APPLYING WEB-BASED VIRTUAL REALITY FOR INCREASED FIDELITY OF INTERACTIVE COURSEWARE

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ABSTRACT

The Virtual Tactical Operations Center (VTOC) will provide an Internet-based simulation of the Tactical Operation Center (TOC) where teams of geographically separated student groups synchronously work together as a staff team to develop operations plans and orders. The teams use the Military Decision Making Process (MDMP) to systematically guide the course of action (COA) planning documents essential to tactical operations using armored vehicles. Some research points to enhanced information processing and more effective learning when depth of fidelity (virtual and three dimensional) increases. The primary purpose of the VTOC project is to determine if the added dimension of depth provides a more effective learning environment for visualizing and analyzing COA solutions. In addition, the VTOC project will assess the effectiveness of collaborative learning over the Internet.

ABOUT THE AUTHORS

George Paschetto is the acting Distance Learning Systems Manager for Fort Knox and the Armor School. He has a Masters Degree in Education, along with 20 years of experience in training development. He also has 18 years of experience designing and implementing automated systems and computer based instruction.

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Roland Garton has been involved with CBT design, development, and management since 1979. With a Master's Degree in Education, he has authored courseware, mostly at the college level, in many diverse disciplines. He has also been involved with management of CBT sites and delivery, documentation and technical writing, programming and teaching, intelligent tutoring systems, and training management systems.

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INTRODUCTION

Program Overview

The Virtual Tactical Operations Center (VTOC) will provide an Internet-based simulation of the Tactical Operation Center (TOC) where teams of geographically separated student groups synchronously work together as a staff team to develop operations plans and orders. The teams use the Military Decision Making Process (MDMP) to systematically guide the course of action (COA) planning documents essential to tactical operations using armored vehicles. The Fort Knox Armor School has developed training in the MDMP for brigade through company level. In order to ensure the quality of student activities, the VTOC must be connected with Small Group Instructors (SGIs) from the Armor School. Students engaging in teaming activities with a common operational goal learn how to work together and how to make effective decisions as they develop plans and orders. The VTOC will provide this work environment and a VR world in which students can visualize various aspects of their plans.

The VTOC project is a Joint Service project involving the Air Force Research Laboratory (AFRL) and the Fort Knox Armor School. AFRL is using the Improved Instructional Techniques in Intelligent Training Systems (INTech) contract to provide funding and research in instructional systems.

VTOC development began in the summer of 1998. This paper represents initial thinking on the approach to the VTOC. We expect to refine the ideas significantly over the course of the project.

Armor Officer Advanced Course

The VTOC will be employed within the Armor Officer Advanced Course (AOAC), which prepares combat arms officers to command armor and other combined arms units at the company level and to assist operations officers at the battalion and brigade levels. The student population is composed of Army Officers (most with the rank of Captain) with Platoon Level experience in armored and mechanized vehicle operations. Although the majority of students are active-duty officers, the population also includes a significant segment of the Army Reserve Component (RC); this RC training requirement will continue to increase.

Beginning in October 1998, AOAC will be an 18-week course composed of large and small group instruction, and other live, virtual, and constructive training. There are four courses held per year, each composed of approximately 100 students, broken into small groups of 12-16 students. The activities of each small group are supervised by a SGI. The small group is required to exercise the military decision making process and analyses tools, and to produce the intermediate products used to support other phases of the process. Eventually, students produce a recommended COA plan, which is briefed to the commander.

Training Requirements

Part of the Army's Force XXI initiatives are Training XXI and Classroom XXI, driven by courseware development designed to serve both active and reserve forces. The Total Army Training System (TATS) is the defining method to provide courseware for Force XXI. The Total Army Distance Learning program provides the planning on the use of distance learning technologies for TATS courseware.

Therefore, Fort Knox Armor School has the following training requirements:

- Provide quality, relevant instruction at a distance.
- Cost-effectively link geographically separated students (Army Reserve component) with Armor School resources.
- Increase the number of students engaged in realistic, tactical decision making processes and communication skills.
- Increase training fidelity of existing training resources.
- Decrease the average student-to-SGI contact time ratio (reducing the need to add instructor personnel).

