SPAWAR
Systems Center
San Diego

# Integrating Usability Engineering in the Iterative Design Process of the Land Attack Combat System (LACS) Human Computer Interface (HCI)

Presented by:

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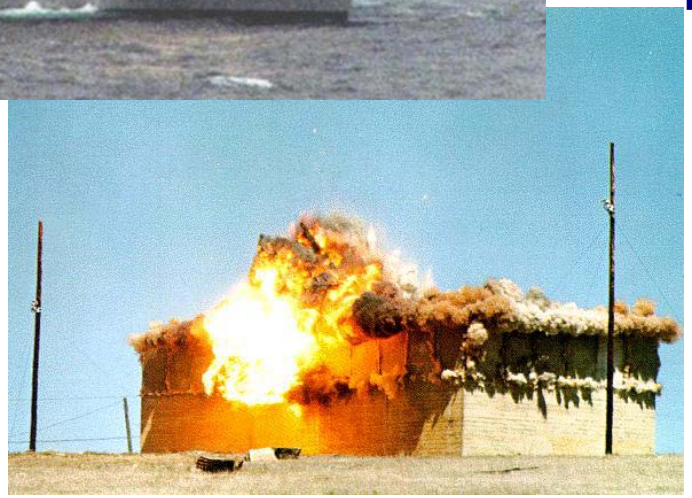
# Overview of LACS



- Study funded by two Future Naval Capability of the Office of Naval Research
- ATTD Transition Candidate for Tactical Tomahawk Weapon Control System (TTWCS) version 6 & 7
- SSC-SD leading work of the HCI development

# LACS FNCs Team

- Government Labs
  - SPAWAR Systems Center - San Diego, CA
  - NAVSEA - Dahlgren, VA
  - NAVAIR - Orlando, FL
  - Naval Submarine & Medical Research Lab, Groton, CT
- Industry & Federally Funded Labs
  - Johns Hopkins Applied Physics Laboratory, MD
  - Pacific Science & Engineering Group Inc., CA
  - Southeastern Computing Consultants Inc., VA
  - Lockheed Martin Advanced Technology Labs, NJ
  - Lockheed Martin Mission Data Systems, PA
- Universities
  - University of Virginia
  - University of Michigan

