

DATE: February 12, 2000

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TO: A. Habayeb

CC: John Kelso and Fernando das Neves

SUBJECT: NAVCIITI Quarterly Report

RE: - Project 2.0 Visualization HCI and Collaboration

- Task 2.1: Command and Control Visualization

*SOW 2.1.2: Design CAVE displays to interpret NUWC acoustic model results December 00*

*SOW 2.1.3: Demonstrate CAVE displays to interpret NUWC acoustic model results, April 01*

*SOW 2.1.4, Evaluate and modify CAVE display interfaces for NUWC acoustic model, July 01*

*Background:* Our objective is to provide a distributed collaborative network of graphical and device independent tools in a shared virtual environment which can be used by Command and Control (C&C) personnel to gain a strategic advantage. Specifically we focus on the mission critical C&C interpretation of acoustic undersea data from towed arrays for the Naval Undersea Weapons Center (NUWC) using the CONRAY simulation models. These simulation models can be extended to "real-time" data acquisition systems. Under the direction of personnel from NUWC and the Naval Research Laboratory (NRL) we have identified a working prototype which we have successfully incorporated into our Device Independent Virtual Environment Reconfigurable-Scalable-Extensible (DIVERSE) tool that works in stereo in the (C)AVE Automated Virtual Environment (CAVE), Immersive Work Bench (IWB), Immersive Desk (I-Desk), desktop workstation simulator, and Head Mounted Display (HMD) systems at the Virginia Tech Center for Virtual Environments and Visualization (CVEV). Hence the idea of "DIVE" (Device Independent Virtual Environment). The DIVE in DIVERSE provides the basis for collaborative C&C.

*Discoveries, Accomplishments, Test Results:* Since the last quarterly report our Points of Contacts (POCs) at NUWC and NRL met at Virginia Tech November 13 and 14, 2000 for a demonstration of the DIVERSE-based CONRAY model and to begin discussion on the "next step" in the development of the CONRAY model. In correspondence with NRL, NUWC generated a task breakdown. CONRAY was rewritten and the code architecture redesigned to improve rendering speed and frame rate, to limit dependencies between CONRAY scene-building and the DIVERSE scene-rendering and navigation. A redefinition of subtasks within SOW 2.1.3 reflects a collaborative development effort between NUWC, NRL and Virginia Tech (VT). The new Command & Control (C&C) software visualization project has been labeled "MIX". The effort put in redesigning the DIVERSE version of CONRAY allowed for a very fast incorporation of the code into MIX.

*Activities during quarter:* On February 5, 2001 NUWC, NRL and VT agreed to coordinate efforts into the following task break down.

**NUWC:** (POCs Ken Lima, Ann Silva, Lauren Mathews, Richard Shell)

1. Develop a geometric method for determining points of intersection for complex conical angles.
2. Develop 3-D Eigenray Manifold 'ray trace' algorithms that employ 3-D reflection, sound-velocity profiles and propagation loss models.
3. Create multiple scenarios that will test operator effectiveness.
4. Make 3-D displays equivalent to Mark II block 1C combat system displays for 2-D vs. 3-D comparison testing:
  - Determine what combat system information should be displayed on the 3-D canvas
  - Update and finalize the form of the information bezel
5. Set up software to read in common navy databases.
6. Coordinate NUWC and NRL efforts and interact with VT as required.

**NRL:** (POCs: Larry Rosenblum, Robert King)

1. Integrate the information bezel with the DRAGON software - bezel should turn on and off from keyboard or I/O device.
2. Ensure control devices operate properly with all software and scenarios - adjust control device parameters as required.
3. Integration of NUWC code into the DRAGON software.
4. Documentation of DRAGON software
  - Diagram of DRAGON component interaction.
  - Quick guide to code modification of elements pertinent to visualization
  - Organized copy of source code
  - Dragon presentation at NUWC

**VT:** (POCs: Ron Kriz, John Kelso, Fernando das Neves)

1. Explore optimization techniques to permit the code to run faster
2. Explore optional enhancements to the current code for incorporation into the DRAGON software such as:
  - Create a bathymetry contour following grid that maps to the bottom
  - Create bottom following vessel tracks.
  - Create the ability to lay generic texture maps of information such as navigational charts, bottom type, gravity maps, etc. on bathymetry.
3. Explore alternative devices and interaction techniques to improve selection and analysis of data subsets.

Ron Kriz and John Kelso visited Robert King at NRL on February 7. Rob showed us his progress on his part of the collaboration. Preliminary results suggest that NUWC, NRL, and VT now have a working relationship where outcome is based on technical issues that each organization has demonstrated expertise. DIVERSE Version 1.01 now includes bug fixes and a Dynamic Shared Object (DSO) for a Head Mounted Display (HMD). This satisfies a long term requirement to scale C&C software across heterogeneous Virtual Environments devices.

*Plans for Next Quarter:*

- SOW 2.1.3: *Demonstrate CAVE displays to interpret NUWC acoustic model results, April 01*
- SOW 2.1.4, *Evaluate and modify CAVE display interfaces for NUWC acoustic model, July 01.*

NUWC will coordinate NUWC and NRL efforts and interact with VT as required. VT will maintain regular communications with NUWC regarding the development of these new subtasks. SOW 2.1.4 will require that the CAVE be operational before July. Presently the CAVE floor with motion platform is completed and construction of the CAVE will begin February 12, 2001. The CAVE will be operational late March. In the interim VT will develop on the I-Desk, IWB, and desktop workstations.