VTOC Goals

In summary, the overall goals of the VTOC project are to:

- Provide the capability to link geographically separated students with each other and with the Armor School to provide a training environment where communication and decision making skills will be developed while applying the doctrine, procedures, and processes vital to directing armored weapons systems in a tactical environment;
- Develop virtual and three-dimensional (3D) Internet training capabilities that can cost-effectively enhance the current training system; and
- Provide a thorough evaluation of the effectiveness of these web-based training (WBT) applications.

TRAINING PROGRAM DESIGN

The AOAC Distance Learning program design provides for three phases of training environments for the Reserve Forces:

- Asynchronous Training - materials delivered via standard distance learning methods (WBT, CBT, self-paced learning);
- Synchronous Training - material delivered via T-NET (Teletraining Network) and web-based collaboration using virtual reality with computer applications (WBC); and
- Resident Training - traditional classroom at Ft. Knox. The VTOC will provide a synchronous collaborative meeting environment, primarily used a a collaborative work environment for the various students at a distance.

The VTOC will also serve to enhance the video-teletraining segments. Instructor personnel will be involved in the VTOC training during synchronous exercises but not necessarily present for asynchronous (inter-unit) training sessions.

Estimated instructional contact time for the DL AOAC is 750 contact hours. The estimated splits for the three phases are:

- Asynchronous - 150 (actual) hours (240 current POI hours)
- Synchronous - 120 hours
- Resident - 120 hours.

INSTRUCTIONAL TECHNOLOGY DESIGN

Research Questions in VR Fidelity and Learning

3D virtual reality environments provide a method to engage the learner with an increased sensory fidelity of interaction, thus providing a more effective environment to test and modify a learner's existing mental model of reality. Often a learner has misconceptions of that reality, and those misconceptions must be revealed before a more accurate concept can be accepted.

Much research has been conducted investigating the potential benefits of increasing the fidelity of a system. Results from this research suggest that more fidelity does not necessarily equate to increased understanding. However, in some training environments, added fidelity allows student to process information in a different, often more effective manner. The added dimension of depth, and a collaborative environment to discuss and view a COA solution, may provide a more effective learning environment to visualize and analyze a COA solution.

This leads to several research questions:

- Is the use of a 3D map more effective than a 2D map for planning and evaluating a COA?
- Does providing a 2D "God's eye view" increase the student's ability to navigate a virtual environment?
- Does a virtual collaborative environment provide any additional learning benefits over the classroom or stand-alone 2D environment?

Research Questions in Web-based Communications

The VTOC will provide a synchronous environment for multiple users across the Internet, so the project will focus on collaborative interactions across the Internet. It is thought that by immersing students within a virtual tactical operations environment, they will be able to learn the communication, organization and planning skills, and knowledge necessary to make effective and efficient course of action decisions. Through this Internet-based virtual environment, military personnel located at remote sites will be able to work together as a team to analyze, plan, evaluate and eventually execute a course of action.

The dynamics of the human interaction which occurs in a small group offers a rich area for study. Can technology offer effective methods for a similar team dynamic across geographically dispersed team members, where the technology may only offer typed text (or perhaps audio)? Some research indicates some special considerations are necessary to accomplish an effective distributed collaboration environment.

Dr. LorRaine Duffy's[1] research on the C2MUVE (Command and Control Multi-user Virtual Environment) examines the environment necessary for effective mission planning by distributed planners. Areas of study include:

- the use of avatars and defined tele-presence requirements;
- embedded speech and gesture recognition technologies;
- and develop context representation (metaphors for interaction).

These areas go to the heart of the question: *How to do people effectively communicate in a geographically dispersed, collaborative environment using current technology?*

COTS Examples of Collaborative Communication

Below are two examples found in a preliminary search of the current COTS offerings. These two examples demonstrate attempts to add shades of meaning to web-based interactions. Often, such interactions are restricted to typed interchanges, in which typing speed and lack of non-verbal cues limit understanding. The VTOC will borrow from these and other techniques to provide as rich a communication avenue as possible.

