Physical Mockups

Redefining the “Collaborative Work Environment” and Improving Human Systems Integration (HSI)

Jessica Vomocil

Human Systems Integration Engineer
L-3 Communications– Maritime Systems
Collaborative Work Environment (CWE)

Collaborative Work Environment: concept derived from virtual workspaces which enable professionals to work together regardless of their geographical location.

Elements include:
- E-mail and Instant messaging
- Application sharing
- Video conferencing
- Document management and version control system

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CWEs offer numerous advantages in collaboration and design but how does it impact integration, and in particular HSI?
Integration Team

- End user communicates needs to government
- Government provides requirements/CONOPS to address user needs
- Contractor and Engineering Teams create design to meet the requirements
- Requirements become constraints for design
- CWE limited capability to involve end users and limited reach back to stakeholders

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Limitations of CWEs

- Need for experienced users
- Data exchange, import and export
- Limited licensing (IT overhead)
- Requires consistent tool set, units of measure
- End User Involvement
- Processing power—Difficult to edit in real time
- Limited interactions between geographically distributed personnel
  - “Stovepipes”
End User Involvement

“We do not see things as they are; we see things as \textit{we} are.”

– Anais Nin, Author

Engineers/ Designers ≠ Users/ Operators

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Physical mockup on the Ship to Shore Connector (SSC) project provided a collaborative environment

- Made easy to solicit additional operator input
- Identify solutions early in design

Considerations:
- Initial cost
- Available space
- Overhead costs for operations and maintenance
- Size and nature of the project
- Travel costs for team members to take advantage of mockup
- Future long term training utilization
L-3 Maritime Systems

- Integrator of naval and marine electrical and electronic systems
  - Machinery and damage control
  - Integrated bridge and navigation systems
  - Electronic propulsion systems

- Three facilities
  - New Orleans, LA
  - Leesburg, VA
  - Ayer, MA

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Replacement for the Landing Craft Air Cushion (LCAC)

Deployed as part of the Amphibious Fleet

Transport weapon systems, equipment, cargo and personnel

- High speed
- High Payload
- Day or night ops
Ship-to-Shore-Connector HSI Improvements

**LCAC Challenges**
- Maintenance hours too large
- Training and attrition rates

**SSC Improvements**
- Improved maintenance concept
  - Targets top 25 high drivers
- Change from 3-person to a 2-person “flight crew”
  - Automation of labor intensive tasks
  - Redundant pilot/co-pilot controls
  - Updated crew member tasking

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Preliminary Design completed by US Navy prior to contract solicitation

Contract awarded to Textron Systems Marine & Land Systems (TS M&LS)

L-3 Communications Maritime Systems responsible for Command, Control, Communications, Computers, and Navigations (C4N) System

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Ship-to-Shore Connector

Original Concept for SSC Two Person Flight Crew

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Full-scale mockup of starboard side cabin (Command Module)

Used throughout program life cycle

Preliminary Design Phase: foam core for initial fit and HMI

Detailed Design Phase: foam core and prototype of HMI (controllers and input devices)
System Integration Lab (SIL)

- Conduct integration testing of C4N hardware/software after detailed design
  - Outfitted with flight hardware
  - SIM/STIM capabilities

- Mitigate high risk SW development items
  - Flight controller

- Verify anthropometric human factors requirements
Early identification of structural interferences in 3-D craft model

HSI issues identified in SIL
- Different concerns identified by engineer vice operator

August 2013 USN launched a design study to address issues

Concentrated engineering design effort
- Focus on five key design elements
- Constraints set by customer
Design Study Outcomes

- Improved seat placement for safety of flight
- Console redesign/improvements from workstation to “Cockpit”
- Upgraded hardware selection
  - User displays
  - User input devices
- Optimize panel location and equipment placement
- Task allocation between crew members
  - Maintained redundancy of critical functions
- Brought together the “stove pipes” and facilitated early integration

