided by small narrow lines to focus the learner's attention
into designated areas.

The upper left portion of each of the TM platform screens contained the
cognitive mapping information, which built on the book metaphor previously described.
For example, the color red was used to identify the USSR section of the book being
studied. The next line was an identification of chapter number and name, that was
presented in light blue. The third line was a lesson designation by number and name
and was rendered in bright green. The last line identified the example being shown by
number and name; it was presented in yellow.

The upper right corner contained hypertext navigation buttons that could take
the user to the cover, the preface, the book contents, the chapter contents, the index, or
the previous screen. All these buttons were presented in light blue, except for the one
for chapter contents, which was done in the same bright green color as the lesson
designation. In this instance, the use of color was a factor to help the learner focus on
the fact that the chapter contained the lessons and the examples. Conversely, a list of
lessons and examples could be viewed by selecting the green button called chapter
contents.

Most of the TM platform screens had from one to four video disc icons displayed
below the navigation section. The icon looked like a stylized computer and monitor and
was depicted in either red or green. If the video disc segment was a motion segment, the icon was green for “go” or motion, and if it was a stop frame or still, then the icon was red for “stop.”

When working with the computer lesson on the Zenith machine, care was taken to place the elements on the screen in a clockwise manner. The blue borders of the screen were drawn first, and then the screen elements began to appear in the upper left and move clockwise to upper right, lower right, lower left, and back to upper left again. On the slower 286 microprocessor it was visually important that the screen design elements be drawn in this order to avoid having them pop onto the screen out of sequence. When SWOS moved the TMCBL to a Zenith with a 486 microprocessor, the drawing order was not obvious, as the image literally jumped onto the screen. It was drawn so fast that the order of screen drawing did not matter.

#17. Use of Color

**Description of key decision**

Color is a screen design tool which can be used to emphasize or add a sense of classification to text or graphic images. Like any other instructional tool, it should not be overused. It should enhance and not detract from the information it is presenting on the computer screen.

**SWOS link**

SWOS personnel had no preconceived idea about what color the components of the display screen should be. SWOS approved the color layout scheme suggested by the ISU experts, but wanted a few of the strategic label buttons to be red instead of light gray. On November 27, 1990, in a phone call with a SWOS instructor providing leadership and coordination for this effort, SWOS chose to have the labels of Speed,
Range, Weapons Systems, and Sensors be displayed in red. The base screen designs were changed to accommodate that request.

**ISU experts link**

The ISU experts selected a black background screen, as it would add the most brilliance to the placement of color text or graphics. It also eliminated the problem of a font color appearing to be incompatible to a background color, thus causing flaring or distortion of the colors. Linkway makes available a palette of font or graphic colors to use for displays, and while all were not used, many of them were. A different color was used for each color of the cognitive map. Red was used to identify the section, and the name USSR, to be consistent with the red Soviet flag. The blue, green, and yellow colors of the cognitive map for chapter, lesson, and example headings were chosen to provide visual variety among the labels. Color images of screens created for this TMCBL can be found in Appendices B, C, and D.

**Literature link**

Grice (1989) suggested that use of color aided learning by making the information more distinctive or memorable. Color should be used for a reason. Using it too much or randomly was distracting and caused users to misinterpret the information as they attempted to understand the reasons for the color.

Shneiderman (1987) enumerated advantages to using color in displays: soothing or striking to the eye, adding accent to an uninteresting display, facilitating subtle discrimination in complex displays, and emphasizing the logical organization of information. Shneiderman supported the use of color as a coding technique, because it led to more rapid task performance and higher satisfaction. However, Shneiderman cautioned that the coding scheme should be consistent throughout the system for continuity.
Albers (1963) wrote of the importance in understanding the interaction of colors and the awareness in which they interact with one another. For example, large areas of red and blue should not be placed next to one another as they are on opposite ends of the spectrum. Muscles of the eye are strained to produce a sharp focus for both colors simultaneously. Similar combinations exist with yellow on purple, or magenta on green. Likewise, too little contrast was also a problem as demonstrated with yellow letters on white or brown letters on black.

Long (1989) discussed the use of color display elements on submarine command and control systems. The use of color in the displays reduced perceived clutter and supported the use of mental representations to formulate and execute tactical plans more readily. Campion (1989), in researching color verses monochrome screen displays, found that given a display in which display areas are well separated, use of color seemed to help in making clear distinctions between features which remained obscured in monochrome.

Thorell and Smith (1990) strongly supported the use of color as a unique type of coding. Thorell and Smith told how it could reduce the need for detailed explanations, show relationships and status, highlight, and aid in learning. The color coding could be applied to a variety of images including pictures, symbols, icons, and text. However, as the number of colors increased, the advantage of color as a coding technique decreased. Thorell and Smith also mentioned that high brightness contrasts attracted information first, while low brightness contrasts subdued information. Thorell and Smith commented that red, blue, green, and yellow were the colors most useful for coding information that needed to be remembered. Thorell and Smith based the conclusions on many studies that included subjects from greatly diverse populations, including New Guinea tribesmen, English children, adults, and monkeys. These four
colors attracted attention more than other colors and were generally preferred across all cultures.

Andriole (1983) suggested that since short term memory only holds five to seven items at a time, the use of more than seven colors for identification purposes was not a good idea. Andriole also believed one should adhere to conventional color designations, such as green meaning “go” or “move forward” and red meaning “stop.” Consistency was important and color codes should not be varied within a system.

Heines (1984) cautioned to be certain that adjacent colors complemented each other and also to avoid colors that were too “hot.” Heines mentioned that display text in any of the three monochromatic colors of red, green, or blue was usually sharper than text from any resulting color combination. Heines recommended text in green or blue, as it was softer than red.

Reid (1984) also supported color coding used redundantly throughout the display to reinforce the user’s understanding. Reid commented that a maximum of five distinct colors could be utilized at the same time for graphic displays.

Thompson (1984) cautioned designers that about 8% of the male population and slightly less than 1% of the female population have some color vision deficiency. A large number of people with some kind of color blindness are unaware of their deficiency, and some do not fully realize it until they sit in front of a color computer monitor.

Martin (1990) commented that one can say things through the use of colors that would best be avoided on a monochrome diagram. Martin also commented that too many colors cause confusion. Martin cautioned, “Although computer graphics tools make it easy to generate charts rich with color, the need to communicate well should override the urge to decorate colorfully” (p.130).
Reynolds (1982) related that images in complimentary colors or white tended to be less sharp than images in primary colors and differed considerably in luminance. If white was regarded with a luminance of 100%, then green had a luminance of 59%, red 30%, yellow 89%, cyan (greenish blue) 70%, and blue 11%. Reynolds summarized that there are some colors with a higher degree of luminance that will show up better against a black background. However, individual instances varied with monitor quality and shadings of the primary colors. Reynolds also mentioned that use of colors can cause confusion and misunderstanding for the user.

Dwyer and Moore (1992) assessed the impact of instructional color coding on visually and verbally oriented tests and on field dependent-independent subjects. A group of 119 undergraduate college students were randomly assigned to one of two treatment groups (color or black and white instruction). The subjects within each respective treatment received four dependent measures which assessed four different types of educational objectives. Results indicated that color coding was an effective variable for maximizing information acquisition levels.

Benbasat and Dexter (1986) assessed the influence of color and information presentation differences on user's perceptions and decision making under varying time constraints. The information was presented in three different modes: tabular chart form, graphical form, and a combination of both. Color led to improvement in decision making and was especially effective when high time constraints were present.

Travis, et al. (1990) investigated the effects of chromatic and luminance contrast on reading colored text on multicolor displays. Results indicated that any combination of text and background colors was suitable as long as the combination maintained adequate luminance and/or chromatic contrast. That is, as long as the text stood out
enough against the colored background and the color combinations did not clash with one another, the combination was acceptable.

Hardin (1990) commented that rendering a visual display in color, rather than black and white, shortened the time required to find a particular object in the display by as much as one-third. Hardin concluded, "With color, the medium is the message" (p.299).

**Discussion**

A consistent color scheme on screens was assured because all of the TMCBL platform screens were drawn using a base screen as the template on which other information was presented. *Linkway* utilizes several layers of information on the screen that appear to be one screen when displayed. The layer to the extreme back is called the base page. *Linkway* stores pages related to a given base page in a folder; thus all of the pages (screens) which were produced displayed the elements found on that folder's base page. From a design standpoint, this was an important concept because the instructional designer could make one change on the base page and have it seen on all the other pages in that particular folder. By carefully placing color and screen components on the base page, the designer would be assured that each screen in that particular folder would appear the same way.

Building on the utilization of a base page, some conventions relative to the use of color were implemented. Any reference to examples was always done in yellow, while reference to lesson names was done in bright green. Chapter numbers and names were done in light blue, and the section designation (USSR) was always displayed in red. The navigation buttons for cover, preface, book contents, index, and previous screen were always presented in light blue. The button for chapter contents was bright green, so that particular choice stood out and demonstrated a relationship to the
lessons and examples being presented. When a student wanted to see a new example, a button was selected from which a lesson choice selection could be made.

Color was used effectively in the video disc icons. If the video disc sequence to be shown for a particular example was a still, the icon was red for “stop frame.” If the video disc sequence was a motion sequence, then the icon was green for “go.” By choosing a color system for a definite reason, the color and its use served both an instructional and an aesthetic purpose.

In summary, specific colors were used to enhance the lesson. Buttons identifying pop-up information boxes used a consistent textual color to identify the type of information contained inside. Information that was considered strategically important was identified with a red text label. Additionally, the cognitive map area in the upper left corner used different colors for the categories of section, chapter, lesson, and example.

#18. Text Readability

*Description of key decision*

Text readability refers to the ease of reading print. Variables for text readability can include font size, character width, kerning, and justification. Computer applications typically address text placement differently than type set text. For the purpose of this study the term text readability refers to message readability on the screen.

*SWOS link*

SWOS had no prior opinion about the inclusion of this key decision. SWOS concurred with the ISU experts regarding its inclusion and approved of subsequent action.
**ISU experts link**

The ISU experts were concerned about getting too much text on the screen. This would tend to minimize the manner in which the display communicated. The ISU experts chose a 12 point font with serifs since it most resembled what people read in books and magazines. Some larger display size fonts were used for headings on the cover, preface, and other start-up screens. Left justified text was used throughout the TMCBL. The composite arrangement of text size and readability was presented to SWOS in September, 1990, during demonstrations. SWOS approved the text design and readability.

**Literature link**

Heines (1984) suggested message clarity was a prerequisite to the success of any communication by text. Heines mentioned other factors which contributed to the readability of text on the screen: type style, line length, justification, and break points. Heines believed that lower case letters had a more positive effect on readability. Heines suggested that some systems now provide for “descenders” on the lowercase letters g, j, p, q, and y. Although children had trouble deciphering these letters the first time they saw them, they adapted quickly.

Hooper and Hannafin (1986) identified the following textual implications when designing computer-based instruction.

1. If the option exists, left justification should be chosen over both center and fully justified text.

2. When possible, text should be presented at a character density of 80 characters as opposed to 40 characters per line. Given comparable legibility, text will be read more efficiently when it is presented in a dense manner.

3. Within practical limits, text should be designed to feature greater numbers of characters per line. Longer lines of text are generally read more efficiently from the computer display than shorter lines.
4. Leading of text should be increased as text density increases. As text becomes more dense it should be double spaced to make it more readable.

Martin (1990) believed that since many computer screens were seen only briefly, one should use typography that communicates as easily as possible. In general, humans responded rapidly to familiar patterns. Thus, unfamiliar ones retarded reading. Martin also believed that font which was in all capital letters retarded reading, as the eye was accustomed to reading in lower case.

Frase and Schwartz (1983) researched typographical cues to facilitate comprehension in printed text. Frase and Schwartz found in their studies that meaningfully segmented and indented text resulted in a 14% to 18% faster response time than standard text. Both segmenting and indenting significantly influenced reader's performance. Frase and Schwartz determined that a variable shown to be most critical was whether the format resulted in a display of easily encoded units, regardless of length or neatness of margins.

Heines (1984) wrote that just because the line length allowed 80 or more characters per line, did not mean one should display text in that format. Heines mentioned a rule of thumb for printed information was to limit the number of words per line to approximately the reader's age until the teen age years. Heines suggested the lines for the computer screens should be even shorter, with a limit of eight to ten words per line for adults.

Heines made a case for considering text elements such as boldface, reverse video, underlining, blinking or flashing, size, rotation, and color. These were valuable for adding emphasis, but should be used with restraint as overuse could seriously impair readability and make the screen less visually appealing.
Tinker (1963) commented that as early as 1914, studies had shown that text set in Roman font, lower case was read 10% faster than similar material set in all capitals. A later study replicated by Tinker, achieved similar results. Tinker found that letters in lower case were interpreted as word units when read, while all capitals had to be deciphered letter by letter. Additionally, all capitals took up at least one-third more space than lower case.

Duchnicky and Kolers (1983) found that subjects were able to read and comprehend scrolled text presented in a variety of window sizes. Duchnicky and Kolers determined that speed of reading scrolled texts accelerated with increases in line length, character density, and window height, with window height having less effect than the other two variables.

Jonassen (1983) investigated the use of blocking text with horizontal rules and providing headings of different types. Headings could be encoded or function as access structures, while blocking techniques for segments of text provided retrieval cues. Jonassen found that headings benefited only younger, less-developed learners and that older, skilled learners employed their own strategies which often do not involve blocking.

Heines (1984) pointed out that right justified text had a detrimental effect on readability, because its effect is different on a computer screen than it is when typeset on paper. Heines identified these reasons: (1) text on paper has variable letter widths, (2) text on paper can utilize kerning which overlaps some letter combinations and reduces inter-letter distances, and (3) text on paper can have spaces added between letters so left and right justification is more pleasing to the eye.
Discussion

The text considerations made by the ISU experts in this TMCBL were limited to the capabilities of the Linkway software. Concern was given to make the screens informative, but yet still readable. While some of the charts and preface screens used larger font for emphasis, most screens used a 12 point font in either upper case or lower case with the first letter capitalized. Because there is research to discourage the use of text in all capital letters, it was used here only for word labels on buttons and was not used to display several sentences of information. Lower case letters were used on screens for directions, background information, or as labels on pop-up buttons. All text was left-justified.

#19. Hypertext

Description of key decision

Hypertext is printed text viewed on a computer screen that is linked to some other element in the computer-based lesson. It looks like normal printed text when viewed on a computer screen. Hypertext may be the same color and shape as other text on the screen or it may be highlighted in some manner. The power of hypertext occurs when it is selected by pointing the arrow to it and clicking the mouse key. The user is then taken to a link that has been programmed specifically for that word. It is used in various ways to explain documents or serve as an on-line glossary. In the TMCBL the hypertext used was in the form of labels that directed the user to another link in the program hierarchy.

SWOS link

SWOS had no prior opinion as to the inclusion of this key decision. SWOS concurred with the ISU experts regarding its inclusion and approved such action.
ISU experts link

The ISU experts knew there would be hundreds of hypertext links needed for this TMCBL. The concept of clicking on a text covered button whether in HyperCard or Linkway functions basically the same. SWOS viewed the initial hypermedia demonstrations during the period of January 6-9, 1990, and were impressed with the hypertext capability. When they saw it implemented in their Threat Matrix materials during the demonstrations presented September 19-23, 1990, SWOS approved.

Literature link

McKnight, Dillon, and Richardson (1991) suggested that hypertext was based on organizing and accessing information, and, as such, would have an important role in the development of information technology which would ultimately shape society. The importance of hypertext resided in the fact that it could alter the way in which people read, write, and organize information. Any powerful information access and retrieval strategy would have far reaching effects that would extend to the office, the school, and even the home.

Marchionini (1989) believed that hypertext/hypermedia systems had three characteristics that made them attractive for information processing and for teaching and learning in particular. First, they integrated a variety of formats and a voluminous amount of information. Marchionini stated that first, users must acquire a new type of literacy to benefit from the opportunities for learning that hypertext/hypermedia offers.

Second, they are enabling rather than directive systems. That is, users directed the learning paths in a way that was meaningful to personal needs and styles. Learners constructed their own knowledge by browsing in hyper documents according to associations of their own cognitive structures.
Third, they facilitated interactions among people and machines as well as among groups of people. Students became collaborators with the system by downloading sections they needed for inclusion into papers or reports. Students identified and shared their own learning paths through the hypertext/hypermedia material, and in sharing with their instructor, began to open new opportunities for teacher-learner collaboration.

Meyrowitz (1989) saw hypertext and hypermedia as having the same potential as the cut, copy, and paste paradigm of computer software applications. Hypertext and hypermedia have now been demonstrated via steps one and two as described above, yet it could only increase in use if factors three and four could be fulfilled. When this has occurred, Meyrowitz feels people will accept and integrate hypertext and hypermedia into their daily work processes.

Martin (1990) remarked that when the user first opened a hyper document on the screen, its organizational structure might not be readily apparent. The software should make the structure visible and guide the user so that the user could find information that was personally valuable.

Landow (1992) commented, “All hypertext systems permit the individual reader to choose his or her own center of investigation and experience” (p. 13). This meant that the reader was not locked into any specific organization or hierarchy. Duchastel (1989) explained that hypertext and hypermedia characterized the beginning of the Age of Information Access. Hypertext/hypermedia was not defined by the wealth of information it made available or by mapping that information or collaborating with others. Instead, it was defined by its capability to access quickly additional information that is related to the current topic of consideration.
Nielsen (1990) described hypertext as "non-sequential" (p.1), in that there is no order that determined the sequence in which the text was to be read. Shneiderman (1989) enumerated three golden rules of hypertext: (p. 115)

1. There is a large body of information organized into numerous fragments.
2. The fragments relate to each other.
3. The user needs only a small fraction at any time.

Slatin (1991) in discussing hypertext stated that none of the numbers, dates, facts and other data could truly be considered information until it had been contextualized in such a way that the significant differences and significant relationships among the information became apparent to the reader. In Christopher Dede's words (1988), this was when information became knowledge.

Discussion

The Linkway authoring software was designed to create and use hypertext to achieve a variety of educational program objectives. Many of the buttons or links in this TMCBL were visually transparent, but contained a colored field with text over them; thus the word INDEX was actually a hypertext button that caused the computer program to branch to that part of the lesson and then display the index. Often a dozen different words on any given lesson screen had this hypertext capability. The hypertext was placed on navigation buttons to facilitate movement within the TMCBL.

#20. Navigation Aides

Description of key decision

Navigation aides are program structures that either serve as a road map to help a user find a way through the lesson elements or take the user to a requested place. In this TMCBL the navigation aides were of both types since some of them did
serve as a road map, while others allowed users to find their way through the program and quickly move anywhere within its structures to find a desired instructional screen.

**SWOS link**

SWOS had no prior opinion regarding the inclusion of this key decision. However, SWOS realized the former computer lesson that had been produced was lacking in navigational aides and often left users with no apparent way to exit the lesson. SWOS concurred with the ISU experts regarding the inclusion of navigational aides and approved such action.

**ISU experts link**

ISU experts incorporated a variety of user navigation aides in all versions of this TMCBL in both HyperCard demonstrations and the resulting Linkway formats. The navigation aides were included to provide maximum user control of movement within the computer-based lesson. The navigation aides were apparent in the demonstrations of September, 1990, and continued to be incorporated in all versions of the TMCBL.

**Literature link**

Gay and Mazur (1991) stressed the importance of consistency and flexibility when designing navigational aides in computer software. Screens were designed so that similar events served similar functions. A consistent level of control was available on screens throughout the computer lesson, and the user always had the option to return to a home base location within the program. Gay and Mazur stressed flexibility because the navigation tools are intended to accommodate a variety of users. That is, there was more than one option to move around, and users easily found what they needed and used it.
Gay and Mazur discussed the value of overview maps to orient students both spatially and thematically. The premise of the map was that if the user clicked on a specific portion of the map, the user was taken to that section of the program. The maps became visual organizers and graphically guided the user to a desired program segment.

Bernstein (1991) believed that appropriate navigational tools in hypermedia applications can achieve three aims for users: empower the user, encourage adventurous exploration, and increase dramatic intensity. Gay, Trumbull, and Mazur (1991) concluded that future designers of software should continue to develop highly visual and interactive systems to assist users in finding pertinent information. Gay, Trumbull, and Mazur also found that users needed adequate learning and practice to be successful navigators, and if the access was flexible and effective, motivation was enhanced and anxiety was reduced.

Martin (1990) wrote of the value of building visual aids to navigation and the creation of a hierarchy to help guide users through the program. Martin suggested users should be able to backtrack immediately over the links that had been followed to reverse any action taken. Martin also said that if the user felt lost or was lost, the user should be able immediately to return to a “home” position, so a different route could be utilized.

Shneiderman (1989) supported navigation design strategies that ensured simplicity. The link structure within the program needed to be simple, intuitive, and consistent, and movement through the system needed to be effortless and require a minimum of conscious thought. Shneiderman suggested designing simple, comprehensive, and global structures that users could use as a cognitive map.
McKnight, Dillon, and Richardson (1991) pointed out that a consensus of the experts in the field revealed that navigation was the greatest single difficulty for users of hypertext. That is, structures were needed which helped users understand how the information was organized and assisted them in finding it to return to a point of origin.

Landow (1991) pointed out that orienting readers in hypermedia was a major challenge. Systems were often disorienting when users found themselves locked into the program with no sense of where they were within the document and did not know how to return to a document read earlier. Landow asserted that designers must provide devices within the hypermedia system that stimulate the reader to think and explore and, at the same time, permit enjoyable navigation through the materials. Devices of orientation allowed users to determine their present location, to have some idea of that location's relation to other materials, to return to the starting point, and to explore materials not directly linked to those in which they presently found themselves.

Jonassen and Grabinger (1990) concurred that the most commonly identified users' problem in hypermedia was that of navigating through it. The authors challenged the instructional designers to consider these questions: (p.15)

- How do users navigate, unaided, through unstructured hypermedia systems?
- What individual differences will predict the paths they choose to follow?
- How much navigation guidance should the users receive?
- What forms of structural cues are most effective in aiding navigation?
- How structured should the hypermedia be?
- How should this structure be represented?
- How important is knowing the "purpose" in helping the hypermedia user?
Nielsen (1990) favored the use of guided tours to acquaint users to the structure and purpose of the hypermedia application. Nielsen also supported the use of overview diagrams to assist the user in determining location within the hypermedia application.

Pintado and Tsichritzis (1990) considered navigation based on the concept of affinity, which represented the conceptual relationships that humans utilized in everyday life to construct a cognitive structure over a generally loosely-structured world. As such, this element of navigation supported multiple views of the same world from different perspectives.

Friedlander (1991) suggested designers needed to offer comprehensive directors and clear spatial maps of the structure of the program, and offer first-time users guided tours and short journeys through the materials. Friedlander asked when users open the program, did they see a screen that was inviting, simple, and reassuring? Could users intuitively navigate through the system, and determine what the buttons and icons mean? Did the design tell the user what the program was about, what it was for, and how to proceed?

Discussion

One of the first design elements the researcher incorporated into the TMCBL was the ability to move through the various screens and folders to build the lesson components. It was important to place the navigation aides on the pages and link them to test pages so one could determine if they worked properly. As the many hundreds of design elements were added to his lesson, it also saved the researcher much time when there was a need to move quickly from one part of the program sequence to another during the building of the lesson. There were easily more than a thousand navigation buttons found within this program that took the user to numerous places within the
lesson. Navigation aides in this lesson allowed the users to move through the material at their own pace to achieve their individual instructional goals.

#21. Button Placement

_Description of key decision_

A button in a computer application is a linking point that evokes some kind of action. In this TMCBL the buttons served one of three purposes. Some buttons were icons that started a video tape player and presented a video still or motion sequence. Other buttons were covered with hypertext which linked them to additional sections of the program. The third type of button was called a pop-up because when it was selected, a small text field popped up to be read. Button placement refers to the location of where the buttons are placed to achieve desired instructional objectives.

_SWOS link_

SWOS had no prior opinion as to the inclusion of this key decision. SWOS concurred with the ISU experts regarding its inclusion and approved of subsequent action.

_ISU experts link_

Like the navigation aides, buttons were part of the design envisioned by ISU experts from the beginning stages of this project. The buttons provided the connecting link to join elements of the computer-based lesson together, and also to present video disc images and data contained in pop-up information boxes. All demonstrations and prototypes utilized buttons extensively for the purposes given in the description. Button placements were fully demonstrated to SWOS during September, 1990.

_Literature link_

Canter, Rivers, and Storrs (1985) identified five modalities which described the way users navigated and interacted with a data base. (p. 93-102)
• Scanning: covering a large area without depth.
• Browsing: following a path until a goal is achieved.
• Searching: striving to find an explicit goal.
• Exploring: finding out the extent of information given.
• Wandering: purposeless and unstructured

In order to experience the above modalities, linking buttons needed to be placed appropriately on program screens for optimum user interaction. Fleming (1987) commented the placement of buttons for navigation purposes needed to be done in such a way that it did not clutter the screen display area. Fleming suggested the more meaningful a display was, the less drill or repetition necessary to memorize it. Hannafin and Peck (1988) discussed functional zones of instructional frames. Buttons for program links needed to be placed carefully within these zones to ensure instructional effectiveness of the presented frame.

Martin (1990) described buttons as serving one of the following functions: a word in text, a contiguous group of words in text, a marked area of a diagram, or a label on part of a diagram (p. 5). When the button was selected it could link to other program components such as the following:

• A line of text
• A segment of hyper document containing a concept
• Another document
• A picture
• A moving video or animation sequence
• A program (p. 7)

Martin described results obtained when a button was activated: (p.7)

Open/close: A document or segment of a document may be opened so that the user can read it or closed so it becomes an icon or title line.

