Creation and Use of the C2 Collaboration Testbed CollabSpace

Nigel Tzeng
Jennifer Ockerman, Ph.D.
Overview

Purpose
- CollabSpace Testbed – Nigel Tzeng
  - Testbed Foundation - NASA World Wind
  - CollabSpace Plug-In
    - Situational Awareness Display
    - Geospatial Whiteboarding
    - C2 Enhanced Chat
    - NCES/SOA Based Design
- FY 06 Experiment – Jennifer Ockerman, Ph.D.
  - Overview
  - Design
  - Environment
  - Task and Procedures
  - Results
  - Conclusion

Questions
Purpose

“C2-E-N-08-01 - Improve the capability for real-time collaboration among C2 entities supporting mission execution.”

-- Air Force Capability-Based Planning
FY08 Command and Control Functional Needs Analysis Report, pg C-42

Explore advanced collaboration techniques with application to C2 and time sensitive mission execution in mobile and dispersed environments.

Three Primary Areas of Study
- Geospatial Collaboration
- Temporal Collaboration
- Process Collaboration

Requires an instrumented collaboration testbed.
Interactive 3D geospatial visualization platform

- 24/7 access to NASA, USGS, NRL, NOAA and other data
- Seamless integration of multiple data sources

Open Source

SIPR Approved
NASA World Wind Data Sources
NASA World Wind - DoD Users
Tracks

- NCES/GIG
- Web services
- JSAF
- FAA
- CEC
Situational Awareness – DHS ERS

Control Systems Integration Group (GVI)

NCES/GIG
Web Services

Disaster Management Interoperability Services/Common Alerting Protocol
Geospatial Whiteboarding

- Polygons
- Polylines
- Freehand
- Points
- Overlays
  - Shapefile
  - XML
- Images
- Icons
  - MIL-STD 2525B
  - DHS ERS
C2 Enhanced Text Chat

Tabs contain multiple rooms
List of questions to you.
Typing a name as first string indicates a request. In this example Fire-1 is asking EOC-0 (the user) to hook FIRE-2.
Click on list item to respond.
List of questions you’ve asked of others.

Color indicates which room a msg is from.
Chat messages to user are bolded.
Hyperlinks to objects in World Wind

Chat messages to user are bolded.
Hyperlinks to objects in World Wind
Color indicates which room a msg is from.
Geospatial Display (Wireless form factor)

- Form-Factors
  - Tablet PC (Wireless)
  - Workstation PC

- Operating System
  - Windows XP
  - Windows 2000
FY 06 Experiment

Dr. Jennifer Ockerman
Experiment Overview

Focus – Text Chat

Purpose – Explore enhanced integrated text chat

Comparison of performance between current chat clients and chat clients augmented for the C2 environment.

- Collapsing multiple room chat into a single display and discriminating based on color coding and labels.
- Automatic task tracking so that requests for information are not lost.
- Automatic hyperlinking of known objects in chat to the geospatial representation or other data.

Reason – Observations of Red Flag at the CAOC-N

- Warfighters observed monitoring multiple chat rooms (typically 4-5 but with reported instances of up to 16 rooms)
FY06 Experiment Design (1 of 2)

**Independent Variables:**
- Volume of chat messages – low and high
- Presence or absence of automated task list
- Presence or absence of automated object links
- Number of windows – single or many

**Dependent Variables:**
- Response time to directed requests
- Response time to geospatial display changes
- Accuracy in response
## FY06 Experiment Design (2 of 2)

- 24 Factorial Design blocked on participants
  - Confounding one first-order interaction and two second-order interactions
  - 22 participants – Johns Hopkins University students
  - Participants separated into four groups: A, B, C, D
  - Order of sessions was random

### Task List

<table>
<thead>
<tr>
<th>Windows</th>
<th>Task List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>No</td>
</tr>
<tr>
<td>Many</td>
<td>Yes</td>
</tr>
<tr>
<td>Single</td>
<td>Low</td>
</tr>
<tr>
<td>Many</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task List</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>B</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>D</td>
<td>B</td>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Links</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Many</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

Information Technologies Group (STI)
Experimental Environment

- Severe earthquake has just occurred in undefined city
- Participant plays part of emergency controller
- Four chat rooms
  - Police
  - Fire
  - Medical
  - FEMA
- Icons on geospatial display
  - Incidents – fires, looting, gas line ruptures, etc.
  - Police
  - Fire equipment
  - Hospitals/Medical equipment
  - Shelters
Experimental Tasks