UCD Team

SPAWAR Systems Center San Diego

NAVSEA DAHLGREN

NAVAIR ORLANDO TRAINING SYSTEMS DIVISION

NSMRL NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

THE JOHNS HOPKINS UNIVERSITY APL

PSE Pacific Science & Engineering

SCCI SOUTHEASTERN COMPUTER CONSULTANTS INC

LOCKHEED MARTIN ATL

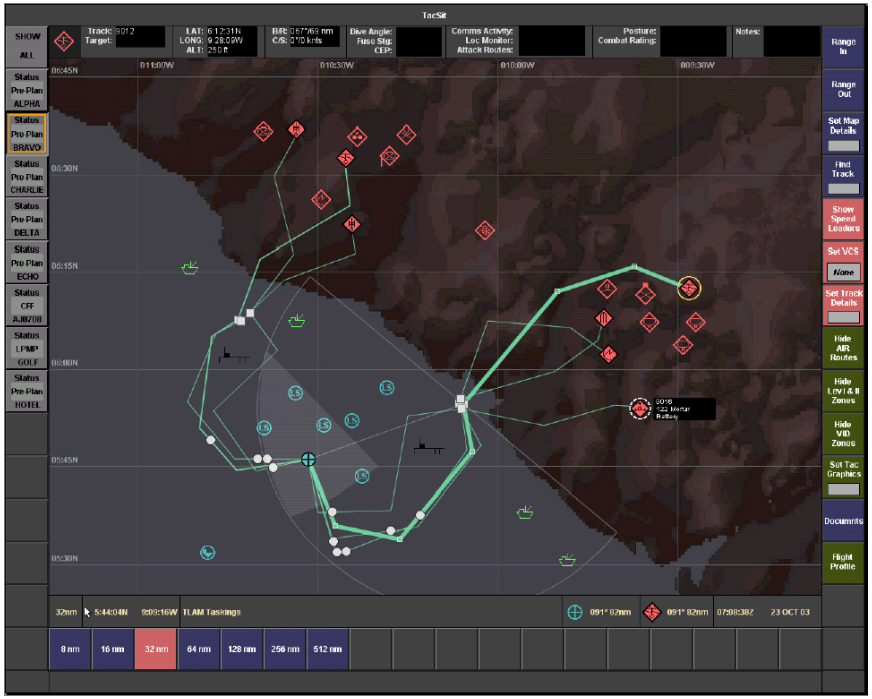
Advanced Technology Laboratories