Systems using a standard browser with ActiveX or JAVA enhancements provide a list of verbs to show action or emphasis in a chat post.

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[1] Naval Advanced Concepts and Systems Technology Division (lduffy@nosc.mil)

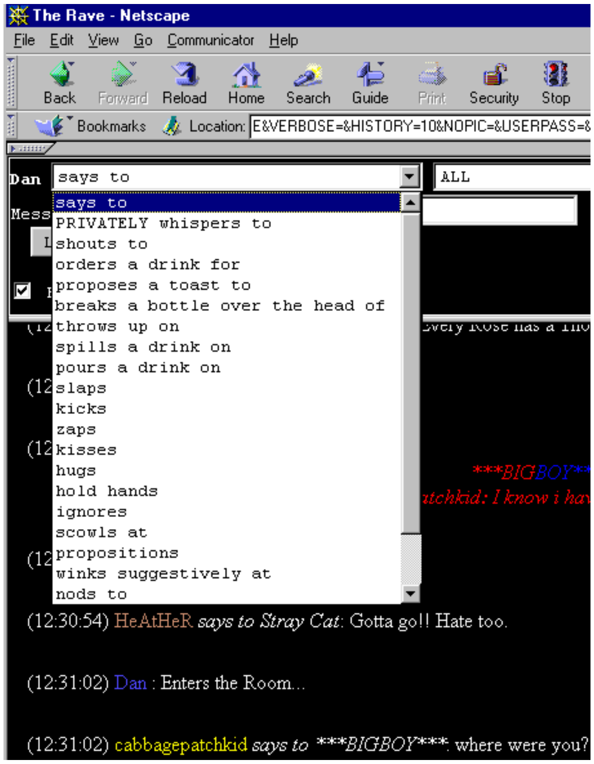

Figure 1 - Pull-down Menu of "Gestures"

More sophisticated systems such as Virtual Places, provide a customized browser with gesture file additions. For example, the avatar can take on a mood, such as happy, angry, sad, or normal. This changes the facial features of the avatar (basically, an avatar for each mood is used). When a chat post is sent, a “gesture” can be added for emphasis. Gestures include a small animation that articulates the text. A gesture palette is available within the text entry box.

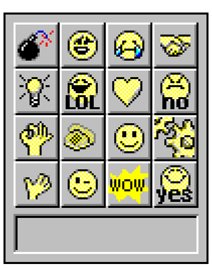

Figure 2 - Virtual Places Gesture Palette

Gestures include an animated hand making the “ok” sign (3rd row item 1), a hand wave (4th row, item 1), a smiley face shaking “no” (2nd row item 4). Custom gestures can be loaded into the gesture palette easily.

Virtual Reality Simulation

The VTOC will be a computer virtual reality environment model of a Single Integrated Command Post System (SICPS) like that represented by Logicon below (see Figure 3).

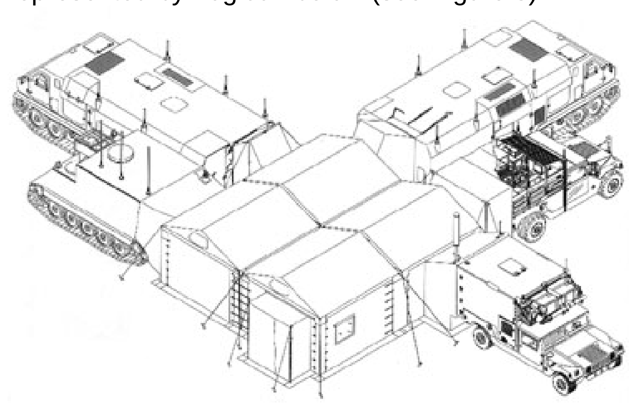

Figure 3 - Logicon SICPS as an example of a TOC

The VTOC differs from the Logicon SICPS in that it is based on eight (8) M577’s backed into a Main Battalion TOC (see Figure 5).