- Follow instructions provided in chat
  - Hook (locate and click on) icon in geospatial display
  - Answer simple questions with yes/no or grid location
  - Place icon at supplied grid location
- Click on changes in icons on geospatial display
  - Acknowledge appearances of new icons
  - 100+/- icons depicted on geospatial display simultaneously
Experiment Screenshots
Experiment Procedure

- Participant consent
- Participant training on configurations to be used
- Four task sessions with short opinion questionnaires in between
- Final opinion questionnaire
- Two hours total for each participant
Expected Results

Performance

- Negatively impacted by higher volume of chat
- Positively impacted by the presence of the ask/request list
- Positively impacted by the presence of the object links
- Negatively impacted by multiple windows or “rooms”

Volume will interact with the other main effects
## Results - Objective

General Linear Model Analysis of Variances  
*(significant p-values)*

<table>
<thead>
<tr>
<th></th>
<th>Acknowledge</th>
<th></th>
<th>Hook</th>
<th></th>
<th>Correct Place</th>
<th></th>
<th>Correct Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>time</td>
<td>%</td>
<td>time</td>
<td>%</td>
<td>time</td>
<td></td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task List</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object Links</td>
<td>0.010</td>
<td>0.101</td>
<td>0.072</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td>0.037</td>
<td>0.010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume x Task List</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume x Object Links</td>
<td>0.057</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume x Windows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows x Task List</td>
<td>0.077</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows x Object Links</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Values in bold indicate significant p-values.*
Results - Subjective

Preference for Single versus Multiple Chat Windows

Confusion Caused by Labeling in Single Chat Window

Ease of Response to Messages for Window Configuration

Enhancement Preferences

Experiment
Neutral
General

Single Window
Multiple Windows

Extremely Confusing
Not at all Confusing

Neutral

Object Links
Task List

Extremely Difficult
Extremely Easy
**Experiment Conclusions**

**Performance**

- Higher volume had negative impact on three of the four tasks but particularly on the chat responses
- Task list had marginal effect on performance but was well liked
- Object links also well liked and had a positive impact on hooking
- Single window positively impacted acknowledgements and was preferred for this type of environment
  - Task lists mitigate some of the attention problems when there are multiple windows but a single task list would be preferred

- When volume was high, object links positively impacted % of and time to provide accurate responses
Final Thoughts

- Single window may show more positive impact when there is more common context between the windows.
- Object Links may be more helpful if also available within the task list.
- Hyperlink from task list message to message in window may show promise in more context rich environments.
- Intend to re-test with warfighters if the opportunity arises.
Questions?
Features

CollabSpace

- 3-D Geospatial Visualization (NASA WorldWind)
- Situational Awareness (APL)
  - MIL-STD 2525B Symbology
  - DHS Emergency Response Symbology
- Geospatial Collaboration (APL)
  - Geospatial Whiteboard, Post-It Nodes, Annotations, Overlays
- Text Chat Collaboration (APL – Jabber/XMPP Protocol)
  - Presence Information
  - C2 Enhanced Chat – Single and Multi-user
- C2 Web Service Integration (APL)
- Metrics Collection Support & Logging
The Collaboration Testbed (CollabSpace) will:

- **R1**: The testbed must instrument each collaboration feature so that metrics can be collected and post experiment reconstruction can occur.
- **R2**: The testbed must provide basic geospatial situational awareness display.
- **R3**: The testbed must provide basic presence capability.
- **R4**: The testbed must provide basic single and multi-user chat capability.
- **R5**: The testbed must provide basic “whiteboarding” capability on the geodisplay.
- **R6**: The testbed must provide data import and export capability from other C2 systems.
- **R7**: The testbed must be extensible.
- **R8**: Investigate secure wireless technology and alternative form factors.
NCES/SOA Based Architecture

Control Systems Integration Group (GVI)

CollabSpace Client

NASA World Wind
3D Geo-Display

CollabSpace Plugin

C2 Web Service
Jabber/XMPP Library

Imagery/Map Server

Jabber/XMPP Server

CollabSpace Clients

NASA World Wind
3D Geo-Display

CollabSpace Plugin

C2 Web Service
Jabber/XMPP Library

C2 Web Services

Object and layer creation events

Maps and Imagery

User Interface and Display Events

Imagery/Map Server

Presence Information, Collaboration Messages and Data

C2 Data (Tracks, Overlays)

APL Developed Software

3rd Party Libraries

NASA World Wind