UVa

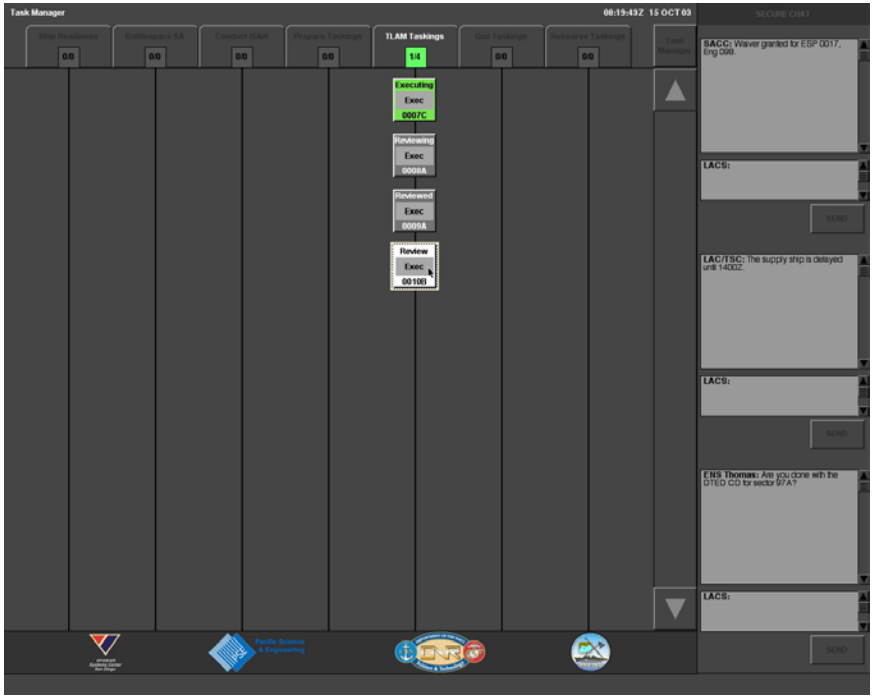
THE UNIVERSITY OF MICHIGAN 1817

TTWCS TACTICAL TOMAHAWK WEAPONS CONTROL SYSTEM

# LACS HCI




TacSit




Task Manager

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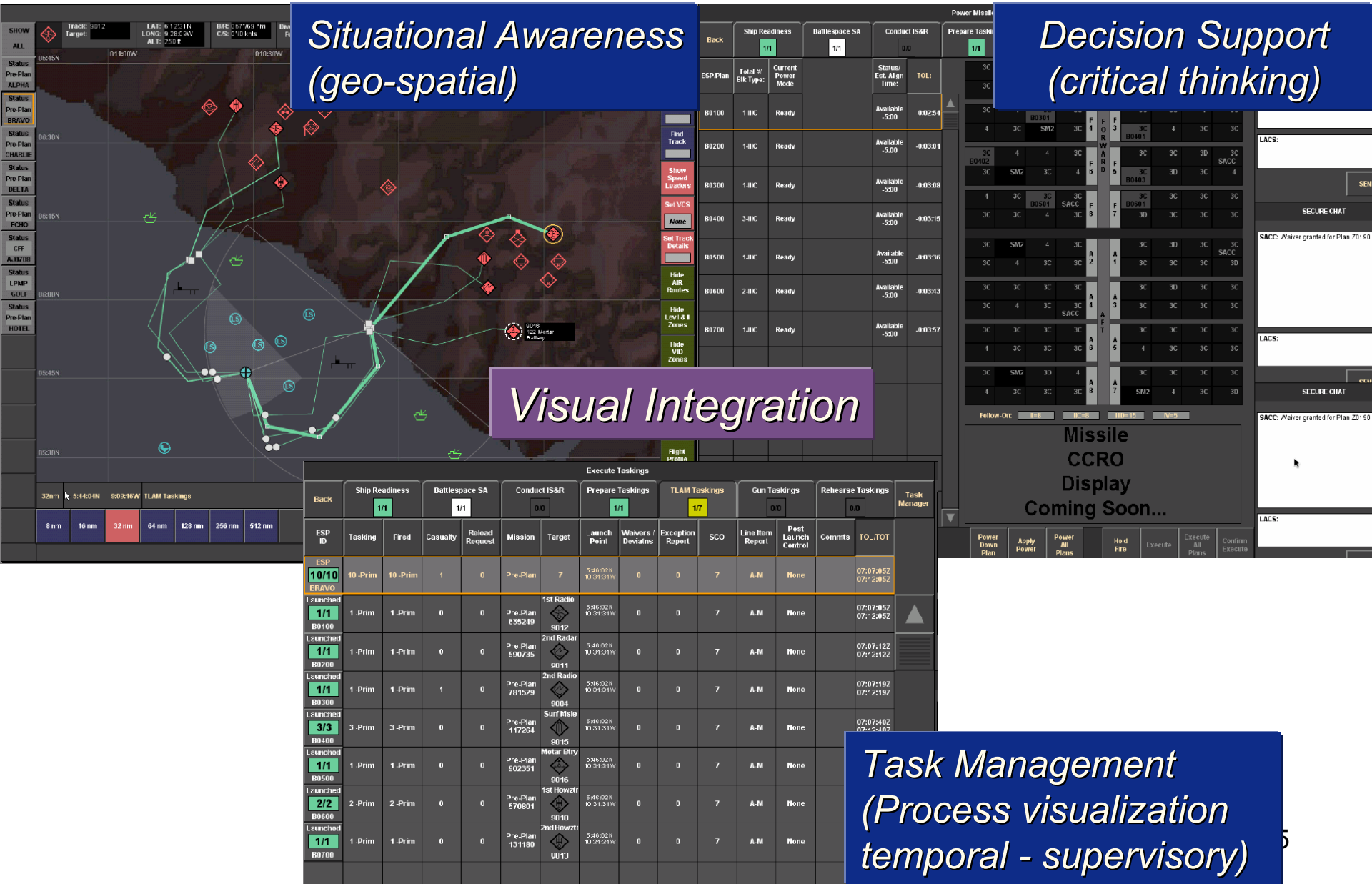
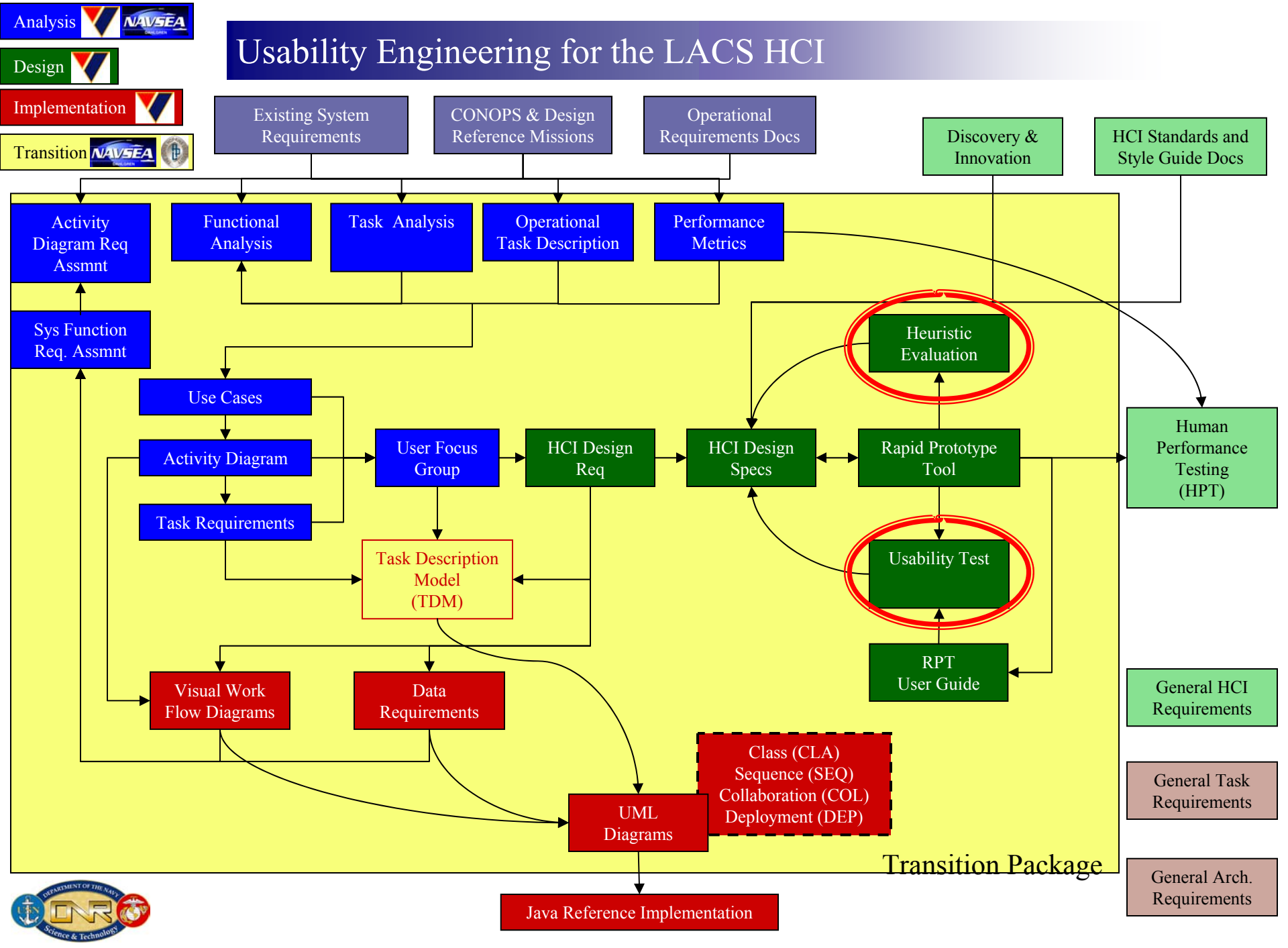
# Usability Engineering for the LACS HCI