INSTRUCTION ORGANIZATION AND FORMAT

The following sections represent current thinking on design. As the program unfolds, there will undoubtedly be significant refinement of these ideas.

VTOC VR World

The VTOC provides a collaborative environment for up to 15 concurrent users to meet as a team and work through situations using the resources provided in the VTOC. The user screen provides a virtual universe for the VTOC resources and a common chat area (if room permits, several separate chat windows can be created, for use by small groups within the main VTOC). The VTOC environment will include functions to share any computer applications (similar to MicroSoft NetMeeting). The specialty TOC’s will be separate subset virtual universes almost identical to the main VTOC. Individual or small groups can meet in a specialty VTOC to work a subset of the situation. All files being worked in any VTOC can be called from the appropriate application from any other VTOC. Some indication of the time/date of the file should provide an indication of the “currency” of the information.

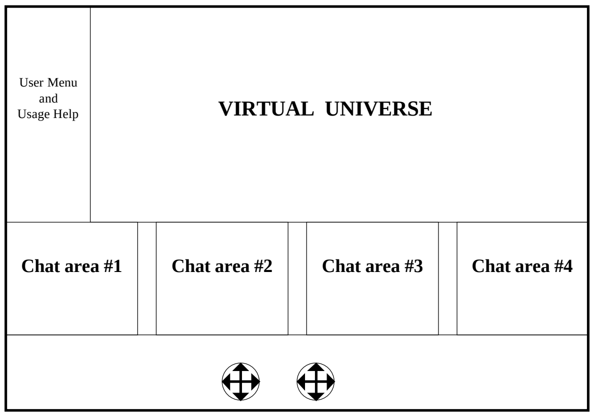

Figure 4 - User Screen Layout

Up to 15 unique avatars could be navigated in the main VTOC, or maneuvered to enter a specialty VTOC or 3D Viewer. The user can also select from the 10 virtual universes (Main plus eight (8) specialty VTOCs plus the 3D Viewer universe), by using the Radio item.

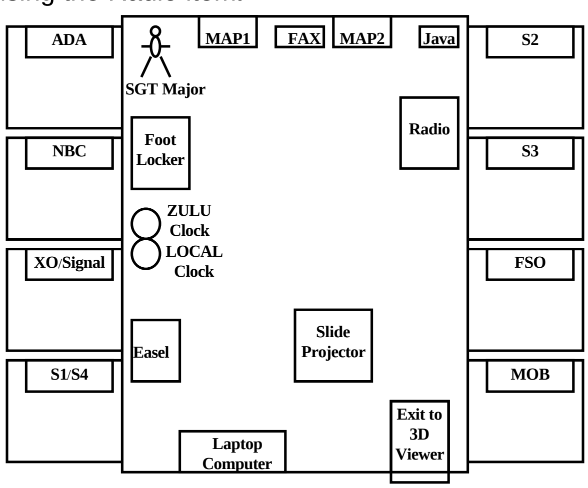

Figure 5 - Battalion TOC Configuration

The main TOC has the eight specialty TOCs with four on either side: contents of the specialty TOC will be described later. The eight specialty TOC’s are:

- ADA - Air Defense Artillery Officer
- NBC - Nuclear/Biological/Chemical Officer
- XO/Signal - Battle Command Executive Officer/Signal Officer
- S1/S4 - Combat Support Officers (Adjutant/Supply)
- S2 - Intelligence Officer
- S3 - Operations Officer (Maneuver)
- FSO - Fire Support Officer
- MOB - Mobilization Officer

3D Virtual Viewer

The 3D Virtual Viewer (3DV) is a virtual reality application that provides a collaborative environment for up to 15 concurrent users to view a Course of Action (COA) sketch. The user screen layout is similar to that of the VTOC.