Expand/contract: An item on the screen may be expanded into more detail or contracted back to one line.
Jump: A different part of the program is displayed.

Display a definition: A glossary definition is displayed in a window.

Display a moving diagram: An animated picture is displayed.

Display a tutorial: A tutorial explanation of the button word(s) is displayed.

Display a note: A note is displayed in a window.

Display a diagram: A diagram is displayed relating to the button words.

Display a moving diagram: An animated picture is displayed.

Play a sound sequence: Recorded sound is played. For example, spoken explanation of a chart.

Display a video sequence: A television sequence may be displayed on the whole computer screen, in a window, or on a separate screen.

Execute a program: A program is initiated. For example an expert system, a spreadsheet tool, or a program to which the hyper document is subordinate.

Martin also commented about the placement of buttons on a diagram. Martin believed an important characteristic of hyper document software was the ability to display buttons in the proximity of a diagram and hyperlink from it. The button(s) could be displayed in a box surrounding a portion of the diagram, and each of them could have a hyperlink to a different target. The user should be able to display the buttons in rapid sequence, selecting any button of interest, and hyperlink from it to the selected material.

Discussion

Decisions for button placements were made for optimum user interaction. The buttons in the TMCBL were one of three types: icons to show video disc images, hypertext buttons that moved the user to a different location, or pop-up information boxes. The video disc icon buttons provided a link to the video disc for the display of still frames or motion sequence images. The hypertext buttons were navigation aides to
move the user through the program. The pop-up information boxes were activated with a hypertext button, but opened to display a scrolling field of data.

#22. Pop-up Information Boxes

*Description of key decision*

A pop-up information box, as its name implies, is an invisible text field that literally pops-up when a button linked to it is selected. The field can be many sizes, and if there is more text to display than will fit into the field, the field can scroll to hold as much information as desired. The pop-up information box remains on the screen until the user clicks in its upper left corner to put it away. An advantage of the pop-up in the TMCBL was that it could be superimposed on or near a line drawing of a surface warship, sensor, or weapons system. This arrangement allowed the user mentally and visually to link the line drawing with the factual data contained in the pop-up.

*SWOS link*

SWOS had no prior opinion as to the inclusion of this key decision. SWOS concurred with the ISU experts regarding its inclusion and approved such action.

*ISU experts link*

ISU experts had planned to include this element in any application that was developed for SWOS, regardless of which computer platform was used. The value of the pop-up information boxes is found in its ability to remain superimposed on an instructional screen display. This allows the user not only to read the data contained in the pop-up, but also to maintain visual and mental contact with the instructional object being displayed. For example, while viewing a line drawing of a ship, users could select from a variety of pop-ups, read their data, and still make the visual and mental connection between the pop-up data and the line drawing of the ship. Pop-up
information boxes were demonstrated for SWOS in September, 1990. The concept was enthusiastically approved as an essential design element.

*Literature link*

Shneiderman (1986) stated an advantage of the pop-ups was that they provided for fast usage of information and program direction and speeded up the users' acclimation to the structure in the program. Pop-ups also provided necessary information via scrolling fields for a particular screen. When not needed, pop-ups were out of the way and left the display screen uncluttered so significant screen spaces could be better utilized.

Palay (1992) believed dialogue boxes and pop-ups should be viewed as shared components, in that their usage was shared throughout the application in a consistent manner. That is, the pop-up boxes and the scrolling bars within them should be comparably designed in their appearance and used throughout the entire application.

Aspillagra (1991) found that learning was enhanced by the availability of the whole picture, plus the label, which was located in a place that was not blocking relevant aspects of the graphic. Learning was also enhanced when the label (pop-up scroll window) was placed in a consistent location.

Stark (1990) commented that an advantage of pop-ups was that they retained a constant visual context of the lesson since they emerged from the current screen display. Dynamically linked to the displayed screen, they reduced the perceived distance from the source to the supplementary information they presented. In this manner, the cognitive continuity of the information between the pop-up and the current display screen was maintained more effectively than if the user went to a totally different screen for the selected information.
Discussion

The pop-up information boxes were an important part of this TMCBL since they were the instructional metaphor through which the technical data was communicated. The pop-ups allowed the user to continue looking at the line drawing of a ship, sensor, or weapons system component, and click on the hypertext labels to read the desired data. By displaying the pop-up information boxes on top of the selected lesson screen, the user was able to see a relationship between the data and the TM platform the data represented. This type of instructional design had the potential to increase schema development in the user, and thereby increase the user's ability to recall the data and the platform that was associated with it.

#23. Use of Line Drawings

Description of key decision

Line drawings for purposes of the TMCBL were from official Naval sources and were scanned and saved as digital files that could be called up from within the Linkway program. The line drawings were of surface warships, sensors, or weapons systems and showed profile images of these Threat Matrix platforms. Samples of line drawings can be found in Appendicies B, D, E, and F. In this program application the line drawings were presented in light gray against a black background. However, in the quiz section for line drawings, the graphics were depicted in white against a blue background.

SWOS link

SWOS had inherited dozens of scanned line drawings as components in a previous computer application that was developed. While the computer application was not user friendly and had been discontinued by SWOS, its line drawings were salvaged and utilized for this TMCBL. SWOS felt they were an important way of
learning to recognize TM platform attributes. SWOS wanted them included in this lesson.

ISU experts link

The ISU experts knew of the SWOS desire to include line drawings and made plans to copy them from the previous computer application to make them accessible from within the Linkway program that was being developed. The line drawings were included to provide a visual mnemonic to assist the users in learning the Threat Matrix information. The line drawings were included as an essential component of the demonstrations made to SWOS in September, 1990, and were retained as an important part of the TMCBL.

Literature link

Ayer and Patrinostro (1992) believed that illustrations should be used to describe a system function when this can be done more efficiently and effectively by graphic methods. Ayer and Patrinostro also felt that line drawings can be used to clarify text and supplement information which is difficult to describe by text alone.

Picher, et.al. (1991) commented that adding still pictures to a hypertext was the easiest way to make the leap from hypertext to hypermedia. Dwyer (1972), however, made a case for simplifying the pictures and suggested that rendering them as line drawings helped to restrain the effect of the pictures and focus their instructional meaning. Dwyer (1988) also argued that use of visuals specifically designed to complement printed instruction could significantly improve student achievement of specific educational objectives.

Soulier (1988) commented that a picture may not be worth a thousand words in all cases. Soulier stated that illustrations needed to be used only in those instances
where common uses of language were not appropriate. Soulier said that simple line
drawings were generally preferred to complex pictorial illustrations.

Discussion

The line drawings served an important function in this TMCBL. Each of them
became the focal point of a specific instructional page. The line drawing remained
visible while descriptive pop-up fields all around it were selected and displayed. The
line drawing was also visible while video stills or motion sequences were selected. In
both cases the line drawing became the schematic link to the data and the video image,
and provided the learner with a more complete visualization of the learning material.

The line drawings were also used for the quizzes that focused on line drawing
recognition. In those particular quizzes students were shown a line drawing and then
asked to identify the platform class it represented.

#24. Objectives of the Lesson

Description of key decision

Instruction should be designed to produce observable and quantifiable behaviors
in the learner. Objectives specify what it is that is needed to be learned, before the
learning takes place. Objectives also assist in evaluating the learning after it has
concluded. All lessons had specific objectives identified by the U. S. Navy, for whom the
materials were developed.

SWOS link

SWOS had dozens of specific learning objectives identified for the Threat Matrix
instruction. SWOS provided these to the ISU experts, so the materials being developed
appropriately matched the learning objectives of SWOS.
The ISU experts knew the value of solid learning objectives, and this directed the development of the instructional materials. The objectives were discussed with SWOS personnel via a telephone call on December 7, 1990, and were received by ISU experts two weeks later.

**Literature link**

Edwards (1977) believed that formulating instructional objectives resulted in organized learning experiences that assured achievement of the objectives. The presence of instructional objectives facilitated the devising of evaluation procedures which gave adequate indication of attainment. In short, instructional objectives were a viable part of the instructional plan inherent in the produced curriculum materials.

Kemp (1985) stated that objectives indicated what a learner should be able to do after completing a unit of instruction and that the objectives should be expressed in precise, unambiguous terms. Teaching and learning activities were then designed to accomplish the stated objectives, and resources to support the instructional activities were selected. Necessary support services were identified for developing and implementing activities and acquiring or producing materials.

Logan (1982) commented that the purpose of objectives was to control the intent of the training, to scope its requirements, and to define its intended outcomes. Terminal objectives translated tasks selected for instruction into measurable learning events.

Mehlmann (1981) asserted that before the definition of the user interface could begin, the designer needed to know the detailed objectives of the planned program or system. Mehlmann commented as follows:

*The objectives are the system designer's most important tool......In fuzzy objectives are sown the seeds of conflict which can make the difference between*
success and failure. Overly detailed objectives, on the other hand, constrict an embryo system and prevent it from evolving with changing circumstances and opportunities. (p. 25)

Romiszowski (1984) described the importance of objectives for the Learning Activity Packet (LAP) and stressed the importance of the objectives being written behaviorally. The completeness of these objectives depended on the level of development of the student involved. The function of the objective was to communicate goals to the student, and thus it was in the student's language. Romiszowski (1981) suggested instructional objectives described the output of the instructional process. If a systems approach was to be employed in the development of the instruction, one could not avoid the use of objectives as a principal tool throughout the process.

Discussion

Although SWOS expressed a need to have this lesson developed, it was difficult for the ISU experts to understand the lesson objectives and identify the specific data to be included. Course objectives, which contained non-classified information, were shared with the ISU experts to expedite the development of the computer-based lesson. However, specific lesson objectives which contained classified data, were not shared. Thus, the researcher included all data from Combat Fleets of the World, so SWOS officials could modify and change the data as necessary, within the program shell.

#25. Instructional Manuals

Description of key decision

An instructional manual is a collection of documented procedures, facts, and illustrations that guide the user through the instructional materials. There are several levels of instructional documentation.

This TMCBL used three kinds of instructional manuals. The simplest form was the Quick Reference Card that was laminated on both sides, and designed to give a
fast overview to the user who wanted to get the TMCBL up and running. The next level in specificity was the *User's Manual* which described in detail the components of the system as well as installation procedures. The most complicated of the manuals was a *Technical Reference Manual* that identified the data points contained in the lesson and located them on each of the lesson pages. This manual was designed for de-bugging the system during development and was used by SWOS to check and verify the data the system contained.

*SWOS link*

While SWOS had no prior opinion relative to the inclusion of this key decision, they did expect appropriate reference information to use with the TMCBL. SWOS concurred with the ISU experts that reference manuals were necessary.

*ISU experts link*

ISU experts had planned to create appropriate user documentation to install, use, and maintain the TMCBL. During the SWOS visit of January 16-19, 1991, the entire TMCBL was delivered to SWOS and installed. At that time SWOS was given three forms of instructional documentation: a quick lesson overview, a user's manual, and a technical reference manual. Each reference was self-contained and provided information for the use, upgrade, repair, and/or modification of the TMCBL.

*Literature link*

Grimm (1987) believed that before writing any form of computer documentation one must understand the system and the users. Understanding the system implied knowledge of the specific computer platform being used as well as the application software driving the TMCBL. Understanding was achieved by defining who the users were, talking with them to determine appropriately their needs, and then determining
the uses of the documentation, its scope, and the style of language that would be included in it.

Rubens (1989) commented that beyond the assistance of human or electronic informants, users depended on written manuals. Most manuals presented the information in a linear fashion, and through the use of tools such as table of contents, indexes, and text layout strategies, readers succeeded in finding the information they needed. Readers had little tolerance for manuals that were poorly indexed or used inconsistent layout strategies for page design. The user treated this informant (the manual) as one with flawed information and distrusted it as a source.

Ayer and Patrinostro (1992) identified relevant parts of system manuals, including chapters, sections, illustrations, appendices, glossary, and index. Ayer and Patrinostro also favored printed output of computer screens as a tool to guide the learner in the use of the manual and, ultimately, the computer system on which it was based. Ayer and Patrinostro highlighted the importance of “procedure” portions of the manual, such as system loading, modifications, or trouble shooting. Steps needed to be clear and simply stated as to what work had to be done, who would do it, and when it must be done.

Diaper and Johnson (1989) discussed the importance of syllabus design for a computer application in terms of the methodology Task Analysis for Knowledge Descriptions (TAKD). This syllabus was based on a procedurally correct series of steps necessary to perform important sequential tasks. Diaper and Johnson favored watching experts use the system and recording the methods they employed in working with the computer system. These recorded steps then could become the basis of a syllabus designed to assist the user.
In a similar vein Jonassen, Hannum, and Tessmer (1989) discussed task analysis as the single most important component in instructional systems design (ISD). The authors contended that careful attention to the identified task analysis procedures discussed would result in a more reliable, user-focused, instructional design. The elements of the task analysis employed during the systems design could become a key component in the production of a user manual for the completed system.

Andriole (1983) differentiated between analytical documentation that described in detail what the application did and how it did it, and the user manual which functioned like road maps for the user. Andriole explained that the steps necessary to compile a good user manual were very similar to the steps necessary to conduct a good computer user and task analysis.

Shneiderman (1987) discussed the value of a quick reference card with concise presentation of the syntax used to utilize the program. Shneiderman also commented that traditional user manuals not only described the system, but contained an alphabetical listing of the contents and a description of the commands. Additional guidelines recommended by Shneiderman included the following:

- Let the user’s tasks guide the organization
- Let the user’s learning process shape sequencing
- Present semantics before syntax
- Keep writing style clean and simple
- Show numerous examples
- Offer meaningful and complete sample sessions
- Draw transition diagrams
- Try advance organizers and summaries
- Provide table of contents, index, and glossary
- Include list of error messages
- Give credits to all project participants

Snyders (1981) suggested some basic questions needed to be answered before and during the manual’s preparation. What is the manual describing? Who am I writing for? How is the manual going to be used? What is the expected life of the manual? Snyders also commented that pictures and graphics that illustrate screen displays are
especially helpful in computer system manuals. Snyders concluded by describing the importance of appearance factors of the manual. It should look professionally done and contain quality printed materials. In short, packaging played a significant part in this aspect of technical communication. Layout was important and attention was given to adequate amounts of white space, appropriate margins, and properly placed graphics.

**Discussion**

A total of three instructional manuals were produced for this research project. The first was a *Users' Manual*, which was 33 pages in length and contained sections that covered the following topics:

- Introduction
- Executive summary
- Lesson design overview
- Lesson objectives
- Lesson contents
- Quiz contents
- *Linkway* folder names and contents
- Listing of *Linkway* file for the program application
- Listing of line drawing files
- Hardware and software elements
- Using and loading the lesson
- Troubleshooting
- Technical information
- Seven (7) floppy disks containing all required software and files

A second form of user documentation was a *Quick Reference Card* which was printed back-to-back on cover stock and laminated. This card was meant to be placed by the work station to assist new users in the operation of the program. The card contained thumbnail images of program screens with descriptions of how to proceed through the program elements. It was purposely designed to be non-technical and gave a quick overview of the TMCBL and its contents.

A third manual, the *Technical Reference Manual*, was extremely specific, detailed, and complete. This manual was 353 pages long and depicted screen print-outs of more than 300 screens which comprised the prototype to the TMCBL.
researcher chose to compile this manual because of the need to verify and correct all
the data contained in the lesson. This manual displayed all the lesson screens and
then identified the technical data from *Combat Fleets of the World* that were inputted
for that particular screen example. This manual listed the page numbers in *Combat
Fleets of the World*, where the inputted data could be found and the frame numbers
presented for each of the video disc sequences. A comprehensive table of contents and
the answers for all the quizzes were also provided. This document was the source
against which all elements of the TMCBL were checked prior to delivery. SWOS used it
in a similar manner when personnel went through the lesson to verify or change any
data as necessary. Samples of the contents of these manuals are found in Appendix H.

**Summary of Triangulation Data**

Twenty-five essential components of the instructional design process used to
create this TMCBL were identified, verified via the triangulation strategies described,
and were then labeled as key decisions. Table 3 summarized this triangulation
procedure.

The first research question asked if the key decision made during an
instructional design process could be identified and verified. The triangulation data
process described previously and the summary tables answer that question
affirmatively.

The second research question asked if the identified and verified key decision
could be presented in a generalized manner, so they could address other TMCBLs. The
resulting list of key decisions was not only specific to this individual TMCBL, but could
be generalized to a wide variety of applications for which computer-based materials
may be designed.
Table 3: Triangulated Key Decisions

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<tr>
<th>No.</th>
<th>Key Decision</th>
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<th>ISU Experts Link</th>
<th>Literature Link</th>
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<tr>
<td>4.</td>
<td>Computer Platform</td>
<td>90.02.06 TMTM, SWOS decided to go w/ DOS over Mac &amp; is sending Kelly a Zenith computer to use to build program</td>
<td>90.01.05-09 ISU recommended Macintosh &amp; HyperCard; at meeting, one month later SWOS chose DOS, ISU concurred.</td>
<td>Meyrowitz (1989) Palay (1992)</td>
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<td>Program Shell</td>
<td>As per specs discussed w/ Simonson prior to involvement 89.09</td>
<td>90.09.19-23 Previewed during rough demo at SWOS visit. Approved.</td>
<td>Edmonds (1981) Yen, et.al. (1991)</td>
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<td>90.09.19-23</td>
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<td>Cognitive Map</td>
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<td>90.09.19-23</td>
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<td>Concurred with ISU experts</td>
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<td>Barba (1993)</td>
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<td>Jeffries, et. al. (1991)</td>
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<td>Simpson &amp; McKnight (1990)</td>
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<td>Use of Line Drawings</td>
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<td>Objectives of Lesson</td>
<td>90.12.07 phone call w/SWOS, will send objectives for TM lessons</td>
<td>ISU requested specific course objectives and they were received 90.12</td>
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<td>During visit of 90.09.19-23 we proposed to create user manuals to assist with usage.</td>
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</table>

Course Evaluation and Prototype Assessment Data

Introduction

The TMCBL designed and created for this study was delivered and installed on January 16, 1991. As part of the delivery responsibilities, the researcher taught key SWOS personnel how to use and modify the data contained in the system. For the next two weeks after installation, these key SWOS personnel went through every data point contained in the TMCBL and checked it for accuracy. They corrected any errors, added any new data, and deleted unwanted data.

Following the successful editing of the TMCBL, one Threat Matrix instructor wanted to use the system with his class to obtain a “feel” for student response to the
materials. Since the lesson was accessible on only one work station, the instructor chose to use it as a teacher presentation tool in a large classroom setting. He projected the computer image on a large screen and used two large screen television monitors to display the video disc images.

The Course Evaluation and Prototype Assessment Data

At the conclusion of the Threat Matrix course, the instructor initiated a standard SWOS course evaluation on March 28, 1991. The evaluation for this particular course contained several written comments regarding the TMCBL which the students had used during their instruction. The data were recorded as open-ended comments by students and the instructor for the course. A compilation of these comments can be found in Appendix I.

The following comment was made by the instructor of the course in his summary report to his superior:

“This is the first time the Iowa State program has been used in the classroom. Reaction has been mixed. Many students favor the program but recommend the purchase of additional large screen projectors to better display the video portion of the program. Others recommend making the program available to students for library check-out to allow them to work on their own time. A few students did not like the program at all, mainly due to the small displays available from 20 inch monitors viewed from seats in the rear of the classroom.

“I recommend continued use of the program. Instruction will be enhanced by a second large screen projector and completion of the remainder of the files by the people from Iowa State.”

Summary of Course Evaluation and Prototype Assessment Data

A total of twenty comments were recorded by individual students and shared with the researcher by the SWOS instructor. The comments reflected a range of opinions, but the general tone of comments was positive.

Of the twenty responses, seventeen comments were made about hypermedia, all of which were positive. Other positive comment categories included the following: four
on individualized instruction, four for motivating and informative, one for logical flow of lesson, and four for objectives of lessons. For the key decision on video disc six comments were positive and five were negative.

The only negative comments were made for the video disc, and those were in response to image quality as well as the quality of the television monitors. The negative comments expressed concern about fuzzy video images and images that were too small to be seen properly. Comments indicating a need for larger television screens were made. The comments were related more to the visual quality of video disc image, and not the inclusion and use of it within the lesson.

It should be pointed out that the TMCBL was designed from the beginning to function as an individual work station. It was not intended to be an instructor presentation tool, although given the right equipment for that adaptation, it could handle this satisfactorily. SWOS wanted to try it out as soon as possible, resulting in this experience by its first group of users. Thus, it can be summarized that all comments from this course evaluation reflected aspects of positive use for the TMCBL.

**Attitude Assessment Data**

**Introduction**

On April 13, 1992, an attitude assessment instrument was sent to eighty-two Naval lieutenants who had completed the Threat Matrix training and used the TMCBL, passed the Threat Matrix examination, graduated from SWOS, and had been assigned command duty aboard ships. The assessments were mailed with postage paid return envelopes and returned over the following five weeks. Thirty-eight responses were received. The cover letter sent to the participants is located in Appendix J. The assessment instrument is located in Appendix K.
The Attitude Assessment Data

The attitude assessment instrument used a five-point Likert scale to assess the officer's attitude towards sixteen different items. In addition to those items, one open-ended question was asked. Officers were encouraged to add a written response on the back of the survey instrument. The question was as follows:

"In your opinion was the idea of using a computer to present information on the Threat Matrix a good one? Using the back side of this survey, please tell us why you feel this way."

A composite listing of the sixteen items and their mean scores is presented in Table 4. This is followed by a summary of the attitude assessment and the mean scores for the sixteen listed items. A composite listing of the written responses to the open-ended question is found in Appendix L.

Summary of Attitude Assessment Data and Their Mean Scores

This assessment instrument was meant to gather opinions only. Answers reflected a high level of support for the TMCBL, which all the Naval lieutenants experienced while in school at SWOS. Some general observations are noted below. The instrument was a five-point Likert scale, and some of the mean scores are shown in parentheses.

- Three questions dealt specifically with instructional design elements of the lesson.
  - recall line drawings (4.5)
  - remember color displays (4.3)
  - recall pop-up boxes of data (4.2).
- Item with highest score: remembered the lesson (4.7)
- Item with the lowest score: owned a personal computer prior to 1-1-91 (3.1)
- Appropriateness of use:
  - potential of help recall (4.5)
  - would like to use it to refresh memory (4.1)
  - make available individual student use (4.4)
Table 4: Items in Attitude Assessment and Their Mean Scores

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Stem</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I remember the TMCBL.</td>
<td>4.7</td>
</tr>
<tr>
<td>2.</td>
<td>My reaction to the use of the TMCBL was positive.</td>
<td>4.1</td>
</tr>
<tr>
<td>3.</td>
<td>I believe that TMCBL would be easy for others to use.</td>
<td>3.9</td>
</tr>
<tr>
<td>4.</td>
<td>As I recall the TMCBL, I remember use of color on display screens.</td>
<td>4.3</td>
</tr>
<tr>
<td>5.</td>
<td>The TMCBL has the potential to help SWOS students learn the facts of the Threat Matrix.</td>
<td>4.5</td>
</tr>
<tr>
<td>6.</td>
<td>I think the TMCBL should be made available for students to use on an individual basis for studying and review.</td>
<td>4.4</td>
</tr>
<tr>
<td>7.</td>
<td>I feel comfortable using a personal computer.</td>
<td>4.6</td>
</tr>
<tr>
<td>8.</td>
<td>I think the line drawings on the TMCBL helped to enhance the lessons.</td>
<td>4.2</td>
</tr>
<tr>
<td>9.</td>
<td>I believe applications such as TMCBL are effective.</td>
<td>4.4</td>
</tr>
<tr>
<td>10.</td>
<td>Prior to January 1, 1991 I owned a personal computer.</td>
<td>3.1</td>
</tr>
<tr>
<td>11.</td>
<td>Now that I have completed the Threat Matrix training, I would find the TMCBL helpful to refresh my memory.</td>
<td>4.4</td>
</tr>
<tr>
<td>12.</td>
<td>While using the TMCBL, I recall pop-up boxes of data that contained specific Threat Matrix facts</td>
<td>4.2</td>
</tr>
<tr>
<td>13.</td>
<td>The TMCBL has the potential to show how elements of the Threat Matrix relate to one another.</td>
<td>4.1</td>
</tr>
<tr>
<td>14.</td>
<td>The TMCBL, has the potential to assist instructors in lesson presentations.</td>
<td>4.3</td>
</tr>
<tr>
<td>15.</td>
<td>While using the TMCBL, I recall line drawings of ships, sensors, and weapons systems.</td>
<td>4.5</td>
</tr>
<tr>
<td>16.</td>
<td>The TMCBL has the potential to help users recall the facts of the Threat Matrix.</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note: TMCBL = Threat Matrix Computer-based Lesson

5 = Agree Strongly, 4 = Agree, 3 = Not Sure, 2 = Disagree, 1 = Disagree Strongly
N=38/82
The item with the lowest score (owned a personal computer prior to 1-1-91) assessed the period of time in which the respondents had been doing their Threat Matrix training. While the score was non-descriptive for that item, the comfort level for using the personal computer was high (4.6).

