Physical Mockups

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

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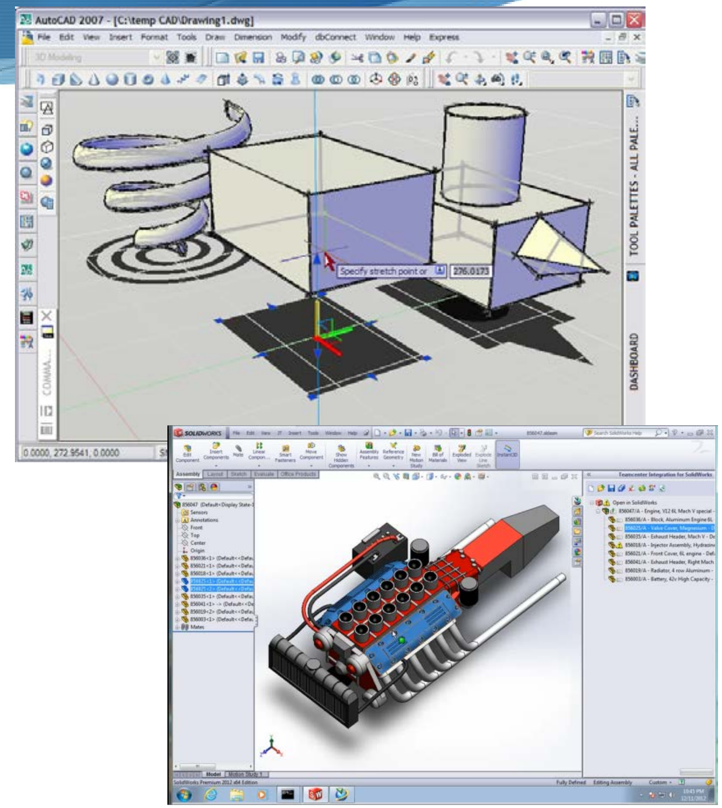
Collaborative Work Environment (CWE)

- **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

Engineering Design: Then and Now

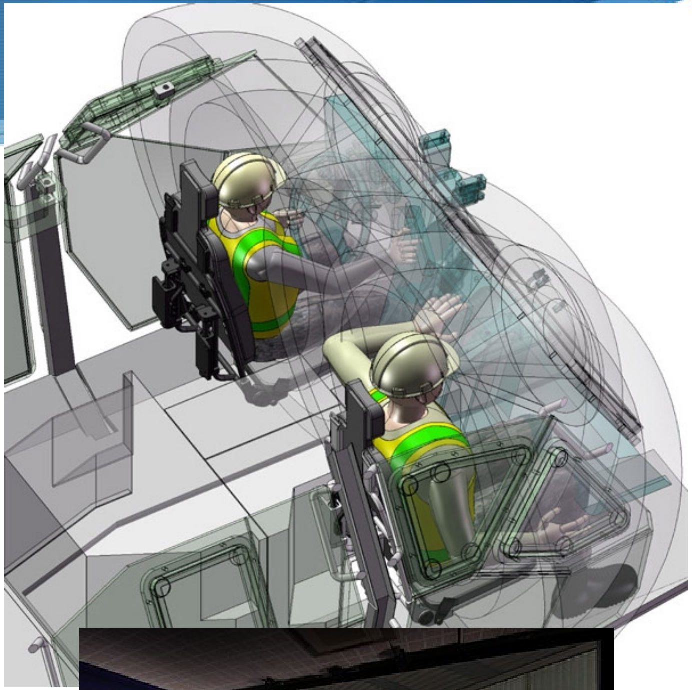


CWEs offer numerous advantages in collaboration and design but how does it impact **integration**, and in particular **HSI**?