*Outstanding Issues:* Now is a good time to begin planning the integration of SOW 2.1.5: *Design Digital Ship CAVE interface (DCSI) for simulation of ship under fire, June 01.* From our experience this year with NUWC and NRL, software integration requires not only the existence of a Digital Ship Lab (DSL) Application Programming Interface (API), but DSL-API documentation as well; both are critical for planning this SOW.

Successful development of a working Command & Control (C&C) model, "MIX", between NUWC, NRL and VT has resulted in raising new questions in the development of C&C models that scale across heterogeneous VE systems. At the February 7, 2001 meeting at NRL we discussed issues related to future C&C models and concluded that Performer based code such as DRAGON and DIVERSE must be changed to OpenGL. But OpenGL presently lacks a scenegraph such as Inventor/VRML. We at VT believe these are also important issues that will need to be addressed in NAVCIITI year-3 C&C projects, if these same models are to prove useful to the current C&C community. From this collaboration it is clear that future C&C software architecture must be determined by hardware, software, and other technical issues and limitations. A visual summary of key components of CONRAY simulation model in its current status is shown in Figure 1.

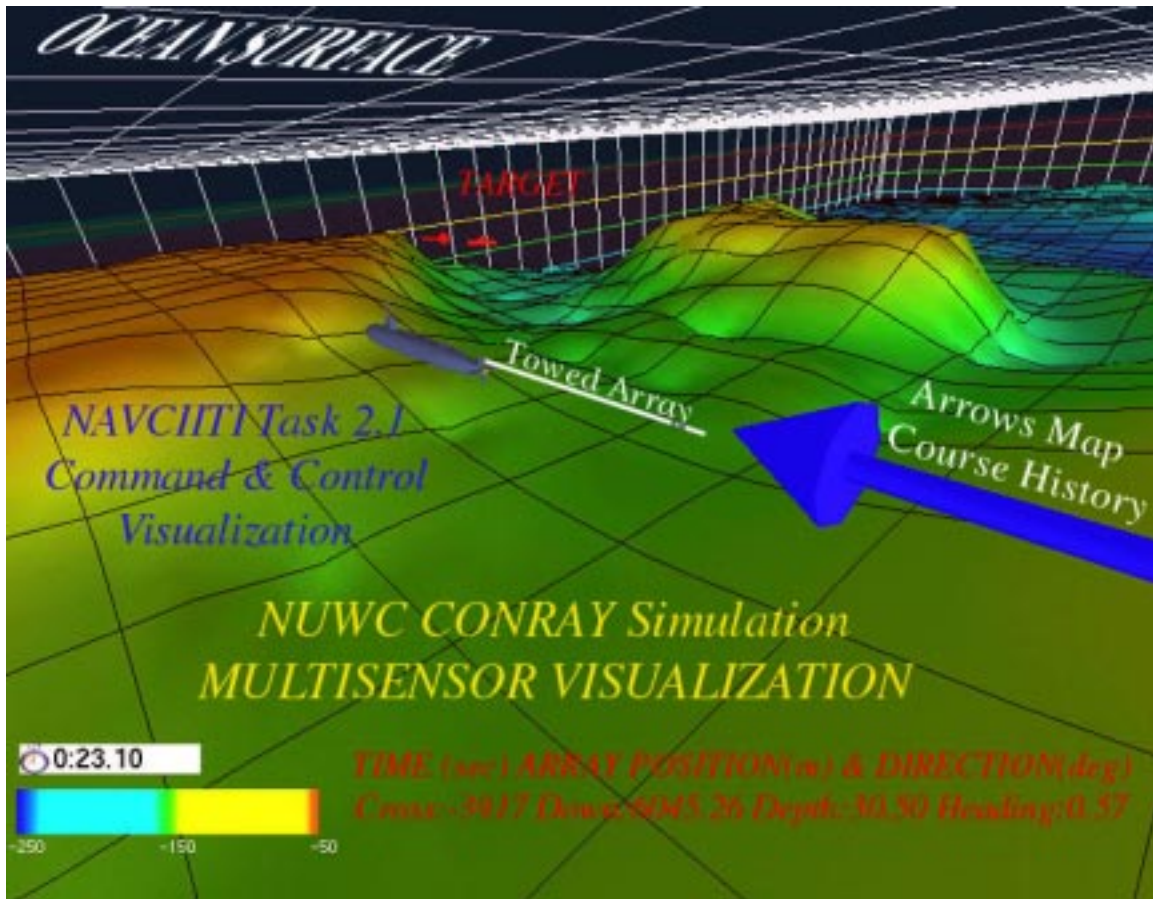


Figure 1. Visual summary of key elements in current DIVERSE-based NUWC CONRAY model

The next most immediate CONRAY feature is to add latitude and longitude for the grid and add bill-boards for each submarine that moves with the submarine. On these bill-boards information relevant to C&C will be posted.