Summary of Open-ended Question on Attitude Assessment Survey

The written responses from the officers were basically supportive of the TMCBL they had used. The topic mentioned most dealt with individual access and use. It was felt that for the TMCBL to be effective, individuals should have easy and frequent access to it during their training. Several respondents felt it would be good to have a system such as this on board ships for review of the Threat Matrix components. It was mentioned how officers learned much factual data in a short time during this part of SWOS training, that the long term memory recall was sometimes a problem.

The line drawings in the lessons were appreciated and were favored over the marginal quality of some video images that were on the video disc the Navy had produced a few years previously. Three responders felt the video images did add to the quality of the lesson, despite the fact that some of the surveillance images were not sharply in focus at all times.

The hardware components of the system (video display) were mentioned a few times, indicating that the system was not being used in the optimum manner. While one respondent indicated a preference for paper copies with the information on it for study, another said that this system assisted in recall of information better than if it were on paper. One individual responded favorably to the pop-up boxes of information, and one also mentioned that it would allow SWOS instructors to teach more efficiently and, perhaps, incorporate an automated teaching and testing component as an integral part of the Threat Matrix training.
The comments from the lieutenants, who at that time were serving aboard ships, were basically very positive and mirrored previous observations by the class members who had seen only a portion of the prototype in March, 1991. The officers seemed to agree that anything that made the learning process more relevant, interesting, and efficient was worth pursuing since it made their experiences more positive and gave SWOS the luxury to use their Threat Matrix teaching time to address other areas of need.

**Personal Interviews Data**

*Introduction*

On February 27, 1992, the researcher conducted a series of five personal interviews with key SWOS personnel. The personal interviews included the Educational Specialist in the Curriculum Standards Office, the Program Manager for Curriculum Development, the Division Director for Teaching of Combat Systems, the Commanding Officer of SWOS, and the principal Threat Matrix instructor in SWOS. The researcher was very impressed with the high dedication to quality that was an obvious attribute of these key SWOS personnel.

The Educational Specialist in the Curriculum Standards Office has been the key SWOS team member who worked most closely with all ISU at SWOS. He is the liaison between the standards and protocol of the Navy, and the private contractors in the outside world that SWOS selects to help them accomplish their mission.

The Program Manager for Curriculum Development represented a private contractor, who actually contracted with Iowa State University to work with SWOS to complete this and several other previous projects. His vision and support for those efforts, and his study, continued to be evident.
The Division Director for Teaching of Combat Systems was a major instigator in bringing the value of the TMCBL to the forefront and keeping it there. He supported it on more than one occasion with his fellow officers because he believed it could and would make a difference in the teaching of the Threat Matrix.

The Commanding Officer of SWOS was a major factor in facilitating the financial support to bring about numerous instructional technology projects at SWOS. His staff of key personnel interviewed for this research shared his vision for using instructional technology to enhance the delivery of SWOS curricula.

The principal Threat Matrix instructor who worked with the researcher was the individual who saw to it that the TMCBL worked and was used. This individual received specialized training from the researcher in the use and modification procedures of this TMCBL.

The interviews with these selected SWOS personnel were recorded on audio tape with the permission of those involved. Transcripts of the interviews can be found in Appendix M. Summary comments of the interviews follow in Table 5.

*The Personal Interviews Data*

In an effort to quantify the series of personal interviews the researcher conducted with key SWOS personnel, the content of the responses was categorized with respect to the identified twenty-five key decisions, and is shown in Table 5. The subjects are numbered one through five in accordance with the following key:

Subject #1: Educational specialist in the Curriculum Standards Office in SWOS

Subject #2: Program Manager for Curriculum Development, working with a private contractor with a charter to SWOS

Subject #3: The Division Director for Combat Systems in SWOS
Findings have been summarized from personal interviews with five SWOS personnel. Indication is given if a responder indicated a key decision, following the completion of the project. The implication was that if during an interview, the interviewee referred to a key decision, that signified a congruency between the instructional design of the TMCBL and the needs and opinions of SWOS.

**Summary of Personal Interviews Data**

All the SWOS personnel interviewed expressed thanks and appreciation to the staff from ISU for the quality of work that had been done on other projects, as well as this particular one. Within the interviews an attempt was made to obtain a historical sense of where SWOS used to be with respect to the training materials for teaching the Threat Matrix, where they were at the period the interviews occurred, and where they see their effort taking them into the future.

It was a common opinion that the old way of working with students, which included viewing hundreds of slides in a classroom and memorizing Threat Matrix components through the use of large stacks of flash cards, was no longer an acceptable alternative. Thus, the TMCBL became the impetus for this project.

All interviewees were optimistic about the future applications of the TMCBL and other similar computer-based lessons. Time to disseminate vast quantities of information that officers needed to perform successfully their duties was limited. Any refinements of the curricula delivery process that would make their teaching more effective and more efficient, would be of much interest to them and to the U. S. Navy in general. SWOS saw the value of putting this entire TMCBL on CD-ROM, and installing
Table 5: Summarized Content of Personal Interviews

<table>
<thead>
<tr>
<th>No.</th>
<th>Key Decision</th>
<th>Summarized Content of Personal Interviews</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Use of Hypermedia</td>
<td>Motion was important, as well as still images</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Is lot better way to learn than using manual flash cards</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial problems of displaying information on a screen where all students could see it</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>As an instructor of TM, (used prototype) in a lecture-type format using graphic display for reinforcement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2.</td>
<td>Use of Video Disc</td>
<td>Delivery of product with a video disc base was a milestone</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potential for visual support to enhance, streamline, speed-up, and improve effectiveness of training</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Now using the video disc in TM class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.</td>
<td>Individual Instruction</td>
<td>Need for TMCBL for TM due to extreme amount of information to learn</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thoughts on better preparation possibly making a difference in situations that previously have led to failure (in real Naval situations)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plans to move it to the fleet, use it here as initial study vehicle, and then in the fleet as a refresher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need for product for student to study on own time and easy for him to access</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needed to get more information to students in less time and save instructional time...so means for students to learn on their own time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-paced study in a lot of areas is one of the best ways to go</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Puts ownership on the student -- our long term intention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 5: (continued)

<table>
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<tr>
<th>No.</th>
<th>Key Decision</th>
<th>Summarized Content of Personal Interviews</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Individual Instruction</td>
<td>Suggestion for future use by SWOS to increase number of work stations for more individualized instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.</td>
<td>Computer Platform</td>
<td>CBL had to be something to run on systems already available</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needed to be user friendly from standpoint of student (an Apple system rather than a Zenith 248 system!)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A milestone decision in project was the IBM compatibles versus Macintoshes</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appreciated the open-mindedness to assess different computers; students, instructors, everybody got involved in deciding the hardware</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contract for project was unique; our communication was not a set specification, but an idea effort; ISU was open to any suggestions; we're pleased with efforts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>5.</td>
<td>Authoring Software</td>
<td>ISU's willingness to take on the project with MS-DOS-based, Linkway</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software compatibility was an issue that was solved</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>We're sort of chasing behind the software now with hardware, rather than going the other way</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6.</td>
<td>Program Shell</td>
<td>Need for system user friendly for SWOS instructors -- system easily changed to add new information on a radar system, submarine, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Logistic problem to keep system current; may have been taken care of, but a concern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suggestion for future use to tailor the existing TAO system and give it more focus at the individual ship class level; have students assigned ships earlier in training, but tactical scenarios where TAO would be involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 5: (continued)

<table>
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<th>Summarized Content of Personal Interviews</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Program Shell</td>
<td>Took us three weeks to sanitize the prototype, make sure all data was accurate, since the program was given to us with an in-class version; source documents aren't necessarily accurate; we verified it and updated it</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soviet is not a big threat now, but we have to look at all weapons systems...so students need to become equally familiar with everything that exists; needs to be expanded tremendously</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need to continually update; other programs exist but they aren't kept up to date and they're not transportable; this project now is owned by SWOS and can be continually updated and then given to the fleets</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expand to use this as a reinforcement device for any part of the command</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project has application in numerous courses in the U. S. Navy</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Book Metaphor</td>
<td>Use not only for short term testing, but long term testing, as well</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Use of Quizzes</td>
<td>Would like to see SWOS add to project and develop a scholarly testing bases with a management model to monitor individual student's progress</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Index of Lessons</td>
<td>The CBL had to be fast, easy, and effective</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Cognitive Map</td>
<td>Students found CBL, perhaps because of motion video, to be a more appealing way to view information</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Motivating and Inform.</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5: (continued)

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<tr>
<th>No.</th>
<th>Key Decision</th>
<th>Summarized Content of Personal Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>Motivating and Inform.</td>
<td>Use of technology to make the material more interesting and people learn more with AV aids that are attractive to them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>12.</td>
<td>Active User Involvement</td>
<td>These kids are all brought up watching t-v, video games, and stuff like that...enhanced audio-visual aids are a huge improvement in presentation and learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>13.</td>
<td>Advance Organizers</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Use of Mnemonics</td>
<td>Need for mnemonics based connection to help students learn info</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>15.</td>
<td>Logical Flow of Lesson</td>
<td>Need for TMCBL to replace flash card approach or poorly organized text</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>16.</td>
<td>Screen Draw Sequence</td>
<td>As I learn more about the system, the flow of information will become even easier</td>
</tr>
<tr>
<td>17.</td>
<td>Use of Color</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Text Readability</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Use of Hypertext</td>
<td>Have students use computer-based lesson and then come back to classroom with a better baseline of knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>20.</td>
<td>Navigation Aides</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Button Placement</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Pop-up Info Boxes</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Use of Line Drawings</td>
<td>Belief line drawings was almost as important as still images</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 5: (continued)

<table>
<thead>
<tr>
<th>No.</th>
<th>Key Decision</th>
<th>Summarized Content of Personal Interviews</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.</td>
<td>Objectives of Lessons</td>
<td>One concern was the classification issue; the videos or disks had to be unclassified, when really, we need to be at the secret level for the department of training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clearance (for research designer, civilian) was an issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I sat down and classified the data to secret level, and then brought it (into the classroom)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>25.</td>
<td>Instruction Manuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

it on ship board reference systems, so officers could review it and refresh their memory on the materials.

As this particular project was coming to a close, the next logical step, transforming the working prototype into a fully functional model complete with all Threat Matrix data, was already in place. At this writing, that had been accomplished by another researcher and the entire system had been completed for SWOS to incorporate into their curriculum as appropriate.

**Chronological Log Data**

**Introduction**

This project began on October 28, 1990, during an initial briefing meeting with the researcher and his major professor, when the major professor gave the researcher a general overview of the envisioned project's scope and outcomes. From that point, the chronology of events included numerous planning meetings at ISU, telephone calls,
and correspondence. A total of five trips to SWOS headquarters in Newport, Rhode Island, occurred during this project, as well as a trip to Atlanta, Georgia, for extensive training in \textit{Linkway}, the IBM authoring program used to produce this TMCBL. Professional presentations regarding this research project were made at two national conventions of the Association for Educational Communications and Technology in Orlando, Florida, (February 14, 1991) and Washington, DC, (February 6, 1992).

\textit{The Chronological Log Data}

A compilation of the chronological log for this study is located in Appendix N. The major portion of the chronology begins in October, 1989, and ends in July, 1992.

\textit{Summary of Chronological Log Data}

Three observations of the chronological log will be discussed. They relate to the choice of computer platform, working with classified information in a de-classified manner, and the placement of this effort within a developmental framework of curriculum reform at SWOS.

The time frame was dependent on the issue of computer platform and the resulting software that would be used to create this project. The deliberations regarding the Macintosh platform were developmentally good for SWOS since they helped them gain a better understanding of the capabilities of hypermedia and its applications to the SWOS curriculum. Without the Macintosh hypermedia demonstrations in January, 1990, the awareness of hypermedia as a tool of instructional technology for SWOS may not have reached its high level. The decision by SWOS to use a DOS platform dictated that the researcher and the Project Director become proficient with the use of DOS and master the use of \textit{Linkway} as a DOS
authoring tool. The time necessary to reach an appropriate level of expertise for instructional design output was affected by the platform situation.

The manner in which the content was handled for this project was unique in that when it was finished, it would be verified and then classified as secret. The researcher was working with data that was classified if it were placed correctly within the Threat Matrix. SWOS was not in a position to hand the researcher all the classified data and ask that it be included in the TMCBL. Instead, all the data from an authoritative source, such as *Combat Fleets of the World*, was used as the primary nucleus for the data in the lesson that was developed. Then, when the lesson was finished, it had to be examined to be certain it was accurate as well as timely. It may have been more expedient if the Project Director and the researcher could have been checked for security and given a classified status to facilitate the timely flow of information and usage. What is important is that the ISU experts and SWOS did work out a satisfactory arrangement to deal with this problem, but it did take time to get the elements of Threat Matrix data developed for simple change.

It is important to remember that this project certainly did not stand alone, but was part of a series of curriculum development efforts at SWOS to incorporate more instructional technology efforts and programs into their educational experiences. Prior to this project, SWOS had worked with Iowa State University to plan, develop, and install a vast collection of instructional technology equipment in a classroom to be used for technology rich educational experiences. SWOS and ISU had also planned and developed a media center in the same manner, for the same reasons. This project served to be yet another episode in a continual effort to pursue instructional technology reform in the educational programs of SWOS. Similarly, there was a project to follow this successful design, completion, and installation of the working prototype. It was to
expand and complete the prototype into a fully functional model, complete with all relevant Threat Matrix data for the USSR, USA, and other powers of the world.

**Participant Observer Field Notes Data**

*Introduction*

Throughout the life of this project, the researcher kept notes related to experiences and events that occurred. From a research standpoint these thoughts should be looked at as one of several data sources, and their presence should add to the verification process already described in this study.

Many of the comments made by the researcher in the discussion for each of the triangulated key decisions and in the chronological log section came from field notes. These comments will not be repeated. This section will focus more on feelings, attitudes, observations, and perceptions, that were experienced during the life of this project. For sake of organization they will be listed chronologically.

*The Participant Observer Field Notes Data*

Field notes were kept during the period of October, 1989, to May, 1994. However, the most relevant ones for purposes of this study occurred during the actual time frame in which the prototype was designed, constructed, delivered, and installed. That time frame was during November, 1989, through January, 1991. The field notes are located in Appendix O.

The field notes have been summarized and appear in this section. Additional observations can be found in the discussion of each key decision in Chapter 4 and also in the comments listed in the chronological log data.
Summary of Participant Observer Field Notes Data

The purpose of this section is to summarize the participant observer field notes found in Appendix O. The researcher identified three significant factors that had far-reaching effects on the key decisions found within the instructional design. The factors included the choice of computer platform and authoring software, decisions related to working with classified data, and the collaborative process of working with the client.

Choice of Computer Platform and Authoring Software

During preliminary discussions by the Threat Matrix Team Meeting (TMTM) a prevalent thought within the group was that this project would utilize Macintosh and HyperCard to address the Threat Matrix problem identified by SWOS. That feeling was not stated, but was implied, by several group members for the following reasons: (1) the preponderance of Macintosh equipment at ISU, (2) the previous DOS based Threat Matrix lesson from SWOS that was unsuccessful, and (3) most of the TMTM members owned or used Macintosh computers with regularity. The Project Director was aware of a potential DOS platform but did not emphasize it and seemed to reflect the same Macintosh perspective as other members of the TMTM.

One of the tasks the TMTM selected was to create modified HyperCard stacks. This was done in two stages: an exploratory demonstration of what the Threat Matrix software could include, and then later a refined version which included gaming elements and access to video disc images. The refined version was later part of a presentation to SWOS during the first series of demonstrations on January 7, 1990, which showcased hypermedia.

Once at SWOS, the ISU experts could see why DOS was being seriously considered. There were dozens of Zenith 286 based computers in the SWOS schools, and while several officers had Macintosh computers for personal use, none was on the
premises of SWOS. After the hypermedia demonstrations, some of the SWOS officers were very open-minded about the ease of use of the Macintosh and were actively supporting its consideration. Although open and willing to consider the Macintosh platform, a substantial number of SWOS personnel were not convinced, and, ultimately, MS-DOS was selected. Thus, ISU experts needed to adjust their strategy accordingly.

The researcher was contemplating potential work on the Threat Matrix project through the use of *HyperCard* on the Macintosh. Involvement of the researcher in the usage of a MS-DOS platform meant that, in addition to the work necessary to design and construct the TMCBL, three additional areas would now also need to be learned: the Zenith computer platform, MS-DOS operating system, and an authoring language to replace *HyperCard*.

With the assistance of an IBM educational representative, three important developments occurred. First, the researcher learned how to use DOS and the Zenith computer. Second, the researcher learned of *Linkway*, an IBM authoring system similar to *HyperCard*. Third, the Project Director and the researcher went to an intensive two-day *Linkway* training school in Atlanta, Georgia.

Shortly after returning from the IBM training school, a Zenith 286 computer system arrived from SWOS, and it became a fully functional *Linkway* authoring platform for the researcher to use from his home office. Despite the training, and the personal platform to use, the researcher felt extremely isolated as a *Linkway* user. It seemed that during that period, no one else in Iowa was using *Linkway* nor could they answer questions about it. The researcher had little success in finding books or magazine articles about *Linkway*. 
Decisions Related to Working with Classified Data

After the screen designs had been created and were ready for the input of SWOS data, two problems became apparent. The problems were related to the availability of classified SWOS data and the geographical distance between SWOS and the researcher.

At no point could SWOS describe exactly what kinds of data to include in the TMCBL since to do so would divulge classified information to ISU experts, who did not have security clearances. The solution suggested by SWOS was to use *Combat Fleets of the World*, a major reference book, to find necessary information for Soviet warships, sensors, and weapons systems. The amount of data was extremely large and presented difficulties in determining how much of it to include. The reference book contained dozens of groupings of USSR surface warships, each comprised of several classes and made up of many vessels, each of which had specific data to be entered. After several conversations with SWOS, the researcher was given a list of USSR ship classes the TMCBL should address. This did limit the amount of work somewhat, but still meant that there were hundreds of bits of data that needed to be placed for learners to access.

SWOS had cleverly solved their classification problem. By having the researcher input all the data from *Combat Fleets of the World*, for the identified classes, SWOS had not identified specific data. The researcher and the Project Director ended up working with classified data in an unclassified way. Development time was lost in the articulation and solution to this problem. Once a plan was identified and implemented, the inclusion of data became a slow, procedural process of methodically inputting data from specified ship classes. Ironically, shortly after the TMCBL was delivered in January, 1991, the lesson was checked for accuracy, corrected, modified by qualified SWOS personnel, and labeled “classified.” The researcher never saw it again.
The second problem was that of geographical distance between the researcher and SWOS. While contact was available via telephone and fax machines, there were times when a closer physical distance would have resulted in greater productivity. Because there were differences in time zones and work schedules, it was difficult to have personal contact at the time when it was needed. The first three trips to SWOS helped significantly in identifying, refining, and delivering the software solution for the Threat Matrix problem of SWOS. The trips emphasized the importance of face-to-face contact of the researcher and the client.

Collaborative Process of Working with the Client

The collaborative experiences which resulted from this study evolved through a textbook-like scenario of the client and the researcher. Since this project followed several other very successful projects between SWOS and ISU, there was a predisposed position of mutual trust. This researcher was able to capitalize on these positive relationships.

Throughout this project, the researcher was impressed by the high quality of all members of SWOS at Newport. From the Commanding Officer, to the Threat Matrix personnel, including the Naval personnel who checked identification badges and escorted the ISU experts around the building, all made the experience there pleasant and personable.

Although this was a collaborative venture, once SWOS identified the parameters of the proposed project, the ISU experts, with the researcher working as the instructional designer, were given wide interpretation to implement project goals. This allowed the researcher to implement numerous key instructional design components, resulting in a TMCBL highly approved by SWOS. The client projected trust and confidence in the researcher which was appreciated.
Results of the Study: Chapter Summary

This lengthy chapter presented and explained six types of data collected for this research study. The types included:

1. Triangulation data
2. Course evaluation and prototype assessment data
3. Attitude assessment data
4. Personal interviews data
5. Chronological log data
6. Participant observer field notes data

The triangulation data affirmed that key decisions made during an instructional design process could be identified and verified. The triangulation data also affirmed that the resulting list of key decisions could be presented in a generalized manner to address instructional designs in other TMCBLs.

The course evaluation and prototype assessment data were collected when the TMCBL was used for the first time with SWOS students. The results reflected aspects of positive use for the TMCBL. However, some of the negative comments received were because of the fact that SWOS had used the TMCBL as a presentation tool to a large class with inadequate capability for video projection. SWOS used it in a classroom setting because it was new and they wanted some immediate feedback regarding its use.

The attitude assessment data consisted of results from a Likert scale instrument and an open-ended questionnaire. The assessment instrument reflected a high level of support for the TMCBL. All the mean scores were high, with the highest score being a response which indicated the officers had remembered the lesson. Similar high mean scores were obtained from questions dealing with instructional design elements and appropriateness of use. A second part of the attitude assessment data was the responses to an open-ended question. The combined responses were positive and reflected that SWOS graduates favored the instructional strategy that
made the learning more relevant, interesting, and efficient. Most key decisions mentioned were hypermedia, video disc, active learner involvement, individualized instruction, use of line drawings, and objectives of lesson.

The personal interview data conveyed a sense of appreciation from SWOS to ISU for the quality of work that had been done on previous projects, as well as this particular one. Those interviewed were optimistic about the future applications of this lesson as well as others which could be designed in a similar manner. SWOS showed interest in refinements in curricular delivery that would result in more effective and efficient teaching and learning. The key decisions discussed at the most length within the interviews included hypermedia, computer platform, authoring software, individualized instruction, program shell, use of quizzes, motivating and informative, and objectives of the lesson.

The chronological log data provided descriptive information relating to the development of the TMCBL. While containing many significant events, the data were discussed in the summary section for this data type. The comments there summarized the chronological data with respect to the choice of computer platform, working with classified information, and the placing of this effort within a developmental framework of SWOS curriculum reform.

The participant observer data, which was summarized, dealt with the choice of computer platform, decisions related to working with classified data, and the collaborative process of working with the client. These data contained personal insights and observations of the researcher.
CHAPTER 5: SUMMARY OF THE STUDY, RECOMMENDATIONS, AND CONCLUSIONS

This chapter presents a summary of the study, with attention given to the problem, research questions, data collection, and findings. Recommendations for further research and implications for other applications of this type of computer-based learning system are also discussed. The chapter concludes with a discussion of the significance and relevance of the study.

The Problem

The problem addressed by this study focused on potential key decisions made during the instructional design process which was used to create the Threat Matrix: A Computer-Based Lesson (TMCBL). The Surface Warfare Officers School (SWOS) in Newport, Rhode Island, requested that a computer-based lesson which would utilize state-of-the-art instructional technology be designed, created, and installed to assist in the teaching and learning of the Threat Matrix (TM). This request by SWOS addressed an authentic need identified by the United States Navy. The Threat Matrix contained thousands of data points describing the weapons, sensing systems, and overall capabilities of surface warships, submarines, fixed wing aircraft, helicopters used by the navies of the world. The computer-based lesson became a teaching tool to enhance the manner in which Naval officers learned the TM data. The problem addressed by this study identified and verified key decisions made during the instructional design process which was used to create the TMCBL.

The Research Questions

The research questions were related to the identification of key decisions made during the instructional design process and for the verification of the key decisions via triangulation. After the lesson was completed the researcher carefully examined and
considered the design elements that were part of this instructional design process. A list of instructional design elements that seemed to have made a difference was compiled. It was this list that became the basis for the analysis described in this research.

Table 6: Instructional Design Decisions Verified by Triangulation

<table>
<thead>
<tr>
<th>Hypermedia</th>
<th>Mnemonics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of video disc</td>
<td>Logical flow of lesson</td>
</tr>
<tr>
<td>Individualized instruction</td>
<td>Screen design</td>
</tr>
<tr>
<td>Computer platform</td>
<td>Use of color</td>
</tr>
<tr>
<td>Authoring software</td>
<td>Text readability</td>
</tr>
<tr>
<td>Program shell</td>
<td>Hypertext</td>
</tr>
<tr>
<td>Book metaphor</td>
<td>Navigation aides</td>
</tr>
<tr>
<td>Use of quizzes</td>
<td>Button placement</td>
</tr>
<tr>
<td>Index of lesson content</td>
<td>Pop-up information boxes</td>
</tr>
<tr>
<td>Cognitive map</td>
<td>Use of line drawings</td>
</tr>
<tr>
<td>Motivating and informative</td>
<td>Objectives of lesson</td>
</tr>
<tr>
<td>Active learner involvement</td>
<td>Instructional manual</td>
</tr>
</tbody>
</table>

Two research questions were identified for this study. The first question asked which design elements were important and considered as potential key decisions. In response to the first research question it was found that key decisions made during an instructional design process could, in fact, be identified and verified. Twenty-five instructional design elements were identified and verified using the qualitative analysis technique of triangulation (Miles and Huberman, 1984; Borg and Gall, 1989; Denzin, 1989). The resulting list of verified key instructional design decisions is identified and summarized in Chapter 4. The list is also located within this chapter in Table 6.

The second question asked if the instructional design elements could be grouped to create a list of key decisions for any instructional design of a hypermedia, computer-based lesson. In response to this research question, it was found that the
identified key instructional design decisions could be presented in a generalized manner, so they addressed a variety of computer-based lessons regardless of content. The key decisions are listed in such a way that their use in computer-based lessons could be identified. This information is presented in Figure 1.

Data Collection

The data used in this study were obtained from six different sources. They are listed below and are described in more specific detail in the discussion that follows.