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 stake holders

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 ***we*** *are."*

– Anais Nin, Author

Engineers/ Designers ≠ Users/ Operators

Physical Mockup Case Study

- 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

Ship-to-Shore-Connector (SSC) Overview

- 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

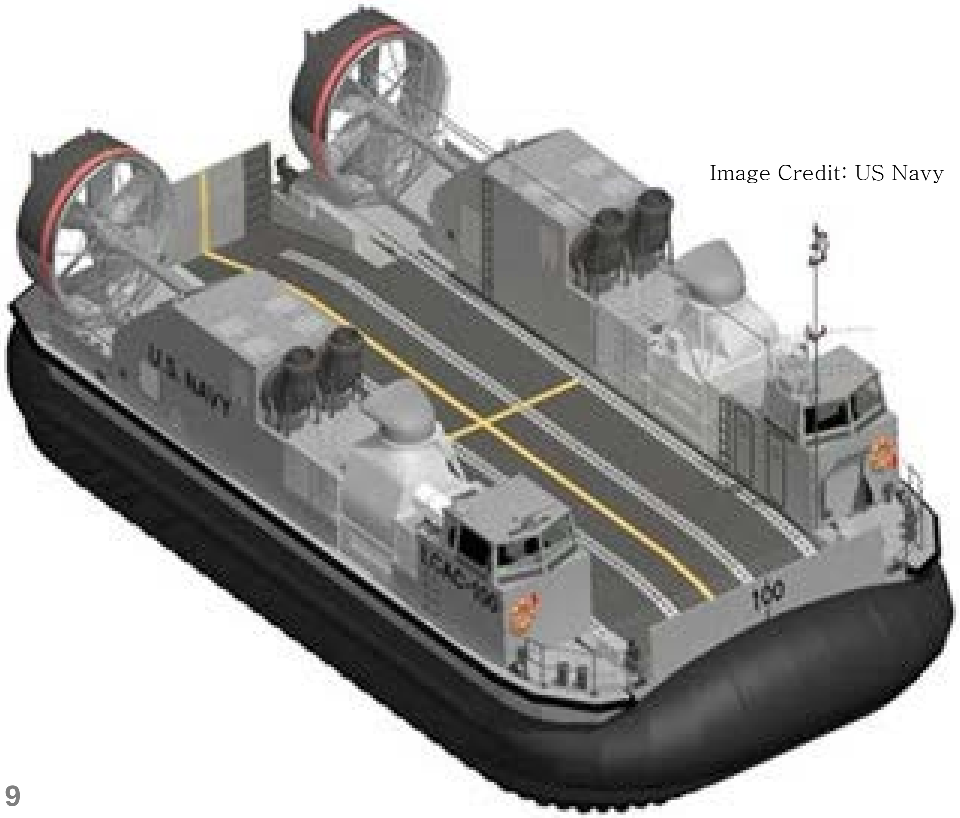


Image Credit: US Navy

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

SSC Integration Team

- 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

Ship-to-Shore Connector

Image Credit: TM&LS

Original Concept for SSC Two Person Flight Crew

System Integration Lab (SIL)

- 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

SIL Used as "CWE"

Field of View– Front Window

Visual Access to Controls

Ladder Well

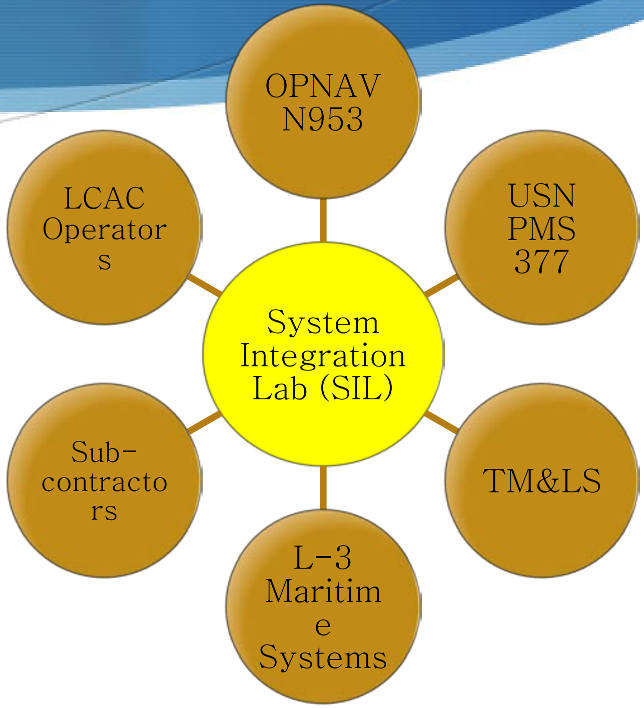
- Early identification of structural interferences in 3-D craft model
- HSI issues identified in SIL
  - Different concerns identified by engineer vice operator
- August 2013 USN launched a design study to address issues
- Concentrated engineering design effort
  - Focus on five key design elements
  - 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