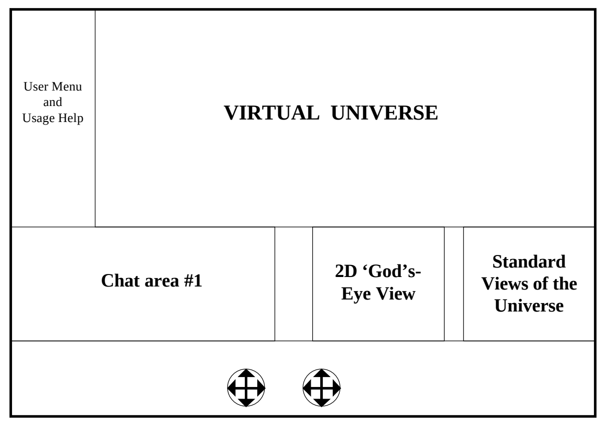

Figure 6 - 3DV User Interface

The purpose of this collaborative environment is to allow a group to analyze the quality of the COA solution by: 1) viewing the solution in a 3D environment; and 2) performing ‘line-of-sight’ analysis on the COA.

Therefore, there will be three discrete components to the 3DV:

- A preprogrammed terrain into the 3DV (Irvington Training Center).
- A drape of the 2D COA map graphic to the 3D terrain. A software translator will take the 2D graphic, combine it with the DTED elevation data for the terrain, and overlay the MapEdit symbols to the terrain.
- The avatars used to traverse the universe.

Entering the 3DV, a user is given a choice of avatars: equipment avatar; or human avatar. An equipment avatar includes: a tank; a HUMVEE; a Bradley; and a helicopter. The ground vehicle avatars are bound to the terrain, the helicopter in bound to the terrain and sky. The human avatars include a selection from representative races: a Caucasian male; Hispanic male; African-

American male; and Caucasian female. The human avatars are bound to the ground and sky.

Map Editing

To allow for the analysis of a COA, the 3DV will be integrated with the MapEdit program (MapEdit is a 2D vector/bitmap graphics editor which provide 8 layers of graphic symbols which represent friend/foe forces and movements. Typically a single layer is used to contain a specific view of the total plan (i.e. one layer maybe the friendly forces, another the foes, another the movements). This graphic is used to describe the battle plan for a specific action. Each layer of the MapEdit graphic can be turned on, or off to provide for sophisticated analysis of the multiple combinations of the layers.

Therefore, the 3DV tool will be tightly integrated with the MapEdit application. The MapEdit graphic will be "draped" into the 3DV universe using a software translator that takes the MapEdit native file and integrates the image to the 3DV terrain.

Once the drape translation is complete, the avatars can transverse the COA 3DV universe, and discuss the quality of the solution. Students should be able to develop their COA products using the 2D MapEdit, then use a translation utility to view their products in 3D. Eventually, students will return to the VTOC to collaborate on the overall COA. Therefore, the translation utility needs to provide timely generation of the COA drape.

The second function of the 3DV, the line-of-sight analysis, requires the positioning of one post at a point of observation. The user/driver can place a post anywhere on the terrain, and the post remains in place while the user/driver moves to different locations to see if it is visible. This is to facilitate visual checks of the terrain and line of sight analyses. The posts will be one of 3 heights: 4 meters, 3 meters, or 1.7 meters. As the user is bound to the terrain, he/she can assess the line of fire necessary to support that movement action.

All avatars will be simple in their characteristics, only bound to the ground or air, as appropriate. No other characteristics are necessary to accomplish the purpose of the 3DV, as the COA is a static representation of the plan of battle.

SUMMARY

The Virtual Tactical Operations Center research and development effort will provide many unique opportunities to explore the application of virtual, collaborative, web-based instructional technologies to meet real-time operational requirements for the U.S. Army. VTOC will supplement and enhance the Fort Knox Armor School's AOAC instruction for Reserve Component company- through battalion-level commanders. The VTOC project will determine if the added dimension of depth in a collaborative environment provides a more effective learning environment for visualizing and analyzing COA solutions.