1. Triangulation data
2. Course evaluation and prototype assessment data by Naval officers who first used the Threat Matrix: A Computer-Based Lesson (TMCBL) on a pilot basis
3. Attitude assessments data of Naval officers who used the TMCBL as an integral part of their Threat Matrix training
4. Personal interview data with key SWOS personnel regarding the need, design, and implementation of the project
5. Chronological log data
6. Participant observer field notes data

Triangulation Data

Using a post analysis of the instructional design process, a listing of key elements implemented during the design was identified. For each of the key elements a triangulated process of verification was completed. The process of triangulation examined three components: anecdotal evidence that Surface Warfare Officers School (SWOS) had either suggested the inclusion of the key element or had no objection to its inclusion; anecdotal evidence that the Iowa State University Design Team (ISU experts) had recommended inclusion of the design element; and citations in the research literature that supported the design element's consideration and use.
When the design element was triangulated via SWOS, ISU experts, and the research literature, then it was identified and verified as a "key decision" or an essential element in the instructional design process. Twenty-five key decisions were identified in this manner. The key decisions are presented and described in Chapter 4 and also discussed in this chapter.

Course Evaluation and Prototype Assessment Data

The TMCBL was delivered and installed on SWOS equipment on January 16, 1991. After its installation a Naval officer trained by the researcher verified or corrected data in this computer-based lesson and then labeled the learning materials as "classified." From this point only SWOS personnel and individuals with proper security clearance had access to the materials.

In February and March of 1991, the TMCBL was used by a SWOS instructor in three sections of classes which focused on recognition of Soviet warship platforms. The computer-based lesson was used with computer projection equipment to display the computer monitor image on a large wall screen for more effective viewing. The video disc sequences were shown on large color television monitors placed on either side of the screen. SWOS wanted to obtain a quick assessment of the potential of the TMCBL, so they elected to use the system in this manner. There was no time for individuals to use it as a stand alone work station.

At the conclusion of the course taught by the SWOS instructor, students evaluated the entire course and its effectiveness, and many made specific comments about the use of the TMCBL as an instructional tool. This data represents some of the initial responses of SWOS students when the TMCBL was used for the first time. A summary of the responses from students who experienced the TMCBL can be found in Appendix I.
Attitude Assessment Data

In April and May, 1992, attitude assessments were completed by officers who had used the TMCBL. The survey instrument was designed by the researcher to gather opinions only, and the resulting score of each of the sixteen items was expressed as a mean score. The last item on the attitude assessment instrument was an open-ended question, which asked the following:

"In your opinion, was the idea of using a computer to present information on the Threat Matrix a good one? Using the back side of this survey, please tell us why you feel this way."

The cover letter sent to the identified subjects is found in Appendix J. A copy of the attitude assessment instrument is found in Appendix K. The resulting mean scores on the survey items and the response summaries are presented in Table 4 of Chapter 4. A composite listing of all the written responses to the open-ended question are located in Appendix L.

Personal Interviews Data

On February 27, 1992, a series of five interviews was conducted with key SWOS personnel regarding the need for and use of this project. The SWOS personnel were administrative officers directly involved in the conception, creation, and implementation of the TMCBL. Those personnel interviewed included the Educational Specialist in the Curriculum Standards Office at SWOS, the Program Manager for Curriculum Development who was working with a private contractor with a charter to SWOS, the Division Director for Combat Systems in SWOS, the Commanding Officer of SWOS, and the principal Threat Matrix instructor at SWOS. The interviews are summarized in Chapter 4 and transcripts of them can be found in Appendix M.
Chronological Log Data

The instructional design project, which is the focus of this study, began on November 11, 1989, at an exploratory meeting to review previous SWOS instructional technology projects and to consider involvement by ISU in this project. During the next one and one-half years the TMCBL was created, tested as a prototype, revised, delivered, and installed.

The chronological logs identify significant events that occurred during visits to SWOS headquarters in Newport, Rhode Island. They also enumerate developmental progress as the TMCBL was formulated and emerged during the instructional design process. A chronology of those key events is found in Appendix N and is discussed in Chapter 4.

Participant Observer Field Notes Data

Participant observer field notes by the researcher were maintained during the project. The anecdotal notes are discussed in Chapter 4 and are found in Appendix O. The participant observer field notes describe the thoughts and observations of the researcher as participant observer (Denzin, 1970; Quinn, 1990).

Findings

The results of this study have shown that it is possible to examine and describe the process of instructional design and verify the key decisions made during the instructional design process. Through triangulation, a series of twenty-five key decisions made during this process were identified and verified. These findings were further supported by the inclusion of other forms of data collected for this study.

The triangulation data linked needs of SWOS personnel, opinions of the ISU experts, and findings in research literature. As a result, twenty-five key decisions of
the instructional design process were identified. The research literature supported the inclusion of all twenty-five key decisions. The key SWOS personnel and the ISU experts also supported all twenty-five key decisions. However, some key decisions were initiated by SWOS and some were initiated by the ISU experts. Key decisions initiated by one of the two groups, were later agreed to by the other group.

Some of the key decisions initiated by SWOS were dictated by previous teaching of the Threat Matrix. For example, SWOS had a video disc and digitized line drawings to include in the TMCBL. SWOS also wanted the computer-based lesson to be motivating for students to use and appropriate for individual instruction. SWOS was aware of the cognitive enhancers of the advance organizer and mnemonics, and wanted to incorporate them into the lesson where possible. The key decisions of computer platform and program shell were also initiated by SWOS, to provide consistency in their installed computer platform base, and to make modifications in the Threat Matrix data as needed.

The key decisions initiated by the ISU experts dealt with instructional strategies and computer screen appearance. Key decisions which focused on instructional strategies were, hypermedia, book metaphor, use of quizzes, index of lesson content, cognitive map, active learner involvement, hypertext, navigation aides, and instructional manuals. Key decisions initiated by the ISU experts which affected the appearance of the computer screens were screen design, use of color, button placement, pop-up information boxes, and text readability.

The key decision for computer platform was initiated by both SWOS and the ISU experts. SWOS initiated the need for the DOS platform, with respect to continuity of equipment, ease of use, and maintenance. ISU experts initiated the Macintosh platform as an inherent component in the hypermedia demonstrations first presented
to SWOS. Both SWOS and the ISU experts expressed no initial opinion on authoring software, as it was contingent on the selection of the computer platform. However, once the computer platform was identified, the ISU experts soon initiated a request to use IBM's Linkway authoring software. Table 7 shows key decisions of SWOS and the ISU experts. The table identifies who initiated the need and confirms if there was no objection to its inclusion.

The course evaluation assessment data and the attitude assessment data collected from SWOS students further supported identification of key decisions. The Naval officers focused on the use of hypermedia and the video disc component as a way of individualizing their instruction on the Threat Matrix. Collected data referred to the positive use of the TMCBL as being a motivating and informative strategy for meeting objectives of the Threat Matrix.

A major difference can be concluded from the data collected from course evaluation respondents compared with the attitude assessment respondents. The course evaluation respondents had not used the TMCBL individually. The attitude assessment respondents were Naval lieutenants serving a tour of duty aboard ship at the time the survey was completed. The Naval lieutenants recalled and identified the importance of active learner involvement and use of line drawings. It can be concluded that the use of the TMCBL within a work station setting, for which it was designed, contributed to awareness of these components within the TMCBL.

In the personal interviews data the respondents also spoke favorably of the instructional design used for the TMCBL. However, the needs of these key SWOS personnel were different than those of the students who used the lesson. These key SWOS personnel, while interested in the totality of the project, emphasized the key
Table 7: Key Decisions of SWOS Personnel and the ISU Experts

<table>
<thead>
<tr>
<th>Key Decision</th>
<th>Key SWOS Personnel</th>
<th>ISU Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hypermedia</td>
<td>•</td>
<td>•</td>
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<tr>
<td>2. Video Disc</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>3. Individualized Instruction</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>4. Computer Platform</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>5. Authoring Software</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>6. Program Shell</td>
<td>•</td>
<td>•</td>
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<tr>
<td>7. Book Metaphor</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>8. Use of Quizzes</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>9. Index of lesson content</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>10. Cognitive Map</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>11. Motivating and Informative</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>12. Active Learner Involvement</td>
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<td>•</td>
</tr>
<tr>
<td>13. Advance Organizers</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>14. Mnemonics</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>15. Logical Flow of Lesson</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>16. Screen Design</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>17. Use of Color</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>18. Text Readability</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>19. Hypertext</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>20. Navigation Aides</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>21. Button Placement</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>22. Pop-up Information Boxes</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>23. Use of Line Drawings</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>24. Objectives of Lesson</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>25. Instructional Manual</td>
<td>•</td>
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</tbody>
</table>
decisions that were made early in the instructional design process. These decisions included use of hypermedia, computer platform, and authoring software. Another key decision emphasized by the SWOS respondents was program shell. This group of SWOS respondents had the responsibility for modifying the program shell to make necessary Threat Matrix changes. While the students who used the TMCBL were not concerned about the decision of a program shell, it was an essential component to these key members of SWOS. In addition, the key SWOS personnel stressed the need for the hypermedia to be motivating and informative, able to meet objectives of the Threat Matrix, provide individualized instruction, and assess student progress through the use of quizzes.

Data collected from the researcher in the form of chronological logs and participant observer field notes related to all the identified key decisions. As the individual most personally involved in the creation of the TMCBL, it was expected that the researcher would be concerned with all its components. Certain key decisions were compounding, in that they greatly affected the manner in which other equally important key decisions could be implemented. For example, the selection of computer platform and authoring software had a profound effect on the other key decisions such as screen design, navigation aides, button placement, pop-up information boxes, and use of color. The key decisions were not prioritized in importance because they functioned collectively within the instructional design process.

In order to accomplish the above mentioned outcomes, some questions are identified for an instructional designer to consider before beginning to develop a computer-based lesson. Below is a check list of questions:

Instructional Decisions:

• What are the objectives of the lesson?
• How can hypertext and/or hypermedia be used?
• How can an awareness of lesson content be facilitated through the use of cognitive maps, metaphors, and advance organizers?
• What can be done to insure logical flow to the lesson?
• How can the lesson be motivating and informative to encourage active learner involvement?
• Is the planned instructional design adaptable to individual learner needs?
• How can visual cues be used to encourage the learner's construction of a mnemonic?

Design Decisions:
• Will a video disc be used? If so, how?
• Will line drawings, diagrams, or other graphics be used?
• How will the layout and placement of objects be used in the screen design?
• Is color an option with the selected computer platform and authoring software? If so, how will it be utilized for maximum effectiveness?
• What navigation aides will be used to assist the learner?
• Where can buttons be placed to preserve the instructional screen space and to ensure their consistent location throughout the program?
• Is it appropriate to use pop-up information boxes with scrolling fields to provide information?
• How will textual displays utilize size and style of font, justification, and length of line?

Functional Decisions:
• Do the computer platform and authoring software meet the needs of the client?
• How can the program shell be modified and changed as needed?

Enhancement Decisions:
• How will an index be utilized in this lesson?
• How will quizzes be incorporated?
• What instructional manuals will be needed to assist the learner use and to maintain or modify the developed lesson?
Recommendations for Further Research

Using triangulation, this study identified and verified twenty-five key decisions that were made during the instructional design process for the TMCBL. This section describes three areas of further research related to this study and discusses future implications of hypermedia design strategies.

The TMCBL created for this study was an example of interactive hypermedia, an emerging form of instructional technology. The number of studies assessing this form of instructional technology is now increasing. Although this study identified and verified twenty-five key decisions utilized in the creation of the TMCBL, there may be others that could also be identified and verified in a similar manner. Further research with a similar computer-based lesson could indicate such key decisions.

Other research concerning key decisions of the instructional design process could compare this study with another computer-based lesson using different instructional objectives. Further research could verify the degree to which various key decisions impacted on different instructional objectives. This research is suggesting that a generic group of key decisions can relate to a wide variety of computer-based lessons. However, the key decisions could be modified to adjust for varying instructional objectives in much the same way as parts of an orchestra adjust to different types of music. For example, in this study respondents indicated the importance of line drawings in relationship to the instructional objective of learning Soviet facts. If the instructional objectives had not related to the Threat Matrix, line drawings might not have been as important a decision.

This study was limited because there was a single work station for the TMCBL. Further research could focus on the use of more work stations to ensure a larger population of subjects. Such research would result in a larger data sample.
Future implications for hypermedia forms of computer-based lessons will include technology that is more powerful and accessible. As instructional designers add more realism to computer-based lessons through the use of hypermedia, a wider range of applications will become evident.

Conclusions

The delivery of instructional materials has, and will continue to be, technologically based. As new equipment and delivery systems become available, the presentation mode may change and vary greatly. No matter what the content or level of technology equipment necessary to experience it, an essential element of any form of instructional technology is the instructional process used to create it. This study identified key decisions that are inherent components in an instructional design process. The effectiveness of any instructional design can only be as effective as the elements which compose it. By identifying key decisions made during this instructional design process, the identified key decisions can have applicability in numerous other computer-based lessons, regardless of their content.

The findings of this research study have emphasized some essential components in any instructional design strategy. The elements incorporated into this computer-based lesson are consistent with components found in constructivist approaches to learning. Piaget (1963, 1983), Papert (1980), and others strongly support a learning environment in which the learner has greater control in determining the manner in which the materials will be experienced and assimilated. This computer-based lesson was created to be non-linear in its design and was hypermedia based. It not only displayed text (hypertext) but also included graphic designs, as well as motion and still video images.
The value of cognitively based learning materials was an important outcome of this research. Cognitive enhancers, such as advance organizers (Ausubel, 1968), metaphors (Patton, 1981; Benest, 1990), and cognitive mapping (Barbara, 1993; Maddix, 1990), were found to be useful. It is apparent that instructional materials can become more pertinent and relevant to learners if they incorporate cognitive enhancers into the design. The matter in which these cognitive enhancers build the linkage or schema (Rumelhart, 1980) in the mind of the learner could be a key to instructional designs of the future. Educators must continue to build mechanisms into their instructional designs which help students at all levels of skill and motivation identify with the strategies used to learn objectives.

The areas of constructivist learning and cognitive enhancers were further assisted by key decisions such as use of quizzes, lesson objectives, use of an index, and navigation strategies. The combination of all these elements, while not ensuring total success of an instructional design, certainly assists and promotes its potential effectiveness.

This study found that key decisions made during the instructional design process could be identified and verified. Knowing key decisions of an instructional design process will provide instructional designers with an increased awareness of the components to be used in other computer-based lessons. Grouping these components by the role they play in the instructional design process can assist in the creation of more effective instructional designs. Instructional, design, functional, and enhancement decisions are individually and collectively relevant to the impact of the computer-based lesson.

The learners of today and tomorrow, whether in elementary, middle school, high school, college, or business and industry, are all faced with a similar task of
acquiring and assimilating vast quantities of information. This research study identified considerations and key decisions that are vitally important to the goal of creating instruction appropriate to the needs of learners.
REFERENCES


Mayer, Richard E. (1979 b). Twenty years of research on advance organizers: Assimilation theory is still the best predictor of results. Instructional science, 8, 133-167.


ACKNOWLEDGMENTS

My friend and mentor, Kermit Buntrock, has commented that several times in his life he felt like the turtle sitting on top of the fence post, realizing that without a considerable amount of help he never would have gotten there. So it is with this effort. I'm here with the help of many others.

Dr. Michael Simonson at Iowa State University was the Project Director, who laid all the groundwork, and made this experience possible. I am grateful to him for his support, encouragement, and perseverance with both the project and me. Mike, thanks for being a learner along with me, as we explored Linkway. Dr. Ann Thompson, the co-chair of my committee, visited with me about seven years ago and encouraged me to become involved in the Ph. D. program. Believe it or not Ann, I am still pleased that we had that conversation. Other distinguished individuals served on my committee and were an integral part of this experience. I have appreciated the assistance of Dr. Anton Netusil, Dr. Thomas Andre, Dr. Lynn Glass, and Dr. Gary Downs. Faculty members, Dr. Harold Dilts and Dr. Donald Rieck, substituted for two committee members during my final oral. For them to absorb the study and the resulting work within the time frame given was expended effort they did not have to give, but rather chose to share. Thanks to all these educators for their contributions.

Next, I wish to thank my many friends of the Surface Warfare Officers School (SWOS) at the Naval Education Training Center in Newport, Rhode Island. Thank you, Dave Monroe for always making me feel like a member of the SWOS team. Thanks, also, Captain Norman Pattarozzi. Your vision and leadership made instructional technology efforts such as this one possible. Commander Michael Crawford, you were a significant moving force that brought this concept from an idea to an implemented effort. Lieutenant Commander John Ebley, thank you for the many
meticulous hours you spent going over the TMCBL and checking all the data it contained. George Allen, thank you for working with SWOS via Oakridge Associated Universities. You were a pillar of support not only for this effort, but for other ISU related projects which preceded it. A special thanks goes to the Naval lieutenants who used the TMCBL in their training and later among their busy shipboard duties, and who took time to respond to the questionnaire described in this study.

Larry Burtness was solely responsible for helping me through the tough technical parts of Linkway involving program code for video buttons, quiz question selection, and a zillion other things that were never included in the Linkway manual. Thanks Larry, for always having an answer or being willing to help me find one!

The Ames Community Schools were very tolerant and understanding of my absence from work on several occasions during this effort. My trips to SWOS, to the IBM training in Atlanta, Georgia, as well as convention presentations caused some absences from the school day. I am appreciative to the school district for its assistance and support in this manner.

I could write a dissertation describing the unequivocal support given to me by my wife Suzanne and my son Ryan. Suzanne, thank you for your love and confidence. Ryan, I so very much enjoyed your being a part of my last trip to SWOS. It was terrific for you to share a place that developed such special meanings for me. Thanks for your time in clicking on the hundreds of buttons in the TMCBL and confirming that they were working.

I wish my parents could be here to share in the final phase of this effort. Both of them passed away during the work of this degree. While they never fully understood this project, they were fiercely proud of my effort in pursuing it. Like good parents, they were always there during those times when I needed the special kind of
"emotional pat on the back" that only a mom or dad can give. To my other parents, Herman and Edith Zobrist, thank you for your continued support for my family and me.

An interesting footnote to the entire Threat Matrix effort occurred on December 25, 1991, when the Soviet Union ceased to exist and a new country, the Confederation of Independent States (CIS), was born. At that point, and as of the date of this writing, what used to be a Soviet threat no longer exists. The ships and their assortment of sensors and weapons systems are still floating somewhere in that part of the world, and the U. S. Navy still wishes to know about them. However, their strategic importance is now less critical than it was during the time in which this unique project was created, developed, and installed. It is my hope that through educational efforts, the era of peace embraced by the USA and the CIS can continue and spread throughout the world.

The entire sum of experiences encountered during the time necessary to create and design the Threat Matrix computer-based lesson and to gather the research data as reported in this study, has been an unbelievable journey. Like all involved and complicated efforts, this one was filled with joys as well as frustrations. It was a unique opportunity to use state-of-the-art methods in instructional design, to solve an authentic problem identified by the United States Navy, and to produce qualitative research "close up and personal." I will always be grateful for the experiences this opportunity provided.
APPENDIX A:
THE BLIND MEN AND THE ELEPHANT
BY JOHN Saxe
The Blind Men and the Elephant
A Hindu fable

It was six men of Indostan
To learning much inclined,
Who went to see the elephant
Though all of them were blind,
That each by observation
Might satisfy his mind.

The first approached the elephant
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me, but the elephant
Is very like a wall!"

The second feeling of the tusk,
Cried, "Ho! What have we here,
So very round and smooth and sharp?
To me 'tis mighty clear
This wonder of an elephant
Is very like a spear!"

The third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
"I see," quoth he, "The elephant
Is very like a snake!"

The fourth reached out his eager hand,
And felt about the knee.
"What most this wondrous beast is like
Is mighty plain," quoth he.
"Tis clear enough the elephant
Is very like a tree!"

The fifth, who chanced to touch the ear
Said "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can. This marvel of An
elephant is very like a fan!"

The sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceedingly stiff and strong.
Though each was partly in the right,
And all were in the wrong!

Saxe, 1887, (pp. 111-112)

APPENDIX B:
THE THREAT MATRIX: A COMPUTER-BASED LESSON
COMPUTER SCREEN QUIZZES
Chapter 1: Warship Drawings Quiz

Question 1

Which USSR surface warship class does this drawing represent? Choose your answer and click on button A, B, C, or D below.

A. Udaley  
B. SAM Khotin  
C. Sovremennyy  
D. Grisha-V

A  B  C  D  StopQuiz

Line drawing quiz screen (top)

Video recogniton quiz screen (bottom)
Chapter 1: Warships Facts Quiz

Question 2

Of the choices listed below, which class of ships can attain the highest speed?

A. Nanshika-II
B. Osa-I
C. Sarancha
D. Tarantul-II

Multiple choice quiz screen
APPENDIX C:

THE THREAT MATRIX: A COMPUTER-BASED LESSON
TITLE SCREEN AND LESSON CONTENT
# Book Contents

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<th>Surface Warships</th>
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<td>Fixed Aircraft</td>
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<td>Chapter 4:</td>
<td>Helicopters</td>
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<tr>
<td>Chapter 5:</td>
<td>Sensors</td>
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<tr>
<td>Chapter 6:</td>
<td>Weapons Systems</td>
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**OTHER**

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<td>Fixed Aircraft</td>
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<td>Helicopters</td>
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<td>Chapter 5:</td>
<td>Sensors</td>
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<tr>
<td>Chapter 6:</td>
<td>Weapons Systems</td>
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</table>
APPENDIX D:
THE THREAT MATRIX: A COMPUTER-BASED LESSON
SHIP STUDY PAGE AND VIDEO IMAGE
Ship study page showing pop-data window (top)

Video image of ship (bottom)
APPENDIX E:

THE THREAT MATRIX: A COMPUTER-BASED LESSON
WEAPONS SYSTEM STUDY PAGE AND MISSILE LAUNCH
Weapons systems study page (top)

Missile launch (bottom)
APPENDIX F:

THE THREAT MATRIX: A COMPUTER-BASED LESSON
SENSORS STUDY PAGE AND LONG SEARCH RADAR
Sensors study page (top)

Long search radar, video image (bottom)
APPENDIX G:
THE THREAT MATRIX: A COMPUTER-BASED LESSON
INDEX PAGE
Index:

<table>
<thead>
<tr>
<th>Letter</th>
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<tbody>
<tr>
<td>N</td>
<td>Nikolay Vilkov</td>
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<td>Nikolayev</td>
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<td>Novorossiysk</td>
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<td>O</td>
<td>Obratnosovyy (Exemplary)</td>
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<td>Ochakov</td>
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<td>Odarenny (Gifted)</td>
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<td>O</td>
<td>Ognevoy (Curtain of Fire)</td>
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<td>Osa-I Class</td>
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<td>Osa-II Class</td>
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<td>O</td>
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<td>Otchavannyy (Merciless)</td>
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<td>Otilicanyy (Perfect)</td>
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<td>Oui Screech</td>
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<td>O</td>
<td>Peel Group</td>
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<td>Petr I'ichyev</td>
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<td>P</td>
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<td>Plate Steer</td>
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<td>P</td>
<td>Prozorlivyy (Sagacious)</td>
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<tr>
<td>P</td>
<td>Punch Boul</td>
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<td>P</td>
<td>Ryavanyy (Spirited)</td>
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<td>P</td>
<td>Raduga</td>
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</tbody>
</table>
APPENDIX H:
THE THREAT MATRIX: A COMPUTER-BASED LESSON
SAMPLE PAGES FROM USERS' MANUAL
AND TECHNICAL REFERENCE MANUAL
"SWOS Threat Matrix"
A Computer Based Lesson

By:

Robert O. Kelly
Iowa State University
Ames, Iowa

Version 1.0
January, 1991

Users' Manual
The Threat Matrix

- sections for USSR, USA, and Other countries

- six chapters for each section, containing:
  
  - Surface Warships
  - Submarines
  - Fixed Aircraft
  - Helicopters
  - Sensors
  - Weapons Systems
Section: USSR

Chapter 1: Surface Warships
- Carriers VSTOL
- Guided Missile Cruisers (N)
- Guided Missile Cruisers (R)
- Light Cruisers
- Guided Missile Destroyers
- Destroyers
- Frigates
- Guided Missile Patrol Boats
- Amphibious Ships
- Fleet Replenishment
- Intelligence Collector

Chapter 2: Submarines

Chapter 3: Fixed Aircraft

Chapter 4: Helicopters

Chapter 5: Sensors
- Long Range Air Search
- Data Link
- Gun Fire Control
- Sonar

Chapter 6: Weapons Systems
- Surface to Surface Missiles
- Surface to Air Missiles
- Air to Surface Missiles
- Guns
- Antisub Missiles
- Antisub Torpedoes
- Antisub Mines

= Chapters Completed
Chapter 1, "Surface Warships"
Example page from lesson

Cognitive Map
This section shows exactly where users are in the lesson. It also shows the user how this lesson example fits into the total "Threat Matrix."

Navigation Buttons
Clicking on the first five buttons will take you to that identified section. Clicking on "PREVIOUS SCREEN" will allow the user to retrace your moves, and see up to 12 previous screens.

Line Drawing
If available for this example, a scanned line drawing will be shown.

Video Buttons
If a green video icon is shown, clicking on it will show a motion video sequence from the videodisc. A red icon will show a still frame.
"TURN OFF VIDEO STILL" gives the user control of how long the video still image is on the screen.