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

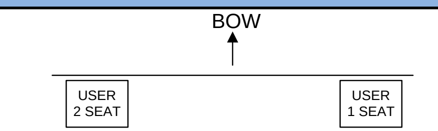
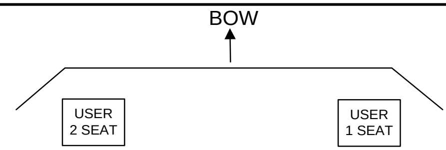
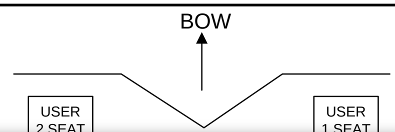
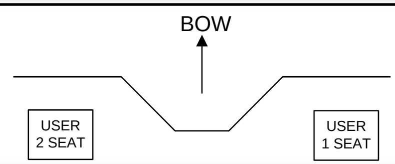
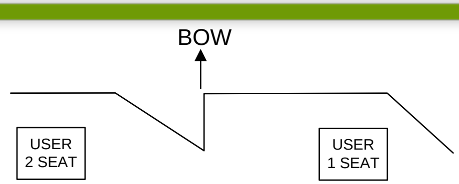
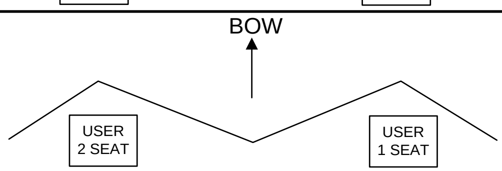
Improved End User Involvement

- 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

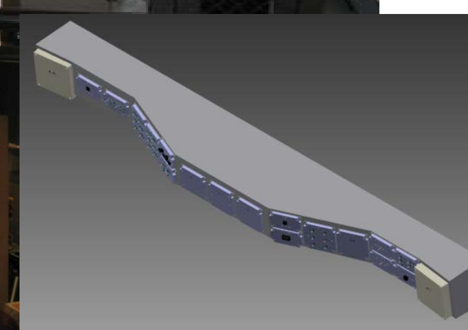
Design Collaborations

Design	Description	Profile, Top View
1	Flat Panel	
2	Angle Outboard Monitors	
3	Angle Inboard Monitors	
4	Angle Inboard Monitors Plus Shift Outboard	
5	Duplicate Cockpit	
6	Angle Both Monitors	

- 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

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

Reach Back to Stake Holders

- SIL has also caught the attention of many key stake holders 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?

Operator Input

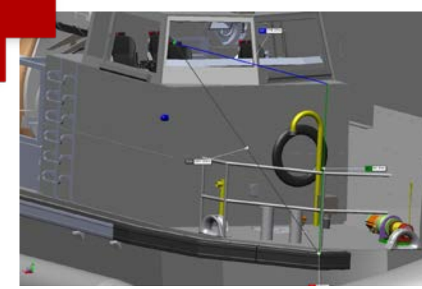
- Jun 2014 hosted LCAC craftmasters in SIL
  - Experience ranged from 1 year to 20+ years
  - Background in all other LCAC crew positions
- Each craftmaster able to climb up and "drive"
  - Testing Software component of C4N
  - Solicited feedback on design
  - Operators gained trust and confidence in the design

Potential Improvements to Mockup: Lessons Learned

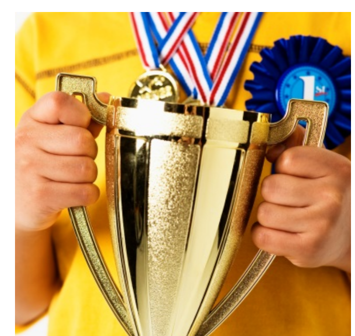
- "Think outside of the box"… literally
  - What other components or effects outside of the system might impact our design later?
  - Identify optimal placement of the mockup based on relative placement of the system or component in relation to other
- Measure twice, write it down three times. Document 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?