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Physical Mockup Overcomes Limitations

- Inherently overcomes many limitations of virtual CWE
  - Independent of user skills
  - No IT overhead
  - No need for data import/export
  - Consistent tools and units
- Improved End User Involvement
- Role of “facilitator”
- Reach back to decision makers
- Real time editing and prototyping

More effective “CWE” led to early identification of integration challenges and improved HSI
Improved End User Involvement

- Identified need to adjust lateral seat placement
  - Operational requirements

- User input drove the initial re-design concepts
  - Safety of flight

- Continued involvement as re-design progressed
  - Task Analysis to support equipment placement
  - Operational scenario to verify design decisions
Role of Facilitator

- Daily planning meeting
  - Review of previous days activities
  - Goals established for day
  - Group organized into smaller working groups with tasks assigned

- Keep group focused on design issues, priorities

- Document and record progress
  - Proposed solution
  - Decision drivers
  - System/operational impact
  - Look ahead/actions

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### Design Collaborations

<table>
<thead>
<tr>
<th>Design</th>
<th>Description</th>
<th>Profile, Top View</th>
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<tbody>
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<td>Flat Panel</td>
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<tr>
<td>2</td>
<td>Angle Outboard Monitors</td>
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<tr>
<td>3</td>
<td>Angle Inboard Monitors</td>
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<tr>
<td>4</td>
<td>Angle Inboard Monitors Plus Shift Outboard</td>
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</tr>
<tr>
<td>5</td>
<td>Duplicate Cockpit</td>
<td><img src="image" alt="Duplicate Cockpit Profile" /></td>
</tr>
<tr>
<td>6</td>
<td>Angle Both Monitors</td>
<td><img src="image" alt="Angle Both Monitors Profile" /></td>
</tr>
</tbody>
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- Brainstormed multiple console configurations
- Trade-off between HSI requirements and guides and other impacts in priority matrix
  - Viewing angles
  - Viewing distances
  - Ease of manufacturing
  - Anthropometric reach
  - Optimized ability to mount additional equipment

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Real Time Editing and Prototyping

- Task Analysis conducted to determine panel and equipment placement
  - Redundant or Singular
- Foam core in SIL with movable components
- Mockup gave general idea and path forward first
- 3-D Model developed to analyze precise values
  - CAD personnel in the SIL
Mockup Use After Design Study

- Early integration of IPTs
  - HVAC
  - Lighting
  - Structure
  - Safety

- Unscheduled use during working group meetings with customer

- Support Test and Evaluation
SIL has also caught the attention of many key stakeholders and helped gain confidence in the program:
- HSI Tech Warrant Holder
- NAVSEA/PEO SHIPS/ PMS 377
- Active Fleet/Users (ACU4 LCAC Craft–Masters)

If a picture is worth 1000 words, how many is a mockup worth?
Jun 2014 hosted LCAC craftmasters in SIL
- Experience ranged from 1 year to 20+ years
- Background in all other LCAC crew positions

Each craftmaster able to climb up and “drive”
- Testing Software component of C4N
- Solicited feedback on design
- Operators gained trust and confidence in the design
Potential Improvements to Mockup: Lessons Learned

- “Think outside of the box”… literally
  - What other components or effects outside of the system might impact our design later?
  - Identify optimal placement of the mockup based on relative placement of the system or component in relation to other

- Measure twice, write it down three times. Document everything.

- Access to actual craft outfittings/equipment as soon as possible
  - Populate with as many items as possible
    - Engineering models of equipment
    - Window fittings, HVAC, overhead lighting
  - Mitigates surprises such as access and interference
Conclusion

- Physical mockup on SSC project overcame limitations of typical CWE
  - Enabled collaboration of all invested parties
  - Optimized use of current technologies and tools
  - Use of Mockup forced early communication and integration
  - Improved HSI by providing design space for collaboration

- SIL will transition from mockup to simulation environment
  - Central to SSC CWE in future
Questions?