Information Pop-up Buttons
Click on any of these buttons to read more about its contents. When finished reading, click on the upper left corner of the pop-up box, and it will go away.
Chapter 5, "Sensors"
Example page from lesson

Cognitive Map
This section shows exactly where users are in the lesson. It also shows the user how this lesson example fits into the total "Threat Matrix."

Navigation Buttons
Clicking on the first five buttons will take you to that identified section. Clicking on "PREVIOUS SCREEN" will allow the user to retrace you moves, and see up to 12 previous screens.

Line Drawing
If available for this example, a scanned line drawing will be shown.

Video Buttons
If a green video icon is shown, clicking on it will show a motion video sequence from the videodisc. A red icon will show a still frame.

"TURN OFF VIDEO STILL" gives the user control of how long the video still image is on the screen.

Information Pop-up Buttons
Click on either of these buttons to read more about its contents. When finished reading, click on the upper left corner of the pop-up box, and it will go away.
Chapter 6, "Weapons Systems"
Example page from lesson

Cognitive Map
This section shows exactly where users are in the lesson. It also shows the user how this lesson example fits into the total "Threat Matrix."

Navigation Buttons
Clicking on the first five buttons will take you to that identified section. Clicking on "PREVIOUS SCREEN" will allow the user to retrace you moves, and see up to 12 previous screens.

Line Drawing
If available for this example, a scanned line drawing will be shown.

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"SWOS Threat Matrix"
A Computer Based Lesson

By:

Robert O. Kelly
Iowa State University
Ames, Iowa

Version 1.0
January, 1991

**Displacement:** 10,000 TONS (12,500 FL)  
**Speed:** 32 kts.  
**Dimensions:** 186.0 x 20.3 x 8.0  
**Machinery:** COCOG; 4 boost gas turbines; 30,000 hp each; 2 cruise gas turbines 12,000 hp each; 2 props; 120,000 hp  
**Boilers:** NO DATA  
**Fuel:** NO DATA  
**Electricity:** 4 gas turbine sets 6000 hp  
**Range:** 2000/30, 8800/15  
**Manpower:** 720 total  
**Ship Names:** 3 ships are in this class: (1) Slava ("Glory"), (2) Marshal Ustinov, (3) One other not named
<table>
<thead>
<tr>
<th>Section: USSR</th>
<th>SENSORS LIST:</th>
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<tr>
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<td>For further data click on &quot;MORE&quot;.</td>
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<td>Lesson ID: Gold Missile Cruisers R</td>
<td>- 3, Palm Frond</td>
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<tr>
<td>Example ID-1: Slava Class</td>
<td>MORE - 1, Top Pair</td>
</tr>
<tr>
<td></td>
<td>MORE - 1, Top Steer</td>
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<td></td>
<td>MORE - 1, Top Dome</td>
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<td></td>
<td>MORE - 2, Top Group</td>
</tr>
<tr>
<td></td>
<td>MORE - 1, Kite Screen</td>
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<td></td>
<td>MORE - 3, Bass Tilt</td>
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<tr>
<td></td>
<td>- 1, Front Door-Front Piece</td>
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<td></td>
<td>- 6, Side Globe EW</td>
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<td>- 4, Rum Tub EW</td>
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<td>- numerous Bell-series</td>
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<tr>
<td></td>
<td>- 2, Chaff RL (II x 2)</td>
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<td>MORE - LF hull-mounted sonar</td>
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<td>Example ID-1: Slava Class</td>
<td>MORE - 8, SA-N-6 vertical-launch SAM groups (VIII x 8, 64 Grumble missiles)</td>
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<td>MORE - 2, SA-N-4 SAM syst. (II x 2), 48 Gecko missiles</td>
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<td>MORE - 2, 130mm 70 cal DP (II x 1)</td>
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<td>MORE - 6, 30mm Gatling AA (I x 6)</td>
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<td>MORE - 10, 533mm TT (V x 2)</td>
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</table>

| MORE - MF VDS - E/O |
|---|---|
| MORE - 2, Toe Plinth sonar |
| MORE - LF hull-mounted sonar | |

| MORE - 2, RBU-6000 ASW RL (XXI x 2) |
|---|---|
| - 1, Hormone-B helicopter |

**SW|Od| 5.6 id=9**
Weight: NO DATA
Length: NO DATA
Range: 30 nm, 4 nm minimum
Guidance: NO DATA
Diameter: NO DATA
RCS: NO DATA
Speed: NO DATA
Warhead: NO DATA
Profile: NO DATA

Found on ship classes: Kirov, Kara & Kresta class cruisers; Kivak I & II class frigates
Additional Information: Consisting of 2 Head Net A antennas, mounted back to back; one in a horizontal plane, the other inclined. Widely used on cruisers and destroyers. The Head Net series radars use a band that gives a 60 to 70 mile detection range on an attack bomber flying at high altitude.

Found On Ship Classes: NO DATA
APPENDIX I:

COURSE EVALUATION AND PROTOTYPE ASSESSMENT DATA
WRITTEN COMMENTS
Appendix I

Course evaluation and prototype assessment data

"Your computer driven program and slides on the Soviet platforms was excellent!"

"Used new computer video presentation which would benefit from zoom capability on area of platforms, and provide detail on systems discussed."

"Don't feel the new computer display in SCIF is clear enough for classroom learning environment. Nice toy for individual VSE and studying but not clear enough."

"Use the SCIF! It's a great A/V system and much better than slides."

"The instructor was excellent, however I'm not impressed w/ the computer generated recognition system. It is difficult to see and impossible to focus and terribly distracting. Perhaps when refined it may be of more use."

"TV pictures need to be shown on a slide screen to see more. Nice computer toy but distracting to watch."

"The new computer system with the video tie is a great idea."

"Computer generated pictures are fun, however not worth the cost."

"Clear, concise summary of the material. Fantastic training aid for the Soviet presentation."

"I really enjoyed the new overhead/TV presentation system. Great pictures/films of Soviets."

"The new computer aided system is excellent, but at least one more large screen projector is required so you can do away with the monitors."

"Keep the new projection system (SCIF). Encourage student use after hours."

"Overall, package well received. The Iowa State package is a major step in the right direction. As we refine the presentation and upgrade some of the classroom facilities, our instruction will only get better."

"Computerized demo program is good, but only if students will get to use and study by it. Otherwise stick to slides."

"Computer multi-media presentations of platforms was very good - helped put everything in context."

"Great audio visual program."

"The computer driven presentation was great, however serious consideration should be given to acquire a second video projector to complement the one already in the SCIF. The two monitors are much too small and detract from an otherwise professional display."

"Impressive multi-media dog and pony show. Would be more useful if computer based instruction and video were available at individual desktop
stations. Entire curriculum could then be interactive/self paced. However, I understand that funding limitations of CNET prevent the implementation of such a perfect world system."

"The multi-media presentation for the Soviet ships is very interesting."

"Computer aided RECC (?) outstanding! Need larger screen TV."
APPENDIX J:
COVER LETTER SENT TO PARTICIPANTS FOR ATTITUDE ASSESSMENT
SAMPLE ENVELOPES USED TO RETURN ATTITUDE ASSESSMENT
During February and March of 1991 you were enrolled in a SWOS class taught by Lt. Cmdr. John Ebley. As part of that class you used, or had demonstrated, a computer based lesson on elements of the Soviet fleet. The lesson was called "The Threat Matrix" because it presented information SWOS students need to learn about the Soviet threat. This system operated using a Zenith computer and used a combination of text and line drawings on screen displays, and also used a video disc player that showed selected images accessed by the computer program.

That particular computer based lesson was a prototype that was created for SWOS, and is now being developed further into an operational model. As part of my graduate study, I am collecting survey data from students who used or saw these materials. I need your help, and would be most appreciative if you would take a few minutes to respond to the one page survey which is enclosed. Your thoughts and opinions are very important to me, as you represent a small group of officers who experienced this prototype lesson.

All survey information will remain confidential. The code number on the survey is being used so that I may know which surveys have not yet been returned. I have visited with officers at SWOS, and they have helped me to be aware of your very busy schedule. For that reason, I have purposely made the survey brief.

Since you may be at sea as you read this, it is difficult for me to identify a specific return date. I would appreciate your return of the enclosed survey as soon as possible, so please complete it at your earliest convenience, and return it to me in the enclosed pre-paid, self-addressed envelope.

Thank you very much for your assistance with this effort.

Sincerely,

Robert O. Kelly
Graduate Student
Iowa State University
ISU Mail Center
Ames, Iowa 50010-9901
APPENDIX K:

THE ATTITUDE ASSESSMENT INSTRUMENT
"SWOS Theat Matrix, A Computer Based Lesson" - User survey

Please circle the number that reflects your response to the item.

<table>
<thead>
<tr>
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<th>Agree Strongly</th>
<th>Agree</th>
<th>Not Sure</th>
<th>Disagree</th>
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Prepared by: Robert Kelly
Research Institute for Studies in Education
College of Education
Iowa State University
Ames, Iowa 50011

Note: TMCBL = Threat Matrix Computer Based Lesson

1. I remember the TMCBL. 1 2 3 4 5
2. My reaction to the use of the TMCBL was positive. 1 2 3 4 5
3. I believe that TMCBL would be easy for others to use. 1 2 3 4 5
4. As I recall the TMCBL, I remember use of color on display screens. 1 2 3 4 5
5. The TMCBL has the potential to help SWOS students learn the facts of the Threat Matrix. 1 2 3 4 5
6. I think the TMCBL should be made available for students to use on an individual basis for studying and review. 1 2 3 4 5
7. I feel comfortable using a personal computer. 1 2 3 4 5
8. I think the line drawings on the TMCBL helped to enhance the lessons. 1 2 3 4 5
9. I believe applications such as TMCBL are effective. 1 2 3 4 5
11. Now that I have completed the Threat Matrix training, I would find the TMCBL helpful to refresh my memory. 1 2 3 4 5
12. While using the TMCBL, I recall pop-up boxes of data that contained specific Threat Matrix facts. 1 2 3 4 5
13. The TMCBL has the potential to show how elements of the Threat Matrix relate to one another. 1 2 3 4 5
14. The TMCBL has the potential to assist instructors in lesson presentations. 1 2 3 4 5
15. While using the TMCBL, I recall line drawings of ships, sensors, and weapons systems. 1 2 3 4 5
16. The TMCBL has the potential to help users recall the facts of the Threat Matrix. 1 2 3 4 5

In your opinion, was the idea of using a computer to present information on the Threat Matrix a good one? Using the back side of this survey, please tell us why you feel this way. --> --> -->

Thank you for your participation in this survey. Your response is appreciated!
APPENDIX L:
RESPONSES TO OPEN ENDED QUESTION
ON ATTITUDE ASSESSMENT
Appendix L

Responses to Open Ended Question on Attitude Assessment

The following is a compilation of the open ended question asked on the attitude assessment instrument. The question asked:

"In your opinion, was the idea of using a computer to present information on the Threat Matrix a good one? Using the back side of this survey, please tell us why you feel this way."

The Naval lieutenants completing the attitude assessment replied:

"As I recall, the structure of the course does not lend itself to the use of this computer program. That particular course is merely a study in short term memory. There is not time to use such a computer program in a course so structured. It is conceivable that the program has uses for ships at sea where on the job training is emphasized."

"The concept is quite good. As I recall, at times there were technical problems with the equipment that prevented us from watching the movie portion of the lesson. But when it worked, it was quite beneficial to me."

"The TMCBL represents a significant increase in the ability focus on detail and recognition features. The displays may be changed rapidly and can be either presented to a large or small group or utilized by an individual. This would be further enhanced by providing flight profiles or arcs and ranges of fire graphically."

"Yes, the prototype I viewed was not especially effective in that it seemed slow and cumbersome. However, I believe this medium has excellent potential for applications such as threat matrix. The combination of CD-ROM video and computer text and line drawings when used at the individual level would be particularly effective."

Really, Really Agree! -- (that the TMCBL should be made available for students to use on an individual basis for studying and review.)"

"Yes, outstanding program. Unrealistic to think that all students could get access unless scaled down to one PC/Monitor. The program was very useful. Line drawings displayed unique feature needed for fast recognition."

"Frankly I only vaguely remember the threat matrix presentations and do not recall the use of the term TMCBL. I do recall a couple of confidential briefings with some special presentation equipment using a matrix call-up but I don't remember it making a big impression on me. I still found that paper notes and a silhouette to be the best memory aids. Sorry I can't be a better help but with the fire hose approach to education that the navy uses and the hectic schedule over the past year you tend to forget a lot."

"Yes."
"With all of the facts and figures that are required knowledge during the threat matrix section of DH school, I feel that the computer/video/still-picture presentation is a great way to introduce threat platforms to students. Several terminals for student usage would be super."

"Yes, but would need several to make it effective for individuals for group/class use. Was better than slides and photos by themselves."

"Computer Based Instruction (CBI) format would be appropriate for much of the SWOS Department Head Curriculum. Students can work independently at their own paced to initially learn and review material that for the most part is learned by rote. This would obviously require individual work stations for each student (or allow for a group of students sharing access). This would reduce classroom instruction requirements and allow students to move through material faster. By incorporating testing into the CBI the student could assess his/her progress independently. Grades could be compiled and recalled by the instructor/proctor using a data base which would be linked to the CBI. Great potential exists to both improve the instructional quality at SWOS and to expedite what can be a tedious traditional classroom learning process through the use of CBI."

"The computer can perform line drawing of the ships and the weapon systems allowing the student to better identify the weapon on the platform and relate that system to a specific platform. It would be even better if the student could have an individual terminal."

"It was a good way to present threat matrix when combined with actual photographs. I still believe that nothing compares to the use of flash cards to learn material such as this."

"Yes. I thought the line drawings were good in that they showed the lay-out of weapons systems. When used with the CD player to show live shots of the ships you could use them effectively to identify and learn the platforms. This feature was not always operational however. The pop-up boxes of data also were very helpful and I thought this was one of the best features. Overall, I think it is a good system with lots of potential. I must also add, however, that in order to pass the recognition tests on Soviet platforms, I had to study still photos."

"The computer presentations used for the TAO portion of SWOS was most helpful. I derived benefit in learning the threat matrix by being able to compare and contrast similar platforms and learn the differences. While some of the photographs were of poor quality, the line drawings were accurate and concise. The computer was used in the classroom forum, but was not available for individual use at the time I took the course. Had it been available for individual use, I would have utilized it."

"Computer data base allows independent study, frequent referral, and a more organized format to study threat platforms. The ability for a user to locate information currently, in a variety of useful and comparable formats is a most beneficial aspect. Definitely helpful in a shipboard arrangement, is made available."

"The combination computer/video disk info made learning the subject matter easier and more enjoyable. I would recommend ships receiving several units as well as SWOS Dept. Head School and DV School receiving many units for individual study."
"I think the computer would be good for individual study only. The slides contained so much information that it is a little overwhelming when presented before a classroom of people. If this materials could be made available to ships it would be an outstanding refresher tool."

"Yes. Combination of facts, line drawings and video disk made a very dry subject more active and easier to recall. Would have preferred it as a study tool as well."

"Anything that helps a student learn is considered a good tool. Who should decide if this tool should be used by the individual student or to the entire class (as was the case for me) is the relevant question. I feel it should be the student who is made aware that the tool exists and let him decide to use it or leave it."

"Yes, especially if the training is made available on board ships for refresher. The majority of time spent learning the threat matrix was from paper the normal school method. The threat program could easily teach the matrix threat by using a quiz feature i.e. showing a particular ship and student identifying emitters and weapons/ranges. It could prove to be very beneficial."

"I don't like gimmicks, programmed texts, etc. in general. I like to read a source and figure it out for myself. Yet, even predisposed against TMCBL, I found it a tremendous learning aide."

"Yes. Using the computer based system with its line diagrams it was easier to point out the different systems. When looking at pictures alone it is difficult to make out every system on a ship."

"Initially, the system seemed a bit too whiz-bang for our purposes, and some of us in class were turned off by the apparent expense. After a few lessons though, it did become apparent that the system offered superb flexibility and supported comparison and discussion without distracting delay. Overall, I do think that it is a good system for classroom on seminar use, but still too expensive for individual, multi-station use."

"Yes. Provides an easy means of constantly refreshing your memory on the threat. Much easier and more effective than flipping through pages of names and numbers."

"Better than a threat matrix on a piece of paper to memorize. Sticks to memory better. Excellent training tool."

"The TMCBL enhanced student learning as a visual aid. Student interaction enabled visual cues and references not gained by reading material or printed threat matrixes."

"Too busy to write."

"TMBCL is a good start. Using it in a group setting is not as beneficial as being able to use one individually. When the hardware requirements are in place to allow students individual usage the program will be much more effective."

"I found the computer application lacking in information and very distracting in the classroom. I felt better utilizing the publications to study the threat."

"My two points of dissatisfaction rest in (1) the instructor's unfamiliarity with the system and (2) the generally poor quality of the pictures used for
identification. In truth the system has great potential, but it appeared clumsy/awkward when used by the instructor. Perhaps this is because it was his first exposure as well, but it certainly distracted from the overall presentation of the TMCBL package."

"If each student has his/her own terminal with access to it, it would be outstanding. As utilized for our class, one instructor ran the show for 60-80 students, at his pace. It was like his toy and we saw what he thought best. Money considerations would be the major factor, in instituting it correctly."

"I circled '5' for every response as a result of my agreeing strongly or confirming each statement. I strongly believe that any subject that requires a multitude of graphics be correlated with facts should be presented and studied using an automated (i.e. computer based) system. I think that your multimedia presentation is only one or two refinements away from what it needs to be. Keep up the good work. Guys like you will help guys like me bring the Navy into the computer age."

"I believe any time you can include audio/visual presentation to a lecture it greatly enhances its effectiveness. The TMCBL is a well-designed system that helped me a great deal in learning the facts of the threat matrix."
APPENDIX M:

PERSONAL INTERVIEWS DATA
SUBJECTS 1-5
What is your job area/title?
I'm an education specialist in the Curriculum Standards Office. I work on anything that comes up of an instructional nature.

What were some of the things that lead SWOS to a decision to use computer technology to help students to learn – in this case The Threat Matrix?

It was a realization that as they study the Threat Matrix, which has some 3,000 more or less bits of information that have to be memorized and recalled on their potentially extreme or strenuous circumstances, the only way these students had to learn those 3,000 plus or minus bits of information, was to write them on flash cards or study them out of a text that was very disorganized, from an instructional standpoint, that was not put together to be a student study guide -- that there was a great deal of difficulty in learning the Threat Matrix. We were looking for alternatives that would be better. We knew that mnemonics could play a big role -- a role of facilities that enhance or modify a person's ability to learn that they may not be consciously aware of -- could play a big part. And we were looking for something other than flash cards or a text that was poorly organized to study, and the logical approach seemed to be something that had a variety of inputs. We thought about audio. Audio's hard, because there aren't that many sound tracks around. Sound is not one of the issues that's ever been part and partial of study. But visual recall, visual recognition, just guided bit recall -- is important. So we decided to try and drag something that had a mnemonic base together to train them. And a logical approach was computer based, rather than something than anything else that was textually based.

And what decision, or what basis did you decide computer base was the way to go?
Had you seen it used in other things, had you seen demos of other strategies, or ?

No.... I think it was more Iowa State's suggestion of an approach, rather than our independent determination that was the right way to go. I had for a long time seen a problem with trying to study Threat Matrix with flash cards, and knew there must be more effective, more efficient ways to do it, that were quite probably somewhat more sophisticated. I was sure that motion could play a big role because there is such an almost infinite number of data points that suddenly become available for the learner that he never has to consciously consider, but they play on memory recall. I knew that motion was important -- that perhaps, almost as important, were still images. Perhaps not quite so important, but important as well, was line drawings. And even words in text as charts and numbers. And I guess we just, I don't know, described the problem to the folks from Iowa State who were here on other projects -- Mike Simonson and many of his colleagues -- who came up with an approach that included all those things that I was looking for, that it just happened to be computer based. There is no other technology available that does it quite as sufficiently.

Once that decision was made, how did you determine what you wanted the product to look like -- how you wanted the product to feel to the user?

I think it kind of grew. I don't know that we had a design scheme in place to begin with. We knew it had to be easy to use. We knew we didn't want the students to struggle through, becoming computer experts before they could become students. We had looked at some alternatives that were developed by the Navy under contract to other universities and we reviewed them and found them to be wanting in a lot of areas. One of the areas wanting was in the computer based approach was that it was incredibly slow to get through the material. Just the update rate and the refresh rate on the screens was way too slow. So we knew that was a stopper. If it took too long to get from flash card to flash card to flash card and the computer set up, the students would say, "To heck with it," and they'd do something else. So it had to be fast. It had to be easy and it has to be effective. We
also determined that if it was going to be computer based, as it appeared it was, that it had to be something that would run on systems that were already available. We did not want to have to go out and buy vast quantities of dissimilar hardware so that we could run something, you know, on a system that wasn't compatible for other uses. The Navy has already invested in MS-DOS base. They have already invested heavily, in our case, in Zenith computers. We wanted something that we could already run with what we had for hardware, rather than going out and buying a whole array of other equipment to run on an Apple base or something else.

How would you characterize the philosophical and financial support base for this concept?

Philosophically it is very strong, because it has been a non-threatening approach. You know, if it works, it works. If it doesn't, we just walk away from it. The cost has been quite reasonable. As the first portion of the project was delivered and has been used, it has shown promise. The staff likes it. The students like it. So there is very little risk in extending it and continuing it to complete the model that has been designed so far. The next phase, though, is to prove its efficiency and its effectiveness, and that requires some continued research and development, and testing and in managing student progress through the system, as well as managing the performance of groups of students. So that's still yet to be done.

But you envision a philosophical and financial support base to do that, as well?

Right. At least at this point because (a) it's been economical to begin with, and also because it appears subjectively to be effective, and of utility to students and staff.

What concerns did you have about the involvement in this project as you began to work with it?

Really, I had none. Iowa State had already done several projects with us. I was very confident of their talent and their experience and their insight, and there was little question that in our minds they had the expertise. One of the things that we have always looked for from Iowa State is a basic scholarly insight. When a person is ill and goes to a physician they look for scholarly insight in medical expertise. When we have an issue that needs to be dealt with as we do with learning a threat matrix, we go to Iowa State, laying out the problem, expecting scholarly insight to be able to find solutions and then develop those solutions. And that's what we're looking for. We had absolute faith in the scholarly insight and expect it to come forth.

If you could identify any benchmark events that occurred as this process was unfolding, what would those bench marks be?

I guess the first one was Iowa State's willingness to take on the project. Having become willing to take it on and recommended a Macintosh-based approach that we rejected, because we had to have it on equipment that was readily available, their willingness to continue to try and find an MS-DOS-based approach, the one that emerged was Linkway. I think that was a bench mark in the process. I think that if Linkway, or something like Linkway, had not been available, perhaps it would have been developed as a project that was developed that we found to be unsuccessful. I think the one that we tried or the one that Iowa State has tried, that came out of the Midwest, and was perhaps unsuccessful because it was completely home grown software. I think the deal to do it on Linkway was a milestone. I think the delivery of the product with a video disk base was a milestone. I think that Iowa State's ability to put very talented people on it as graduate students was a milestone, and has continued to be a strength of the program. And probably the scholarly insight that Iowa State maintains over the project throughout is a bench mark.

Appendix M

Personal interview transcript: Subject # 1
And Iowa State's obvious intention to do well by the project. There is a great deal of pride and ownership and development in the success of the project. Nobody likes to be tied to an unsuccessful venture and Iowa State is particularly strong in their desire to be very successful at what they do, and they have worked very hard to ensure the success of this project.

**Once the prototype was delivered, how was it used from your point of view?**

Before the prototype was delivered, the students were required to memorize this threat matrix. The entrance into that threat matrix was a series of classes where the instructor would have stacks of carousels of slides, and slide carousel after slide carousel after slide carousel. They would ramble through, talking about each one of the slides and the issue that was there to be presented to students. But having rambled through all these carousels, there was very little opportunity for students to go back and study the information that they were required to memorize, with the mnemonics of all those still images. They did have the benefit of some commercially available text, one of which was used for the basis of this, and others to find photographs. But it's such a tedious and large job to maintain a data base of pictures that is spread throughout the book, that it's impractical. I lost track of the question.

We're talking about how it was used once it was developed.

Okay, yeah. So we used these slides and then when the slides were done -- six, eight, ten hours, whatever it turned out to be -- of going through all these slides, the students were left with the role of memorizing it all on their own. When this first generation was delivered, instead of using slides, and instead of using video tape, which we used very little of to begin with, we now had a vehicle where the instructors were able to bring in at least this fraction of the finished project and use it in lieu of the slides. Instructors found it to be a more effective way to put out the information. The students found it, perhaps because of the motion video, to be a more appealing way to view the information. But at this point that's the greatest use that's been made of it. It is not been made available to any great extent for students for self-study. And that is indeed the next phase of the project is to finish what's already been started -- we've done one-sixth of it -- finish the other five-sixths, and then deliver it on enough platforms, so that students can come back and use it as a self-study tool. It's been used now only as a presentation model, presentation tool by the staff. It has not been used extensively as a self-study tool. And that's where it really will prove itself -- I hope.

As it was used, as a presentation tool, did any problems emerge that you are aware of?

The only problems were nickel-dime. They weren't related to the design effort.

Maybe you've already eluded to this to some degree, but on what basis did SWOS decide to expand the prototype into the fully-operational pilot that is now being carried out? Why did they expand it?

A continued belief in the value of the approach. We started proceeding in this direction because we considered there would be sufficient value in mnemonics to go that route, and we have always maintained that position. And until this device demonstrates that that's not true, we will continue to believe that, and continue to proceed on to demonstration. We haven't gotten to the demonstration phase yet of mnemonics as the way to study the data points, to memorize them better. One of the other outposts we're looking for, is not only short term memory, but we're expecting mnemonics will be memorable enough that they will improve the durability of the material, so that in addition to short term memory, there will
be better long term memory. And we have to ensure that the testing model that we
have developed for the final proof of this concept includes not only short term
testing, but as well, long term testing. And our students, because they study the
threat matrix very early on in their tour here, because they are here for six months,
it is not unreasonable to proceed with the notion that we could also develop a post
test very near the end of their tour here, which might be some three or four months
after they finished studying the threat matrix, to see how perishable the process
has been.

Once all the chapters are complete, like we are currently working on, then what
will happen next? You've talked about that to some degree.

Well, what I would like to see next is a two-phase project that we're in the
business of designing right now. One is to develop a scholarly testing base. I don't
know if we would characterize the tests that have been developed at this point as
beginning and end-all of a scholarly development. So I think the issue of testing
needs to be addressed in a more scholarly, comprehensive manner. In addition to
the test questions themselves, which will hopefully demonstrate the student's
accumulation of knowledge, there needs to be a management model built on top of
the Linkway -- on top of the chapters when they are all filled -- so that each
individual student's progress through the matrix, in a hyper-fashion, can be
monitored by the system, and it will continually move him towards those areas that
he has not demonstrated proficiency in, and eliminate from his future study those
areas where he has already proven proficiency. So it continually focuses among the
unknown and gives credit for the known, so that when a student starts with the
study and proceeds through until he's done, the system will keep track of his
progress and continually focus him on the unknown.

Would you want the system keeping track of his progress — would you want that to
be done for the student's benefit or for the instructor's benefit?

Both. The school has to be able to determine that the students accomplish
the learning which is required -- the memorization which is required. The student
has to know that he has accomplished it as well. Beginning and end-all is not to
prove it here at the school. The beginning and end-all is to have it available in a
crisis in the middle of the night in a hostile environment, and you have to recall it
and use it to avoid circumstances that have resulted in things like the Starkton case
with two Exocet missiles. Proper vigilance, and proper training, and proper
attention to detail, and the ability to recall are all important. We can handle the
training issue. We can't necessarily be responsible for the vigilance. We can't
necessarily be responsible for the attention to detail. But we can be responsible for
the initial training.

You were eluding to the fact that it might be used in a moment of hostile intent.
Are you referring to an on-shipboard kind of use?

Yes.

Tell me what you are referring to with that. What do you mean by that?

The whole idea of requiring students to memorize the matrix is based in the
notion that the instances of hostility are very fast-paced and the potential for
students to spend an awful lot of time in consideration, is pretty remote. During the
days of John Paul Jones you could see your enemy on the horizon and it was hours
before you got close enough to engage. Now we have a circumstance where you
may never see that enemy. You may be engaged unwittingly before you have any
realization there is even any engagement in progress. Or the time from which you
determine there is an engagement in progress until it is completed may be so short
that there is virtually no time to react. It all has to be done very quickly -- almost
instinctively — with a tremendous amount of pressure, with a host of variables, and many unknowns. I think the Stark is an ideal example of that notion. The Stark was in a hostile environment, it had been declared to be hostile for such a long time, that the threat became something of a given — much like people exceeding the speed limit. We know that 45 might be the safe speed limit for the driving conditions, but we are so used to going 50, that pretty soon we accept 50 as the level of risk, where we lose track of the delta on what’s reasonable risk and what’s unreasonable risk. Take a circumstance like the Stark, where there had been many, many, many, many passes of threatening aircraft, and what were presumed to be non-threatening aircraft, up until that one pass when, in this case, an Iraqi aircraft launched two missiles. Hundreds of times before they had made the same kind of approach, and turned off and gone home without launching. Pretty soon you get to thinking that 45 is a safe speed to drive and that that aircraft coming in is a safe aircraft. When it launched, and when they determined they were in a hostile situation, potentially a life-threatening situation, there were an awfully lot of actions that needed to be taken in a very short period of time, and a host of variables that needed to be considered — and a host of unknowns that should have been considered. And Stark was unable to respond effectively and they got hit. Perhaps if they had been better prepared, whether in vigilance or in training or attention to detail or maintenance of equipment, I don’t know the variables that led to the failure. I don’t know what variables might have led to success, necessarily, but I just can’t help but wonder if things had been different, it might have gone otherwise.

So if the system would have been on-board the ship, and it had been practiced and used regularly, that may have been a factor? Is that what you are saying?

I don’t know if I would even want to say that. I think that one of the sets of variables that is important in the considerations that are made in hostile environments are all of the threats that are there, the priority of the threats, and an officer’s ability to sort out them, prioritize them, and take them on in sequence, and be able to do them in a timely fashion. Timeliness was probably the downfall of the Stark at the moment. Actions that could have been taken and weren’t taken, because of a lack of timeliness, could have been driven, perhaps, by insufficient insight — and that insight surely can be factored against training. That’s not totally, but there may be other mitigating circumstances.

Do you see other applications for this form of instructional technology here at SWOS besides the threat matrix?

Yeah, I do. Absolutely. There is a host of areas where the issue of mnemonics can play immensely on students’ perceptions of issue, their recognition of issues. I think the notion of visuals plays an important part in training. We use an inordinate number of visuals — everything from the simplest, textural, transparencies — but we put bullets in texts up on a screen to make a point — to work our way through an issue — to sophisticated line drawings — to sophisticated three-dimensional drawings — to sophisticated full motion, animated drawings. There’s an awfully lot of potential for visual support to enhance and streamline and speed-up and improve the effectiveness of training. We’re always trying to push on that and make it more readily available.

Have you talked to other folks outside of SWOS about the project — contemporaries of yours elsewhere around the country? If so, what have you told them?

Not really, no. I haven’t talked to any because we are waiting for the proof of the concept to come in. At this point we haven’t proven the concept. I would rather wait until we have it all in one sock before I go out and declare. There will be time to make that declaration when it’s done. This is premature. In fact, we have been approached by other outside organizations — IBM, one that you are aware of —
to publish the application of Linkway in this kind of situation, and we rejected and resisted publishing at this point, because we think the development is not sufficiently proven yet. We don't want to go public until it's been proven in private.

If you were involved in a similar effort like this, and were able to start from scratch, and do it all over again, is there anything you would do differently?

Well, we would try to cut out the gaps in execution. There were some long, dry spells -- some long periods where there was no work, or very little work that could be done, because of lack of funding. This project has run on a very limited budget. It's a budget that was derived from excess money really, money that had not been committed to other things. It was able to be committed to this. It was pretty restrictive in the amount, so when it ran out, we had to wait until there was another pool of money that we could draw from. So it's been a budgeting problem more than anything else. As far as the design, development, execution -- I wouldn't change any of that. (Pause) Maybe move you guys closer!

Yeah, that would be all right!

Do it all in Bermuda, perhaps!

There you go! So as far as doing it over again, you would just prefer to secure a better source of funding?

Yeah. I would like to have it more consistently funded over the short term, rather than sporadically funded over the long term.

Lastly, any other thoughts, questions, or comments that you would like to make about anything you have done so far?

Probably not. We have high expectations for it. We look to move it to the fleet when it's done, to be able to use it here as an initial study vehicle, but we think it will be so effective that we will be able to send it to the entire fleet when it is finished and people will be able to use it in the fleet as a refresher. We here will use it as an initial study vehicle, and it will be so effective that they will want to use it.

Good. We look forward to that.

We do, too.
I am Program Manager for Curriculum Development for the Surface Warfare Officers School and basically I work for a private contractor with a charter to the school, to help the school stay current in all the warfare areas. Do you want me to go more than that?

No. If you think there is something else you...

Well, no. I mean I could go through the process, but that's it.

Okay. Let's see. First of all, I'm aware that students had used flash cards before anything else became available. Are you aware of other strategies that your officers in the SWOS training would have used to learn the factual material?

Are you talking about the TAO Project?

Yes.

Not really. Flash cards are the routine.

Could you take a few minutes and explain some of the events that may have led up to the decision to start using computer technology as a tool to help teach some of the threat matrix material?

Well, I think from my perspective it seemed we had seen some demonstrations, not only by Iowa State, but by other computer-aided companies, IBM -- that indicated that there were a lot better ways to learn than using manual flash cards. The flash cards didn't afford the opportunity per system, and platform, and weapon, and all kinds of weapon-system associations with platforms -- whether it be air surface or subsurface. You can't do that nearly as well with flash cards as you can with a computerized system, which the student could call up the association. That is, a certain radar system with a certain class of ships. Furthermore, although I'm not an expert on it at all, I think we all appreciate that audio-visual systems, if properly done, result in a much higher learning rate than a mechanical system, such as flash cards.

So you saw some demos from some other vendors that kind of figured into this.

Yes.

Was there anything else that peaked your interest in this area?

I don't think so.

Had you seen things from the other branches of the Navy? I don't know how much you might...

No, I think really it was just the recognition that we were in the Stone Age as far as means to enable people to learn things. It wasn't just the TAO's across the board. Very basic black and white transparencies. There was a lot of technology out there that could make the material more interesting and, as I said, we know people can learn a lot more when they have audio visual aids that are attractive to them.

Did you define TAO?

Well, a Tactical Action Officer is an officer who, is the officer in the ship who has the training across a broad spectrum of his ship's weapons systems, sensors, capabilities, and its abilities to handle a wide variety of thrusts. He is the officer who normally in a watch rotation on a ship who in most cases the captain delegates the authority in an emergency situation to fight the ship, because the captain can't be there.
every minute of the day. So the TAO is the captain's agent who has extensive training, as I said, in weapons systems, and thrusts to the ship, and is a little more experienced than most people on the ship other than the EXO/CO. He's usually a department head. (There are usually three on a ship and they are the most experienced officers, other than the CO Ensign.) The TAO training here at SWOS prepares them for that role.

Once you made a decision you wanted to do something to take you out of the Stone Age, as you said, and you wanted to get involved in some form of technology, did you have any preconceived ideas how you wanted this product to look, how you wanted it to feel to the users while they were doing it? I mean, did any of that sort of stuff run through your mind?

Well, I think my ideas are driven by what the people who are going to use it said to us -- not only the students, but more importantly, the instructors. There were some things from that, that I thought should could out of it. One is that the system ought to be user friendly to the instructor. That means that the system had to be easily changed from a standpoint of instructor -- demand on his time -- as if we had new information on a Soviet radar system, or Soviet submarine, or something like that -- that it wouldn't require an inordinate amount of time on the instructor's part to modify the software or the disk or whatever it might be -- for use in the classroom, because the instructor's time is very demanding. That was one point. The second point was that they had to be able to easily employ or utilize the presentation of the systems in the classroom. We made a mistake in that Iowa State model classroom because it was too hard. We didn't ask the instructors enough of what they should have had. We told them here's what we think you should have. That's a mistake that we make a lot of times. So there were two things from the instructors' standpoint. Thirdly, the system should be user friendly from a standpoint of the student, that he during off hours or off class time, could go to a study lab and be able to study on his own, and it would be easy for him to access. It needed to be an Apple system rather than a Zenith 248 system! (Chuckle)

Let's next move on to support that exists within the Navy for the concept. I'm interested in a philosophical support for doing this, and also I'm interested in your perception of the degree of financial commitment that you think the Navy may have had.

Well, I think the philosophical support is there. I think the educational specialists in the Navy, and the Chief of Naval Education of Training, and the computer display systems people, training ed. people, always recognized the advantages of the system. But the commitment to dollars is... I don't know the answer to that.

Would you perceive that the changes in the defense structure would work to your advantage, in that regard?

What do you mean by that?

Well, with the changes in defense funding and spending, that we are seeing, that we are hearing talked about -- you know, peace dividends --

Oh, you mean the reductions?

Will more money be freed up, you know, for this stuff?

I don't think there is any connection to that particular.

I see.

The current CO, though, is very, very strong on training. In fact, he was here for graduation and was extremely impressed with the school. And the way in which

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the school has had some reasonably good access to training dollars because of that visit -- not the visit, perhaps, in particular -- but principally because this CO is very, very keen on training and training right. But whether money from decommissioning frigates will come to SWOS or to the training establishment, I can't make any connection with that in particular. No, I don't think so.

Can you share any concerns you might have had, George, from the beginning? I'm wondering about concerns you might have had in doing this project. Was there anything that concerned you, like, "Are we going down the right path? Are we doing this appropriately? Or are we being supported?"

No, I don't think so. I think the school had committed the money through the contract to do this project. It took an awfully long time to get it done. I think one of the concerns was the classification issue. The package that was developed had to be unclassified out of Jane's Fighting Ship. How were you going to work it? (Phone interruption) Where were we? Oh, the project itself. I think the classification issue was...uh.. I kind of went away from the project a bit there when I changed contractors, you know, and I didn't know. But I think the classification issue was clearly a concern from the standpoint of producing a TAO's -- the videos or disks had to be unclassified. When really, we need to be at the secret level for the department of training.

So, how might we have dealt with that issue differently?

Give the contractor a clearance. I mean, if SECORE had done it, it would have been no problem -- SECORE, or the DOD facility. The DOD -- they work for the Department of Defense. The company has a secret clearance. Of course, I have a secret clearance, and everybody else around here does. Oakridge, is a DOE contractor, and the DOE and the DOD'ers don't connect! (Chuckle)

(Chuckle) I see, okay.

That's how it could have been solved. The other concern about the project, was again, and it's the logistics tail, that is keeping the system current -- keeping the package current by updating the disks and that kind of thing. That may have been taken care of, but I'm not aware of how it was being done. Was that covered?

You mean in terms of information in the field or something?

Yeah.

I think Commander Ebley was basically doing that.

So he's covering that? Okay.

Yeah. In fact, when I brought it out here he and I did quite an intensive in-service session about how to get in, and how to change the data, and how to lock fields, and all that sort of stuff.

Good.

He basically took the unclassified version that I had delivered and installed, and went in and changed, or redid everything.

That's good. Oh, yeah.

Let's move on to phase II, George, which was the period of time in which I was actually involved in working with it. You had made a decision to have Iowa State go ahead and develop a prototype.
Right.

Did your involvement with Iowa State affect your feelings or your attitudes towards the usage of this project in any way? In other words, was there anything Iowa State did, that helped to clarify your focus or your intent? Or did you just do what you pretty much identified?

There certainly wasn't any negative reaction to Iowa State. I mean, if that's what you're asking. I mean, I felt that, oh, the people from Iowa State were supportive, and cordial, and wanted to do a good job for the school.

Great, we hope so. I want all kinds of feedback here. If you could identify some benchmark events that occurred during this construction phase, and during the installation phase -- if there were some really key things that happened, that were really important in the process, what might those be?

I guess one of the times when you all came, and Mike was here, was the demonstration of the various systems that are out there, that could be applied to a video project. In other words, that demo that showed the natural history somewhere.

It was an art gallery, I think.

Yeah, right. That was an enlightening thing to determine that there are already systems out there that can do this very well, and the ability to go to that huge disk, compact disk, and identify swords, and have all the pictures of the swords. (Chuckle) And to relate that directly, and go to identify radar, and have all the ships that have the radar -- that was an encouraging thing for the project. (Pause) There was something else I wanted to say. (Pause)

That demo would have been in the, I think about the fall of 1991, I believe -- somewhere in there.

Fall of '91? I can't remember. And then there was some translation of those capabilities into an initial demo, that I think you did, of putting TAO type things into that kind of format, and that was encouraging -- a measure of progress on the project.

Once I delivered the prototype in January of 1991, which is when that was, how did you know it was being used by SWOS, or did you, at that point?

I didn't. I don't know if they were using it then or not.

I think Commander Ebley used it in a class, as a teacher instructional tool?

That far back?

Yeah, shortly.

You said, "January '91"?

That's when it was installed.

Okay.

On what basis do you think a decision was made to expand this prototype that I did, into what's going on now, which is what we're calling an operational pilot? On what basis did they decide?

It works! (Chuckle)
It works! (Chuckler)

It works. Again, it comes back to instructor ease of employment, student acceptance, that sort of thing. It works. That's why you go on. You did it right!

**Good! Good! Good! Let's go on to Chapter Three. What's going to happen when this prototype is fully modified like it has been done now, and it's quote 'done'?**

I guess you have to tell me what the modification is going to be. I know it's going on, but I've not been involved in it.

*When I was here and delivered it, I did three of the six Soviet chapters. That's all I did. Now, what has happened since, and what is going on now is - all the other Soviet chapters are being completed, the U.S. A. is being completed, and other world fleets -- so basically the entire complement is being finished up. So my question is: When that is all done for the CIS, USA, and other nations, what do you think is going to happen next? How will it...*

...be approached?

**Yeah. What's down the road?**

Well, from my perspective, and you know, I, uh, what I think ought to be done, and of course what I say is not what the school will do -- but what I think should be done is -- obviously the system ought to be maintained. It ought to be kept current. The follow on to that, if I had my way, with the way the TAO's are taught, would be that they would -- and this system could be easily modified to do that -- is that they would be -- instead of getting this whole range of the threat matrix, of the whole world -- is that the students would be given a very much reduced, broad overview of the threat systems, that we face. But then they would find out earlier in the schooling what ship class they are going to. Not the ship perhaps, but the ship class. But anyways, they would then focus a lot more on going to the FFG-7 *Hellowazard Perry* and some concentrated effort on -- these are the sensors and the weapons systems capabilities of this class of ship -- and these are the threats that I can handle. So that he's more focused. He spends more time on the ship that he's going to, the weapons systems that he's got, and the threats that he can handle. So the focus is on the tactical use of the sensors that's got, against the threats he can handle. My answer, I guess, to your question for the future, would be to tailor the existing TAO system that you install, and give it more focus at the individual ship class level. That is, as I've talked about, and then to build some tactical scenarios where he, as a TAO, would fight the ship, based on some more detailed application capabilities of the ship, and the threats that that ship with its sensory and weapons systems would institute. That would be my view of it probably.

**Okay. Next.**

Another thing I wanted to mention to you is to try to think about what were some milestone things -- that the flap that we went through with the IBM compatibles versus Macintoshes.

**Yeah. I was aware that you were making some decisions, but I wasn't aware of what was driving those decisions.**

It's just that, you know, that everybody -- that lots of people -- and John, being one of them, has an Apple at home, and I had an Apple when I was at the War College, and when I retired and came here, we went to the IBM system. It's night and day. And we wasted -- ended up causing a lot of delay -- getting this determination of IBM's ability to have the Linkway system -- to get more of a menu-type display. It's been solved, obviously, at cost and a lot of time consumed in solving that problem. The
Navy's on an IBM system, so... (Chuckles) But the decision that we would not go to an Apple system, and then to get the capability and software to make the IBM compatible, somewhat, with what other people knew was very easy through the Macintosh system, or the Apple.

Have you talked to other folks in the Navy who are not here at SWOS, from time to time, and just said, "I want to tell you about this thing we are doing?" Have you shared this project with other people? And if so, how did you characterize it?

I may have talked to people about it. But not in a focused way.

I see.

I don't know what you mean by "how would I characterized it". You mean, did I like it or not like it?

Well, I don't want you to quote yourself, but I'm just curious if they heard you talking about it, what sort of feeling would they get from you about the way you feel about the project?

I think it's the right thing to do. Just because of the way I basically feel about what we know about what these systems can do for learning.

Sure. This second to the last one - If you were involved in this project in a similar manner, and started all over again...

(Chuckles)

If I could only do it again, right? (Chuckles) What would you do differently?

How would I do it differently? (Pause)

Or would you? Maybe you wouldn't.

You try to answer that question, and you say, "What were the problems you had with the current -- the way it was done?" The problems were: the software compatibility issue was one issue, the clearance thing is another issue, all of which were solved, but what else? Clearance... Make sure... I guess the most important thing is to make sure from the very outset that the instructors and the students have a say. We need to say, "Here's what we would like to do," and conceptually and in principle, and ask the people who are going to use it and receive it, "How am I going to use it?" and "What's the means for me to best understand it?" I think that's the first thing that's very important that you do. And I'm not sure -- I know we had some sessions, and got input from instructors. Mike Crawford was a key player. I think that's very important. And I think we did that reasonably well. We could always have done it better, I think. If we could have solved the computer and the clearance thing, it would have helped.

Any other thoughts you'd like to share, George, about the creation, the installations, or the delivery of the project -- that we haven't talked about?

No, I don't think so. I just think it was a lot of time. But I think it has been a worthwhile thing. It has huge application across a whole lot of other training stuff, you know? I mean, you know that better than I, from where you teach, and from what goes on there at Iowa State. We tried to do that media center down there. We did it. But it's not even used. It's too hard -- too complicated. And the quality of the presentations, although pretty much state of the art today, it's garbage compared to what has happened in the last two years. You know, I have the unique perspective here, because I sit in on a lot of department head, PCO, and some division officer

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courses. We have thousands of black and white transparencies in this school. I have told my boss at SECORE, -- have asked him, "If you can come up with a Nobel's whistles type system that will take the black and white transparencies or make color transparencies that don't cost twenty-five thousand dollars to have them color --" These kids are all brought up watching t-v, Nintendo, and games, and stuff like that. You know that enhanced audio-visual aids are a huge improvement in presentation and learning. If somebody can come up with a means to do that without a huge expense, they get the Pulitzer prize!

Hey, we'll keep thinking about that! (Chuckle)

No, really! (Chuckle)
Commander can you tell me what your job area is, at the time we got involved in this?

It was Division Aid for Combat Systems and for (cannot understand)

And now you are...?

In the War Games Department in the Naval War College.

Okay. What are some of the events that led up to the decision to use the computer technology to help teach the threat matrix?

We needed to get more information out to the students in less time and save instructional time, so we could put other material in the instructional hour, since the course is limited to twenty-four weeks. We couldn't get any more time in the course. The material was necessary to get out to the students, so finding a means for them to learn it on their own time, thus gives us more time in the classroom for other purposes.

Once the decision was made by SWOS to proceed, how did you decide what you wanted the product to look like, or to feel like, to the students?

I think it was an on-going process. I don't think we knew at first exactly what we wanted. To be honest with you, I wasn't in on the initial decision to do it. I was told that we were going to do it.

I see.

And then I got actively involved in it. I think it was one of these things that we kind of messed with it, kind of played with it.

That's true. I'm interested in your perceptions about the philosophical, as well as the financial support, that existed with the Navy before, during, or at the present time.

On?

On the threat matrix project.

Well, the money was there in a special project fund. Like anything else in the Navy, you have to come up with justification or reason to get the money. And the money is getting increasingly tight. I think in the long run it will save us a lot of money to have a decent, (tape unintelligible) where we don't have so many man-hours beating it into their heads -- they can do it on their own. It's been proven that self-paced study in a lot of areas is one of the best ways to go.

Did you perceive a philosophical level of support, as you started? Did people believe in the concept, or did you have to convince people?

I think the lower levels believed in it, but we had to convince people at the higher levels that it was worth the time and the money to proceed on it.

Any concerns that you had as you were starting -- embarking on the project?

Well, my concerns were the people that weren't actually at the level of instruction that were going to drive things that we weren't going to really use. I've seen that many times in the Navy, that peoples at other levels have driven things that people at lower levels were expected to use, which wasn't compatible with what they needed.

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Yeah, I see. Let's go on to the middle phase where I became more involved. Did your involvement affect your feelings or your attitudes about the use of the project in anyway? Was there anything we did, either pro or con, that helped you, or enlightened you, or was a factor with you?

I don't think there was anything con. I think one thing was that I really appreciated, was the open-mindedness. In the beginning I kind of got the feeling that we were going to have one type of hardware crammed at us, and the program was going to be one way. But we brought in a lot of different computers. We looked at them. We assessed them. We assessed different programs. And not at a level above us. The students and instructors got involved. Everybody got involved in it -- the hardware that we could use and the program which we used. Then we could assumely decide the approach, the product, since then.

If you could identify any bench mark events that would have occurred during this process, what might those be?

I think the decision to use an IBM computer was the big thing. Because we would have never been able to use it at the level we were going to use it now, if we had gone with a Macintosh or something else, because we had so many computers in the system. That was the biggest thing. Of course IBM helped us by giving us the Linkway program, about the time we were looking at it.

Any other bench marks come to mind?

No.

Okay. Once the prototype was delivered -- that I delivered in January of '91, how was it initially used?

Well, we took a program. It took us about three weeks to sanitize it -- make sure all the data in it was accurate, since the program was given to us with an in-class version of it. Source documents aren't necessarily accurate. We verified it, updated it. Then we started using it in the curriculum in some minor ways, all the way up to the point where we're using it quite a bit now, I understand.

As you used it, have any problems emerged that you can identify?

The biggest problem we had initially was being able to display the information on a screen where all students could see it.

Do you mean a projected image?

Yeah. You're talking about a computer display and you're talking about a video display, and we only have one large screen display. I think since then, they've gotten two where they can put two large screen displays up for forty or fifty students. Because it was hard for them to see a T-V monitor and a large screen display at the same time.

On what basis did SWOS decide to expand the prototype into the current effort right now? How did they make that decision?

Well, I think initial funding gave us a limited point at which we were going to go. And the product is no good as it is designed, unless it covers every weapons system in the world. The other thing that has actually made a big change on it, is initially it was U. S. and Soviet, and the Soviet is not the big threat now. There's really nobody a big threat, but we have to look at all weapons systems or we may come back, because the Falklands and the Iraqi War proved that. We are finding our own systems and British systems and French systems, so the students need to become equally familiar with everything that exists. So it needs to be expanded tremendously.

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Once Dave gets all the chapters completed, what happens next?

I think we're going to have to continually update. We probably should be able to handle it at the school level because we're trained instructors in using the Linkway, but what I perceive is, there is a product similar to this that exists at GA School in San Diego. There's a couple of other systems somewhere there were funded through projects in Washington or other projects, and they were owned and maintained by other people. Therefore, they are not kept up to date and they're not transportable. This one is owned by SWOS. And the fact that it is owned by SWOS and is kept up to date by technicians, it is conceivable that we should be able to send copies of the program with students to the fleet, to use on their tours out there on any computer. Even though they won't have a video disk, they can have the data that's on the program. But NOT give them the capability of going into Linkway and changing it. That has to reside here so we can keep a data base up to date. But that's the way I envision it -- is going out to the fleet -- you know. It's something that's cheap. It's not controlled. It doesn't have to be controlled by anyone. It's a tool. There are too damn many tools running around out there that are maintained by people with money that never put money into them to update them.

Yeah, yeah. Assuming you fully implement it like you just described, and assuming you get more work stations here at SWOS, with the system on it, how would those be used?

Well, before I left here, I envisioned that the plan being was they would have enough work stations where students could go in at night and run the material. And the first ten weeks of the twenty-four week curriculum is the Tactical Action portion. And of that, I think we equated somewhere around ten classroom days for use to instruct the material that could be replaced by students going in the evening and learning themselves, and we could take those two weeks and turn them into instructional periods of other packages and other systems that need to be taught. Since you can't expand the twenty-four week curriculum, and you only have thirty-seven and one-half hours in a week that you can instruct, something gets lost. This will give them some time. That was envisioned. Just let them learn it themselves, test themselves, and utilize it during the course.

Do you believe the implication of this form of technology may have impact on other activities at SWOS? And if so, what might those be?

Well, I think we all agree computer-aided instruction is coming into its own, and it's kind of hard to set the government short on money, but if we buy enough computers it's envisioned that we can do it the same way that they did it in the Naval Academy and the Navy -- that every student can have a computer on his own desk, as a tool to use in education. There are a lot of different programs that can be utilized, but you're back to the old thing -- we're talking government -- we're talking money. We're not talking private student education systems.

I guess what I was wondering, are there other instructional programs here at SWOS that would lend themselves to this kind of a platform besides threat matrix?

Oh, I imagine engineering (plant lay-out of engineering -- gas turbines systems, engineering systems), navigation (navigation training), while it's a simpler type of program, it's all computer-aided programming. This could be done -- things that students could self-teach themselves, could be tested on in a computer, and then utilize in a course and later tested on by an instructor. This is the type of thing you're looking at -- an engineering plant, the lay-out of a plant, the machinery, the make-up, how the machinery operates -- doesn't have to be taught in a classroom. Navigation. Certain navigation things shouldn't have to be taught in the classroom. Basic deck seamanship equipment and systems -- things they can identify with a picture,
explanation, how to use and test it. The tactics, now — theoretical — I don't believe so. It needs more of a personal interface with somebody with experience. That type of thing.

Have you talked about this project to other Naval friends of yours outside of SWOS or outside of Newport? If so, how did you describe or characterize it?

No, sir. That was a limited degree. Yes, I have. I have explained to them what it was being put together and what its potential was.

If you were involved in a similar effort again, and you repeated this project, would there be anything you would do differently?

It would have been nice to have you a lot closer here, instead of half-way across the country.

Right. I'd buy that!

But, it's understood that those are things you have to deal with. The number of communications we had and the frequency we had together helped. But, as I said, that was about the only thing I saw. It would have been handier to have you closer. But with the telephone and a fax, and everything else today, it's really not necessary.

Any other thoughts, that we haven't touched on, that you'd like to share or mention?

No. I think it was interesting. And of note, I used some of the information in my practicum for my Master's. (Chuckle)

(Chuckle) Okay, thank you, sir.

You bet.
Uh, it's always, oh, what's the correct term for it?

Bureaucracy?

Yeah, I didn't want to really say bureaucracy. But we have a lot more latitude at the school here, and the funding support we believe is at a sufficient level. Being a taxpayer, we're also of the opinion that to dump a billion dollars in to get something that's only worth thirty thousand, is not the right way to go, so we weighed it very, very carefully on how we've spent our money and on what we think is the value added to the current instruction we want.

Did you have any concerns about embarking on the project?

No, none whatsoever.

Okay. Let's go on to the middle phase, where I got involved. You had some contact with Iowa State.

Correct.

Did that contact do anything to affect your feelings or your attitudes about the project as it unfolded?

Well, let's be quite blunt. Since we renewed the contract several times, we were quite pleased with Iowa State's efforts into it. And I think the exchange not only benefited us, I think it benefited Iowa State in several areas. We had smart kids. Education is education, whether we do it in the United States Navy or whether we do it out in the civilian world. I think both of them learned quite a bit from the project. We're quite pleased with the efforts so far.

Was there anything particular Iowa State did in the process of development that was meaningful to you – that was a positive indicator?

Well, in my viewpoint, they were open to any suggestions. That is probably one of the biggest pluses we had. That our communication between the two of us was... The contract was unique in one way. It was not a set specification -- you will deliver me a box that will do this and a box that will do that. It was more of an idea effort. And I think the exchange back and forth and the reception of ideas on both sides worked very, very well.

If you could identify any benchmarks that occurred during this whole process, what might those be?

Well, the benchmark, I think, was a realization between both parties that it was not going to be a simple task. The benchmark, I think, was the cooperation. It wasn't an adversarial relationship that you get in a lot of projects. It was more for a common good. It was a mind set. I think that was this benchmark. If it didn't look right, well, we said, why not this way, and we felt it out and solved the problem.
From your point of view, sir, were you aware of any problems that emerged after we delivered it?

No, not .... The big problem now is the next step. We did X, now we want to go to Y. I think that's it.

Let's talk about Y for a minute. What is step Y?

Well, Y -- we're trying to figure out... We've got the basic format and we think the basic format will work. Now we have to prove out the Y theory. Does it work? How well it works? And how can we improve on the system some more, and that's about Y.

So, once you get to Y, and once Y is proved out, then how would you see the system being used?

Well, then what you do with the system is, if Y works out, then you implement it to improve the educational process. And not only has it application in the school house, but eventually, if it works out, it has application in numerous courses in the United States Navy and even on shipboard applications. So, we're wrestling with it. Actually, I was an economics major in college, and then they made me an engineer in the Navy, and now I'm over here in the educational business, and you get a little broad background here. Everybody thinks, knows, what you should do. The hard part is getting you there -- to do it. And that's what we're struggling with -- to do it very efficiently.

Do you believe there are other implications for this form of technology here in SWOS?

Oh, yeah -- in SWOS and Navy wide. The project that's done is more of a memorization and recall -- and there's a lot of that. Problem-solving and case study is an entirely different problem. But this is a lot of memorization, and basic skills, and basic knowledge levels, and if you can do that efficiently, then you're in much better shape.

Sir, I'm curious. As you talk to your professional colleagues in the Navy, did you share with them this project? And if so, what did you tell them about it?

I just told them that we were looking at a way to improve the system. We have a propensity to say, "Yes, this is a save-all system," before we know what it's going to do. I just told them, "Yes, we're working on it, and I'll let you know how it comes out." There's no need to build up false hopes or go off on a wrong tangent until you prove it. Boeing doesn't do it when they build airplanes, and I don't want to do it here in the educational setting.

Sir, if you were involved in a similar effort again -- you started over from scratch -- would you do anything differently?

No, probably not. I think we had a pretty good feel for what we thought the problem was, and I think it worked very, very well. We could have, you know, thrown more money at it, but I don't know if that would have got us the results any better.

Any other thoughts you want to share about the whole project that we haven't touched on?

Well, no. I'm quite pleased, like I said. I think we worked very, very well together. The proofs going to be in the pudding when we finish with Y, and see how the project turns out. You know, it's like any R and D project. It could be a boon or it could be a bust. I'm pretty confident, though, this is going to be more in the boon area than the bust area.

Appendix M
Personal interview transcript: Subject #4
Okay, sir. Thank you very much.

I enjoyed it.
Could you tell me your job title, just so I get it straight?

I'm the threat instructor with the department school in SWOS.

Okay. Let's see. First question – This is during the design process that I was involved with. Did your involvement with Iowa State affect your feelings or your attitudes about the usage of this project as you came on board?

I was introduced to the project as it exists now, so that it was a demonstration set-up for Soviet systems but with future for expanding the system if we thought it was feasible, and we've obviously done that. I've used it in the classroom, and I think that it has enormous amount of value outside of the classroom. So that we will bring the students in and basically let them self-teach themselves this portion of the course. I've grown to like it a lot more, the more I use it. It's very straightforward and easy to use, and easy to update. And, I guess, as I learn more about the system, the flow of information will become even easier.

The next question dealt with perceptions you may have had about the project as you saw it evolve. I think you just eluded to one - and that is, the more you used it, the...

I'm not a computer literate person. I can run a word processing program after a while, and I can make a bar of graphics type of display, but that's about the limit of my expertise.

But didn't you do any work on this, though?

And after an introduction to this I was able to. I'm a little smarter now.

(Chuckled)

I've learned a lot more about the various computer languages, and just in the interplay between the different languages. One of the problems we had last year was when the DOS access was taken away from me, and we installed a security program into the computer, and we found that caused a problem. I wasn't able to use the full extent of the program. Now, once we identified that as a problem, I got my DOS access back.

Great, great.

I can keep going.

Were there any specific contacts you had with anybody at Iowa state that were helpful to you in this whole process?

I think working with you and with Mike Simonson in learning how to use the program and in looking at the way it was constructed — I thought that the methodology and the thought processes that went into the actual mechanical construction of the program and the way it was laid out, makes it real user friendly and simple to use. The people, you know, -- any support that I needed -- was only a phone call away. And it was only because of financial needs that we weren't able to get onto the modem, bulletin board hook-up. So any time I needed help I could get it.

Were there any times when there was involvement with Iowa State that was troublesome, that was less than satisfactory, or a problem to you?

Not to my recollection. No.

Okay, if you could identify some bench mark events that occurred from the time we started developing until we installed, what might those bench marks be?
I was not in the development process. I was brought into this as a user, and owner, basically, after the system became existing here at SWOS. So, I really can't answer that question. I was not, you know, on the development side of it.

Okay. Let's see. Once the prototype was delivered, you were involved at that point. How was it used?

It was used, primarily, in a classroom instructional level, since we have only one system. I sat down and classified the data to secret level, and then brought it into an auditorium, and used a large screen projector and two color t-v monitors to display the computer system, using a large screen projector and the video disks was displayed on the monitors. I used that to instruct for two department classes -- Class 117 and 118 -- my Soviet threat lessons. And then went through various changes in the building structure. I've lost the use of that auditorium right now, and we've stopped using it in the classroom.

So your initial use was in an instructor format?

It was a lecture format. It was a lecture-type format using that as my graphic display for reinforcement.

Did individual students sit down and use it at all?

I had a couple students who were ex-staff members in Class 117, who used it, and found it was friendly, and wanted to know how they could get a hold of it. I told them when it was finished I'm sure the product will be made available. At this point, it's not.

As you used it in those ways, did any problems emerge, that you could identify?

Not., only from the point that was external from the system -- mainly in the display part of the system where we were using a small... (The monitors I used were 19 inch.) From the back of the auditorium they were hard to see. And now we have purchased a large screen projector. It's single lens. We didn't do our homework very well, and we bought one that's not computer compatible, but I can feed, now, the video disk into that, so I can display that. And I've still got the computer capable large screen display. Once this room is finished with construction, I'm going to be able to move back in there again.

I see. On what basis do you think SWOS decided to expand the prototype, and go the route we're going right now?

I think given the success we had last year with it in the classroom, and with the additional emphasis being on, putting the owners on the student to learn, as well as the state of the government budget. So that if we are facing manpower cuts, one of the easiest places to take people out of the classroom off the podium and put the student into a self-teaching environment, is in a factual based lesson, like recognition and capabilities, parameters, type instruction -- where we can sit down and say, "Okay, here's a job sheet. Learn this, by this date, and we'll test you on it." And put the ownership on the student. I think that's our long term intention is to do that. Given the expansion into other U. S. systems and sensors, we are able to do that, not just in weapons type lessons or in threat type lessons, but also in lessons on sound buoys and ASW systems, where we can give them, maybe, a precursor to the lesson -- have them go through the computer based lesson and then come back to the classroom and expand the amount of information we have given them and go further into depth -- having them come in with a better baseline of knowledge. I think that's -- in the long term -- I can foresee that happening.
May I back up just a second? You said, "ASW." Can you define what ASW is?"

Oh, Anti-Submarine Warfare.

Okay. Some people may transcribe this, and I just want them to know and understand. So, the decision to expand was, pretty much, do you think, tied up in what you just described?

I think you're looking at the decision to expand the system on several different planes. One is, given we can take people off the podium and use that time that we have allotted in the curriculum. The students are here for six months. We can use that time to other ends, and give them access to the system either after hours or at lunch. Or in a dedicated classroom environment say, "Okay, this is your period to go over and use the system." And allow us to use our time to other ends, like I said, at the instructor level, as well. Also, we can reduce the demands on instructor load, which we have. And hopefully that's going to happen, because I have quite a load I'm looking to reduce with this system.

So what will you do instead of this?

I've got other parts of the curriculum that I run, that this system doesn't apply to.

I see.

... in equipment maintenance, and personnel, and system management -- that I'll be able to pay more attention to, given this reduces my work load quite a bit.

After all the chapters are complete -- for CIS, USA, and other fleets -- what happens next?

We've gotten inquiries from commands outside of SWOS to use the system, as we're going to use it, for recognition training and for instructional reinforcement, in their curriculums. But I think you can probably envision an end where we would give this piece of equipment to each ship in the fleet or each aircraft squadron or submarine, so that they could train their own people on board. And use it as a ready reference. It's a rather rapid access piece of equipment that, rather than having to page through a two or three hundred page club, I can call up, very quickly, a piece of data that I would need. And through some of the messages I've seen, you can see the Navy moving in that direction already.

Are you at liberty to share the other commands who are interested?

I've gotten phone calls from Sub-group II in New London, and they would like to know when this system is going to be available, and I told them probably sometime this summer. I'm sure, once we get this system full up, and blessed by the local command, we'll bring in people from D.C. to look at it, and make it available to other commands with SWOS as the principal owner-operator.

Next, I want to go on to implications this form of technology may have elsewhere in SWOS.

In SWOS I think you can see this type of technology being used for other parts of the curriculum, given summable design or put/create the system that we want. You can use this type of instruction for any factual-based instruction you would desire. You can use it in the engineering world. Create a program that would take you through an engineering plant. Or run through a series of casualty-control exercises where you would step through each of the steps you would have to take as a watch stander to stop a casualty from cascading and then correct it. I think you can also use it anywhere I'm
going to give a reading assignment or where I would have to go to a piece of reference material, I could use this as a reinforcement device for any part of the command. At the lower levels of the course -- the divisional officer course and the department head course -- I see a lot of use of it. At the command level, parts of the course they deal more in policy and perception and in more theoretical type affairs, but they deal more in very big pictures, and we deal more in hard equipment knowledge.

Do some of these other areas of SWOS know about this? I mean, have they seen parts of it?

They have heard of it and they have probably had it demonstrated to them. I know we have demonstrated to a lot of the flag officers who have come through, including the Chief of Naval Operations. He saw it last August. But I'm not sure they are aware that we able to expand, or that they have given thought to expanding in their curriculum into this sort of instructional device. I'm sure that once we get this bought as a instructional device here, that other parts of the command here and other parts of the Navy training world are going to want something like this. The other people who came up, not only sub group II, but also the people from Doverin, Eeverse's training people, also looked at this type of instructional aid, and I think you talked to them last spring.

Now, where are they from? From Florida?

No, down in Virginia. Doverin, Virginia, the Eeverse Training System there. I gave them your number.

I think Mike Simonson might have.

Someone at Iowa State, I think, may have talked to them. And they were saying the same thing, saying, that they could lay out schematic diagrams of a ship and push a student through that way and I think the Linkways and the threat matrix set-up would be the way they would want to go.

We have about two or three more questions left, John.

Okay.

As you have talked to your other colleagues in the Navy, away from SWOS -- I mean I assume you've been to some other Naval facilities in the last year and a half or so --

True.

Have you talked to them at all about this project? And if so, how did you characterize it?

I talked to a couple people about it, in some of the instruction that I've done down in Danurke, Virginia, and also when I went down to a meeting in Memphis in CN-TETRA -- Chief of Naval Technical Training, and we mentioned the fact that the system exists and we're working it up, and they expressed interest in seeing the final product to assess its exportability to other commands. And I think given enough publicity, careful publicity, we'll be able to sell this almost as a standard piece of equipment at each of the training schools, in the areas that we use it for now, and possibly in other curriculums.

Okay. John, if you could turn the clock back and start your involvement all over again, to the point where you came on board, is there anything you would do differently?

I think, that given druthers, and knowing what I know now, and what happened in the Soviet Union, even not knowing what was going to happen in the Soviet Union -- I think I would have developed the U. S. side of it first. That would have been,
I think, a lot easier to develop, because of the amount of information we have available to us, and it would have made the system much more valuable for use in the classroom. And I think we would have been much more rapid in development from the demonstration through the ready-to-buy-the-whole-shooting-match. Because we would have been able to use it a lot more at that point. There's a lot more U. S. instruction we do and it currently it's a Soviet based system. And we do less Soviet instruction -- even a year and a half ago -- than we do U. S. So we would have used a lot more this type of system than we do now.

Anything else?

No. I'm anxious to see the final product in another six or eight weeks and see how it comes out. I think the other thing I would have done earlier on in the project, was to look at the hardware end of it a little better. I'm not sure that we actually looked at the long term effects of the hardware. We just said, "Okay, build us the software, and we have a computer that we'll install it on." And we didn't look at the ease of use, the security standpoint, or the exportability standpoint of being able to mail this out to a fleet unit. Of having it come in on ten or twelve three and a half inch floppies, where if we had said earlier on, "Okay, we want to put this onto a single, removable hard drive," (which were available), I think we would be further along. From the hardware standpoint I think we'd have a better grip on what we were doing, instead of just trying to build it from the ground up now. And we're sort of chasing behind the software now with hardware, rather than going the other way.

Anything else you'd like to share about your involvement that we haven't touched on?

No, I think that's about it. I think we're going to get a lot of good use out of this system.

Great. I hope so. Thanks.

Appendix M
Personal interview transcript: Subject #5
APPENDIX N:

CHRONOLOGICAL LOG DATA
Appendix N

Chronological Log Data

Listed below are significant chronological events which occurred during research study.

10-28-89 Preliminary briefing meeting was held with major professor and researcher to give researcher overview of project scope and expected outcomes.

11-02-89 First of a series of Threat Matrix Team Meetings (TMTM) to be scheduled during the year was held. The meeting was attended by the major professor (project director), the researcher, staff from the ISU Media Resources Center, two professors from the department, and several graduate students.

At the meeting SWOS perceptions and requirements for the research project were described by the project director, based on previous contacts he had with SWOS officials, while completing other instructional technology projects which had been contracted by SWOS to ISU. (The TMTM group later in the project was referred to as the ISU Experts to distinguish them from the Naval personnel working with the project.)

11-03-89 TMTM was held in which a DOS solution to the SWOS research project was demonstrated and discussed.

11-17-89 TMTM was held in which the researcher presented a HyperCard solution to the SWOS project.

11-30-89 TMTM dinner meeting was held in Ames, IA where the successful conclusion of Phase 1 and Phase 2 SWOS projects were celebrated, and this project, Phase 3, was introduced and described. In attendance were all personnel who had been actively involved in Phases 1 and 2, and those who would also be working with Phase 3.

Note: Phase 1 was a project to design, equip, and install an Instructional Materials Center at SWOS, and provide necessary training for its use. Phase 2 was a project to design, equip, and install a prototype instructional technology augmented classroom at SWOS.

12-11-89 TMTM was held to consider presentations to be made at SWOS in January, 1990, to demonstrate hypermedia capabilities in instructional materials.

12-18-89 TMTM was held to prepare final plans and assign duties for presentations for researcher's SWOS trip #1.

12-28-89 TMTM final shakedown meeting was held, prior to the trip, with walk through presentations and compilations of lists for equipment and materials.

01-06-90 SWOS trip #1 took place to Newport, Rhode Island, for to present a wide variety of hypermedia demonstrations.

01-09-90 In attendance were the major professor (Project Director), the researcher, the director of Media Services from ISU, and two other graduate students.

01-16-90 Phone call was made to SWOS specialist in the Curriculum Standards Office to discuss progress in planning and to obtain phone number for contacting the Division Director for the Teaching of Combat Systems.
Phone call was made to the Division Director for the Teaching of Combat Systems regarding specifications of the Threat Matrix, slides SWOS would like to add to a new video disc ISU would produce, and possible other non-classified reference books to use for Naval data identification besides, *Jane's Fighting Ships*.

TMTM was held when researcher presented more fully developed pre-prototype demos using HyperCard.

Phone call was made from SWOS specialist in the Curriculum Standards Office to obtain home address and phone number of the researcher. The SWOS specialist at this time was working on a declassified (sanitized) Threat Matrix listing to provide to researcher.

Phone call was made from major professor to SWOS advising Navy the Threat Matrix listings had been sent via express mail.

Express mail package of the Threat Matrix listings arrived at SWOS.

Phone call was made from major professor to researcher to advise him that SWOS was wavering on the use of Macintosh and HyperCard, and may decide to use a DOS platform instead.

TMTM was held. Announcement was made that SWOS had chosen to use DOS as the platform for the Threat Matrix Computer Based Lesson. Group discussed pros and cons of working with DOS and its related authoring program (*Linkway*). In attendance were the researcher, major professor, and an IBM educational representative. Prospects of attending an IBM sponsored, intensive training school on the use of *Linkway* was discussed.

SWOS confirmed via telephone that they were sending a Zenith 286 based system to the researcher to use for development of the lesson. The system was to be kept at the home of the researcher for preparation of the project.

Researcher met with IBM educational representative to become more familiar with necessary start-up skills to use a DOS system and *Linkway*.

Preliminary planning and development of the elements to be developed into the computer based lesson was done by the researcher.

Major professor and researcher attended an intensive *Linkway* training school, given at IBM training headquarters in Atlanta, Georgia.

Development of content and instructional design components based on consultations with major professor continued.

Researcher met with major professor to deliver preliminary schematics of *Linkway* program components for major professor to take to SWOS on 06-18-90.

Major professor came to home of researcher to shoot video showing how the lesson screens were progressing. The video was intended to go to SWOS on 06-18-90 to be shown to the SWOS team.
Lesson development continued by researcher.

07-27-90 Researcher received confirmation of USSR warship categories from Division Director for the Teaching of Combat Systems, to be used for format headings on program screens.

07-90 Journal article on the Threat Matrix project, co-authored by the major professor and research was published in the premier issue of *HyperNexus*, summer, 1990.

08-90 Demo version of computer based lesson was completed, and decisions were made by researcher and major professor regarding naming arrangement of *Linkway* folders, inclusion and structure of index, and incorporation of line drawings from a previous SWOS instructional program.

09-19-90 through 09-23-90 SWOS trip #2 was held to Newport, Rhode Island, to present rough demo of what the completed prototype will look like, and to receive SWOS feedback regarding screen designs and instructional design components.

09-90 through 12-90 Inclusion was made of all SWOS data based on feedback at demos. During this period all other elements of the prototype were developed and installed via the *Linkway* authoring system.

11-27-90 Phone call was made to Division Director for the Teaching of Combat Systems, to confirm change in specs on color labels on strategic SWOS categories. The buttons selected by SWOS will have label names in red, while all others will remain light gray.

12-07-90 Phone call was made to Division Director for the Teaching of Combat Systems to request a formal list of SWOS course objectives. These had been discussed in briefings, but were needed to fine tune some of the lesson components.

12-27-90 Major professor came to home of researcher to see demo of current version of prototype. He expressed support for the prototype.

01-16-91 through 01-19-91 SWOS trip #3 was held to Newport, Rhode Island, to deliver and install prototype on SWOS computers, provide executive demos of final version, and to train selected SWOS personnel in the management and modification of the computer based lesson and the data it contained. During the installation of the computer based lesson on the evening of 01-16-91, the United States began their aerial bombardment of Iran in the Persian Gulf War.

02-14-91 Presentation was made by the researcher about the Threat Matrix computer based lesson at the national convention of Association for Educational Communications and Technology (AECT) in Orlando, Florida.

03-91 Researcher received written evaluation comments via a SWOS Threat Matrix instructor, from officers who had used the computer based lesson as a part of their training. This was the first time the Threat Matrix computer based lesson had been used in an instructional setting.
Major professor and researcher presented a two hour training workshop on the use of *Linkway* at a state convention of Iowa Computer Using Educators in Des Moines, Iowa.

Attitude assessment instrument was sent to 82 Naval lieutenants who had completed the Threat Matrix training, passed the Threat Matrix examination, graduated from SWOS, and were assigned to command duty aboard U. S. Navy ships.

Attitude assessment instruments were returned to the researcher at Iowa State University. A total of 38 responses were received from the 82 disseminated. A summary of the findings of this assessment can be found in Chapter IV.

Presentation about the Threat Matrix computer based lesson was given at the national convention of Association for Educational Communications and Technology (AECT) in Washington, D. C.

Researcher received award plaque and honorarium from Division for Instructional Development (DID) of AECT, "For Outstanding Practice by a Graduate Student in Instructional Development." The award was given for a proposal submitted which outlined the computer based lesson created for SWOS.

SWOS trip #4 was held to Newport, Rhode Island. SWOS had the prototype the researcher had created and wanted to expand it to include all elements of the Soviet section, as well as all elements for the USA and other navies of the world. Another researcher was involved in the expansion of the prototype, and this meeting was for him to consult with SWOS about the development of his work. This researcher went on the trip primarily to gather interview data with key SWOS personnel, regarding the prototype computer based lesson the researcher created.

SWOS trip #5 was held to Newport, Rhode Island for researcher and son (all expenses paid by the researcher) to attend an executive briefing and photo opportunity for the Threat Matrix computer based system given for a Vice Admiral form the Pentagon. Researcher and son also attended a Change of Command Ceremony for the Commanding Officer of SWOS who was transferring to other duties at the Naval Education Training Center in Newport.

Phone call and fax were made to SWOS specialist in the Curriculum Standards Office, regarding the specifications and description of the Combat Information Center (CIC) aboard all U. S. Naval warships.

Phone calls were made to two SWOS Threat Matrix instructors regarding terminology and specific procedures used when CIC personnel encounter a potentially threatening target. The interview was recorded with permission on audio tape, and became the factual basis for the scenario, "The Uninvited Birthday Guest," found in the introduction of Chapter 1 for this dissertation.

Work was completed on this dissertation.
APPENDIX O:
PARTICIPANT OBSERVER FIELD NOTES DATA
Appendix O

Participant Observer Field Notes Data

11-02-89  Re: Exploratory meeting about participation in the Threat Matrix project

Dr. Simonson chatted with me about potential participation in the Threat Matrix project. We saw a portion of a program developed for SWOS by another university. It was filled with valuable factual data and used a metaphor of the television game show "Jeopardy," to guide the learner through the program. I thought it had many unfriendly user features and often the user got lost and could not figure out how to get out of the program. I felt the concept was good, but the implementation left a great deal to be desired. The lesson did not seem to have logical flow as it moved from one element to another.

I was enthused with the idea of using whatever expertise I had or would acquire to help solve a "real world" problem. It seems like this project would not only allow me to satisfy a research need, but also, and equally important, be able to create something, as well.

11-03-89  Re: Threat Matrix Team Meeting (TMTM) in which a DOS solution was presented

This was the first official TMTM meeting. Dr. Simonson invited a representative of a software development company to make a presentation to us on how they would design a solution to the Threat Matrix problem. The representative told us how they would use a DOS computer platform to create the desired software application. As I listened to the individual, I sensed this person was not only assertively positive about what their software company would produce, but I felt they were telling the TMTM what they thought the TMTM wanted to hear. The more I heard this representative speak, the more I knew this would be a perfect application for HyperCard, instead of the DOS software that was described.

I was baffled as to why Dr. Simonson was even considering the DOS platform as a possibility. All the TMTM members had much successful experience with the Macintosh, and could see no reason to consider anything else. (Later I realized that SWOS lived in a DOS world, and to them, some other platform would probably sound as foreign, as DOS did to me.)

11-17-89  Re: Researcher presented a HyperCard solution to the TMTM

I spent a lot of time creating a simple demo version of a HyperCard stack that showed how the Threat Matrix problem might look. It was a quick and dirty treatment for sure, but it included options to identify silhouette of ships and utilized a quiz game approach. At the TMTM, people liked the ideas I presented, and the door was still open. It sure felt good to me, to be able not only to talk about what I had envisioned, but also to be able actually to show it and receive feedback.
11-30-89  Re: TMTM dinner meeting at an Ames restaurant

This meeting was a celebration of the successful completion of Phase 1 and Phase 2 activities ISU had completed for SWOS. They had designed and created a state of the art media center, and several hi-tech classrooms containing a vast array of instructional technology capabilities. Dr. Simonson showed us some slides of the Phase 1 and 2 projects, and in general, discussed the overall Threat Matrix problem. It all looked wonderful, and I hoped ISU would choose not only to enter a bid on the project, but that HyperCard would be used to create the software solution. If that happened, then maybe I could be involved in some way.

12-89  A few days after the dinner meeting Dr. Simonson asked me if I would like to assume responsibility for developing and creating the SWOS prototype of the Threat Matrix project. I said yes.

12-11-89  Re: TMTM to plan for a hypermedia presentation to SWOS in early January, 1990

Dr. Simonson, in conversations with SWOS officials, has set up several demonstration meetings whereby presenters from ISU will go to SWOS and help them experience and understand how hypermedia can be a part of their curricular revisions.

At the meeting the TMTM brainstormed titles of commercially produced hypermedia materials that we could demonstrate to SWOS. It was decided that two graduate students, in addition to myself, will make the various presentations to SWOS. I chose to present a video disc program called, “The '88 Vote,” which features a wide range of materials dealing with the 1988 presidential election. The other two graduate students will be doing similar demos on biology, art, and space exploration.

Besides the three graduate students, Dr. Simonson and Al Kent (Director of Media Resources Center) will also be going. I’m excited to be a part of a cadre of educators who will soon be demonstrating what we hope will be the central focus of the computer lesson I will be generating.

12-28-89  The TMTM group met to do a rough walk through of their various hypermedia presentations, check out equipment problems, etc. It was like a dress rehearsal before the performance, and we looked like we were ready.

01-06-90  We left for Des Moines to fly to Providence, Rhode Island, with about 300 pounds of equipment. Once at Providence, we rented a car for the 30 mile drive to Newport. A sense of high adventure prevailed as we made our way to the city by the bay.

01-07-90  Today we went to SWOS. The SWOS people treated us like visiting dignitaries, and made us feel immediately welcome. We made our way to the large media classroom that ISU had designed and equipped, and then also the Media Center. Both projects were very impressive. Our host on this and all future visits was Dave Monroe, Specialist in the Curriculum Standards Office at SWOS. He provided the civilian link between the Naval personnel and contracted projects with vendors, such as Iowa State
University. We later learned that most of the officers in SWOS serve relatively short tours of duty, and are then transferred to ships at sea, or to other educational facilities. Dave is there to provide continuity in the SWOS educational effort.

As the hour for the start of our presentation approached, numerous Naval personnel in dark navy blues began to come into the classroom. They knew why we were there, and many of them seemed very interested in all the gadgets we had brought with us. Dr. Simonson introduced all of us, and our presentations began. My HyperCard demo went very well, and a short time later I demonstrated "The '88 Vote." The Naval personnel seemed impressed to see how one could use the video images and sound clips on the video disc, and access them by way of a designed HyperCard stack on the Macintosh. The morning concluded as other graduate students made similar presentations using various forms and titles of hypermedia.

01-08-90 The next day we went back out to SWOS for more meetings, and this time to watch two individuals from IBM present their answer to hypermedia. Their equipment was good, and soon became apparent that they were sales personnel, and knew little about education or instructional technology. They had this new exciting authoring program called Linkway, which neither of them knew anything about. All they knew how to do was to run the demo.

We later had a meeting with key SWOS personnel and Dr. Simonson explained our proposal to them and outlined what we would do to provide a solution to their Threat Matrix need, using Macintosh computers. SWOS had many questions and we had excellent discussions, both pro and con for the concept and for DOS versus Macintosh. A final decision would be made later, and ISU would be advised of what SWOS chose. We concluded our meeting, packed up all our equipment, and returned to Ames the next day.

01-16-90 Re: Phone call to SWOS Specialist in the Curriculum Standards Office

I phoned the SWOS Specialist to get phone numbers so that I could contact the Division director for the teaching of Combat Systems. I asked him several questions about the video disc, reference books, and other preliminary questions.

SWOS had not yet told us if the wanted ISU to complete the project for them, and if so, whether they wanted it to be on a DOS or Macintosh platform. ISU is getting ready to make a proposal to SWOS for the project. I hoped it would all work out, as this looked like a good opportunity for me.

01-19-90 Re: TMTM meeting, researcher presents a more fully developed pre-prototype demo using HyperCard.

This demo was more detailed than the previous version and utilized a couple of little gaming strategies to "Name that Plane" or "Name that Ship." TMTM has not fully developed the scenario around which any kind of Threat Matrix materials would be developed. We are certainly kept busy thinking about the possibilities.
This month is going slowly! Although we had been to SWOS during the first of the month, and I've been involved in making tentative plans, we still do not know for sure if we will be doing the project or not.

02-06-90  Re:  SWOS has chosen DOS

Dr. Simonson received the phone call from DOS, which initially made me feel very disappointed. SWOS had chosen DOS instead of Macintosh, for what were very good reasons. SWOS still wanted ISU to receive the bid to develop the prototype materials. ISU had to reassess their position and respond accordingly. I knew that this contingency might happen, but my first knee jerk reaction was, "Oh, no."

Within a few hours many things rolled into action. I chose to continue to work with the project as originally proposed by Dr. Simonson, only this time I realized that, in addition to developing, writing, and creating the entire computer based lesson, now I would have to learn DOS, the Linkway authoring system, and become familiar with a totally foreign computer platform. SWOS said they would ship me one of their Zenith 286 based systems, which would be used for the authoring. That would assure that anything I created here, would most certainly run on the SWOS machines. I am thinking exciting thoughts for the opportunities this project represents, but do have some concerns if I will be able to accomplish all that needs to be done.

02-12-90  Re: Researcher meets with IBM educational representative to become acquainted with DOS and Linkway.

This DOS is going to take a mental attitude adjustment for me! It is unfriendly, very exact, and totally opposite of everything for which the Macintosh is appreciated. The Zenith computer came from SWOS, and I got Linkway up and running. I like the color capability it has and think maybe this will be okay after all!

03-27-90  Re: IBM training school for Linkway

I am becoming more acquainted with Linkway and am struggling with DOS a great deal. Dr. Simonson and I decided to attend a two day Linkway training school at IBM headquarters in Atlanta, Georgia.

04-90 through 05-90  I am beginning to feel stuffed with Linkway knowledge.

I now have the Linkway software and the Zenith computer, sent by SWOS. "It doesn't get any better than this!"
I feel like I am the only human in Iowa using or wanting to use Linkway! For that matter, the only others seemed to be the folks in the class in Atlanta. Linkway seems to be a "loner" in the world of computer authoring. There is profound absence of any printed articles, reviews, or third party published books on Linkway. I have decided to do it myself, make my own contacts, and locate whatever support I can find.

I met a capable guy from the state of Washington at the Linkway workshop and called on him when I had Linkway questions. Larry is always very helpful, and I plan to keep in touch with him. IBM finally opened up a Linkway BBS with an 800 phone number and AT LAST, I can interact with other people who are using Linkway. I soon found that I was not the only persons feeling ambivalent about how to use Linkway. It seems everyone feels the same as I do.

I got rolling and learned how to make folders into which pages of lessons will be stored to present in the program. I learned how to get very good at doing the things they had dumped on us in Atlanta in the two short days. Finally things are falling into place and making sense. I left there feeling like I was hypnotized with information overflow! It finally had soaked into all of my cognitive schema, and being the visual learner I am, I am putting up charts, signs, and crib sheets around my office. I'm not too bad with Linkway.

I am having a tough time deciding where to put the buttons, what color they should be, and how many of them can go on the page at the same time. I want to keep an instructional space on the screen for the line drawings that are going to go there. I have several versions or screen design lay-outs ready to go, but all are tentative and exploratory until we get more specifics from SWOS.

I have put my rough drafts in Linkway folders containing lessons that might find their way into the SWOS project. I want to get some of these demos done, so that Dr. Simonson can come over and see them.

06-16-90 Re: Project Director shoots video of preliminary Linkway efforts.

I have produced several screens of what could easily turn into the computer based lesson and made them all inter-connected with a series of buttons. Dr. Simonson came over today and shot a video that he was going to take with him to SWOS on 6-18-90. He was pleased with what he saw, and I am sure that SWOS will be, also.

Summer 1990

I continue to create more potential pages, but am at the point where what I want is specific information about building the lesson, so I can begin to create a series of modules that will ultimately become the entire lesson. During the summer I've had several SWOS contacts by phone and mail to obtain more specific information about the Threat Matrix and the names of the Soviet classes of warships that I am to include in the final lesson.

The project has been put on hold until I have more definitive facts regarding what the categories for the project will be. I continue to experiment and learn with Linkway, but want to begin building the screen templates that are to become the computer based lesson.
At times like this I am frustrated that SWOS is so far away. While I can call them on the phone and fax them, it is hard to get exactly what information I want right now. I think it must have something to do with the fact that I may be working with classified data, but no one has told me that for sure.

07-90
Re: Published article in HyperNexus journal

An article co-authored by Dr. Simonson and myself was published in the premier issue of HyperNexus, which is a journal of hypermedia and multimedia studies, produced by the International Society for Technology in Education (ISTE). The article was an overview of the current efforts of ISU and SWOS, and outlined the objectives and outcomes of the project. It sure feels good to see an article published about what I am doing. Now just to get it finished!

I am now getting a good understanding of the rather meticulous placement of pop-up buttons. I learned that with Linkway, you can put elements common to all screens in a given folder on the background page. That way they will automatically be a part of any new pages created in that folder. I realized this would make production of the pages easier, once I find out what SWOS wants to put on them.

08-90
I made a rather lengthy demo version of what the SWOS lesson could look like when it is completed. It was a more complete version of what had been shot for the demo video in June.

I am feeling a bit smug about my ability to use Linkway and create some really great looking software. I know that the demo, no matter how good it is, is actually the tip of the iceberg, and the amount of work left is very substantial!

09-90
through
09-23-90
Re: SWOS trip #2 to Newport, Rhode Island, to show them the demo and receive feedback

During this time Dr. Simonson and I went to SWOS to show them the demo in its current form and receive their feedback. They liked what they saw very much, but did have some concerns about the colors of button labels on some of the warship pages. My impression was that SWOS was very excited about the project and wanted to use it as soon as they could. Monroe and Ebley made me really feel like an instructional developer!

late fall, winter of 1990
My office at home is looking very cluttered with all of the materials, charts, and notes taped on the walls. I now can see how the program elements will come together, and the flow charts on the wall help me see how each part fits into the whole project. I developed a modular scheme for folders that dealt with different subjects, each of which will contain the screen pages for that particular subject. For example, there will be a weapons folder that contains all the pages dealing with weapons identification, another such folder for sensor, two for warships, etc.

I feel like I am building a very large project, brick by brick. Every single letter, button, and command has to be entered one at a time. Some less knowledgeable people suggested I should just use some computer automated system to do it for me. HA! I am using some automated
system (Linkway) and I feel as if I am building the Great Wall of China by myself, one stone at a time!

12-90 Dr. Simonson and I are going to Newport, and make the final delivery of the project and install it in early January. We set the date of January 7. The horse race to make the deadline has begun. The project really looks professional, but there is SO MUCH more to do.

Fortunately, mother nature looked on me with mercy and dumped a big snowstorm on Ames the day before we were to go to Newport. Ames now has ten inches of snow and the airports are closed. I have been given a window of another week. It would NOW be totally ready, and so would I.

1-16-91 Re: SWOS trip #3 to Newport to install the computer based lesson.

This is it. I've been waiting for this moment a long time. It is finished! I did a series of executive demos for the SWOS brass and they were very pleased. I could tell for many of them that this was "their baby," and they were proud to have something that no one else in the Navy had.

I showed some of their senior staff members how to change and modify the program I had created, and took plenty of time to watch them use the system, to be certain they knew how to operate it. It worked great, they were thrilled, we were all thrilled, and it was a wrap!

The evening of installation was memorable as it was on January 16, 1991, that the bombing in the Persian Gulf War began, while we were on the Navy base installing the computer based lesson.

Other events that occurred after January 16 1991, can be found in the chronological log data in Appendix N.
APPENDIX P:
PRESS RELEASES AND PUBLICATIONS
ISU DEVELOPS COMPUTER TRAINING PROGRAM FOR NAVY

AMES, Iowa -- A new computer program developed at Iowa State University will help U.S. Naval officers memorize thousands of facts about every combat fleet in the world.

To respond to potential military threats, Naval officers are expected to be able to identify ships, submarines, aircraft, sensors and weapons systems of major military powers, said Michael Simonson, the ISU curriculum and instruction professor who led the team developing the program.

"The computer-based system lets everyone learn in a way that matches the way he or she learns the best," Simonson said. Some learn best from visuals, others from written facts, he said. The Threat Matrix computer program allows the learner to jump back and forth between pictures and text.

It is being tested at the Navy's Surface Warfare Officers School (SWOS) in Newport, R.I.

Rather than using the traditional flashcard method of learning, Naval officers use an IBM computer and a videodisc player to memorize the thousands of weapons systems in the United States and U.S.S.R. Most other countries use weapons from the United States and the U.S.S.R.

"Computer-based lessons are relatively new and very exciting," Simonson said.

(more)
Anchors away for ISU training program

A new computer program developed at Iowa State will help U.S. Naval officers memorize tens of thousands of facts about every combat fleet in the world.

To respond to potential military threats, Naval officers must be able to identify ships, submarines, aircraft, sensors and weapons systems of major military powers, said Michael Simonson, the ISU curriculum and instruction professor who led the team developing the program.

"The computer-based system lets everyone learn in a way that matches the way he or she learns the best," Simonson said. Some learn best from visuals, others from text, he said. The Threat Matrix computer program allows the learner to jump back and forth between the two.

It is being tested at the Navy's Surface Warfare Officers School (SWOS) in Newport, R.I.

"Computer-based lessons are relatively new and very exciting," Simonson said.

The Threat Matrix program is the latest technology innovation developed by the College of Education for SWOS. In 1988, Simonson led a team to improve the Naval school's audio-visual instructional system.

The Threat Matrix program is designed like a textbook, Simonson said, divided into sections for the military systems of the United States, U.S.S.R. and other world powers.

For example, an officer studying U.S.S.R. surface warships might call up information on the Kirov. A line drawing of the ship appears on the computer screen, along with information about the ship's dimensions, speed and range.

Still photos and a motion sequence of the ship also are available.

"The lesson allows officers to explore and learn at their own pace," Simonson said.

An IBM computer and videodisc replaces the traditional flashcards as Naval officers memorize the thousands of weapons systems in the United States and U.S.S.R. Most other countries use weapons from these two countries.

ISU received a $17,000 grant from the U.S. Department of Energy's Oak Ridge Associated Universities in Tennessee to develop the project. Simonson designed the program's outline and the program content was developed by Robert Kelly, a graduate student in ISU's instructional technology program.

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Mike Simonson, curriculum and instruction professor, calls up one of the thousands of weapons systems in the world included in the computer program developed at ISU for use by the U.S. Navy. The program will help Naval officers memorize thousands of facts about every combat fleet in the world.
NATIONAL AWARD FOR INSTRUCTIONAL DESIGN ANNOUNCED

AT&T, AECT (Association for Educational Communications and Technology), and the Division of Instructional Design recently announced that Bob Kelly, doctoral student in Instructional Technology has been selected to receive a national instructional design award.

The award The AT&T Corporate Training Group Award for Outstanding Practice by a Graduate Student in Instructional Development, honored Kelly for his instructional design used in "SWOS Threat Matrix - A Computer Based Lesson." Kelly has worked closely with Michael Simonson in the design and implementation of this prototype hypermedia model designed to assist U.S. Naval officers in Newport, Rhode Island in learning thousands of strategic facts about naval fleets of the world.

The award and $500 honorarium were presented during the annual awards luncheon, February 7, 1992 in Washington, D.C.
ISU STUDENT RECEIVES AWARD FOR COMPUTER PROGRAM

AMES, Iowa -- Bob Kelly, doctoral student in instructional technology at Iowa State University, has won the AT&T Corporate Training Group Award for Outstanding Practice by a Graduate Student in Instructional Development.

Kelly, a sixth grade teacher at Fellows Elementary School in Ames, designed a computer program to help U.S. Naval officers learn thousands of strategic facts about the naval fleets of the world.

Kelly worked closely with ISU curriculum and instruction professor Michael Simonson in the design and implementation of the program.

Kelly received a plaque and $500 at the annual awards luncheon on Feb. 7 in Washington, D.C.
ISU doctoral student wins AT&T award

Bob Kelly, a doctoral student in instructional technology at Iowa State University, has won the AT&T Corporate Training Group Award for Outstanding Practice by a Graduate Student in Instructional Development.

Kelly, a sixth-grade teacher at Fellows Elementary, designed a computer program to help U.S. Naval officers learn thousands of strategic facts about the naval fleets of the world.
DID Selects 1992 Award Winners

The Division of Instructional Development conducted its 10th annual awards ceremony during the AECT convention. Awards were presented in seven categories.

OUTSTANDING BOOK AWARD
Gary Anglin
Instructional Technology: Past, Present and Future
(published by Libraries Unlimited)

SPECIAL BOOK AWARD FOR SIGNIFICANT CONTRIBUTION TO THE CLASSIC LITERATURE OF THE FIELD
Paul Reitler
The Evolution of American Educational Technology
(published by Libraries Unlimited)

OUTSTANDING JOURNAL ARTICLE AWARD
Diane Clyneski
"Software Tools for Empowering Instructional Developers" (Performance Improvement Quarterly, Vol. 4, No. 1)

SPECIAL AWARD FOR SIGNIFICANT CONTRIBUTION TO THE FIELD
Thomas Duffy and David Jonassen
For editing two special issues of Educational Technology magazine

AT&T AWARD FOR OUTSTANDING PRACTICE BY A GRADUATE STUDENT IN INSTRUCTIONAL DEVELOPMENT
Robert Kelly
For design of an outstanding computer-based hypermedia lesson

ROBERT M. OAGNE AWARD FOR OUTSTANDING RESEARCH BY A GRADUATE STUDENT
Sam Haken
For the paper "Learner Control and Incentive in Computer Assisted Instruction"

PRESIDENTIAL AWARD FOR OUTSTANDING SERVICE TO THE DIVISION
Robert Reiser
For 10 years of service as chair of the DID Awards program
Background

In 1988, Iowa State University's College of Education and Media Resources Center (Ames, Iowa), contracted with Oak Ridge Associated Universities (Oak Ridge, Tennessee) to develop a plan to promote the increased use of educational technology by the instructors and students of the United States Navy's Surface Warfare Officer School (SWOS). Located in Newport, Rhode Island, the mission of SWOS is:

• provide the Naval Warfare Force, through a system of functional training, with officers professionally qualified to serve as effective naval leaders on surface warfare ships with the ultimate goal of Command at Sea,
• serve as a focal point for development and integration of qualification standards and functional training in support of the established continuum of Surface Warfare Officer professional and billet specialty training.

One of the curriculum areas at SWOS is designed to prepare officers to work in a ship's "Combat Information Center" (CIC), where they have the responsibility of interpreting information collected from electronic sensors and human lookouts. When a "contact" is made by the ship's radar, or from a surveillance plane, it is the responsibility of this officer to determine what the "contact" is, and to determine its threat.

One of the basic skills needed by a CIC officer is the ability to recall the names and characteristics of all of the ships and aircraft of the fleets of the nations of the world. Initially, this information is memorized, and SWOS students are tested on their ability to remember this data. SWOS instructors and students organize this "threat" information into a chart with columns (ships) and rows (characteristics) and they refer to it as the "threat matrix" (TM). The TM lists over 2000 facts that must be memorized including:

- colored pictures of ships, aircraft, and weapons (e.g., missiles),
- line drawings of ships, aircraft, and weapons,
- names of ships, aircraft, and weapons,
- characteristics of ships, aircraft, and weapons (e.g., speed, weight, electronic characteristics)
- relationships between other categories of information.

Once the data in the TM are memorized, students apply their knowledge in simulations that evaluate their ability to function in a Combat Information Center (CIC).

Purpose and Design

The purpose of this project is to design and evaluate a computer based interactive video lesson that individually teaches the TM facts. The project has two phases. First, a lesson had to be prepared. Since the "official" computer of the US Navy is the MS-DOS based Zenith 246, it was chosen as the "platform" for the lesson. Since the information contained in the TM was partially classified, and constantly in need of updating, a simple-to-modify lesson had to be prepared. IBM's LinkWay was chosen as the tool software used to create the TM lesson. LinkWay also supports a lesson's access of a videodisc player. The characteristics of the TM lesson are:

- created using IBM LinkWay;
- designed to include still photographs and motion segments accessed by using a videodisc;
- written to be a drill-and-practice computer-based lesson with student practice and self-testing included.

He is currently involved in the design and implementation of their project.

Michael R. Simonson is a professor in Instructional Technology at Iowa State University.

They can be contacted at N-31 Legerman Hall, Iowa State University, Ames, Iowa 50011.
The Threat Matrix: A hypermedia development project

Robert T. Kelly
Michael R. Simonsen

Research and Development: The Threat Matrix

The Threat Matrix has over 2000 facts that must be memorized...

IBM Spotlight on Iowa Education

Background

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- Created using IBM LinkWay
- Designed to include still photographs and motion segments accessed by using a videodisc
- Written to be a drill-and-practice computer-based lesson with student practice and self-testing included

The second component of this project will be the experimental evaluation of the TM lesson, which will occur after the instructional media has been produced.

Robert O. Kelly is a doctoral student in Instructional Technology at Iowa State University. He is currently involved in the design and implementation of their project.

Michael R. Simonsen is a professor in Instructional Technology at Iowa State University.

They can be contacted at N-31 Lagomarcio Hall, Iowa State University, Ames, Iowa 50011.

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