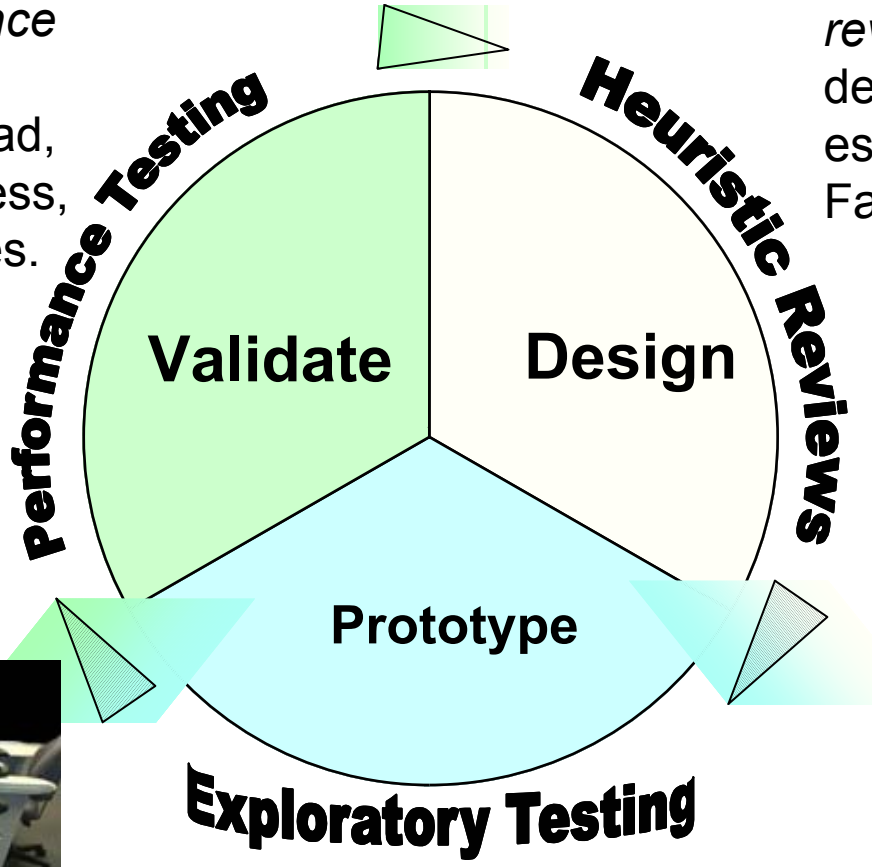
# Usability Engineering for the LACS HCI



# Usability Evaluation Within Spiral Development

Conduct *performance testing* to measure throughput, workload, situational awareness, and team processes.

Conduct *heuristic reviews* to ensure designs follow established Human Factors principles.

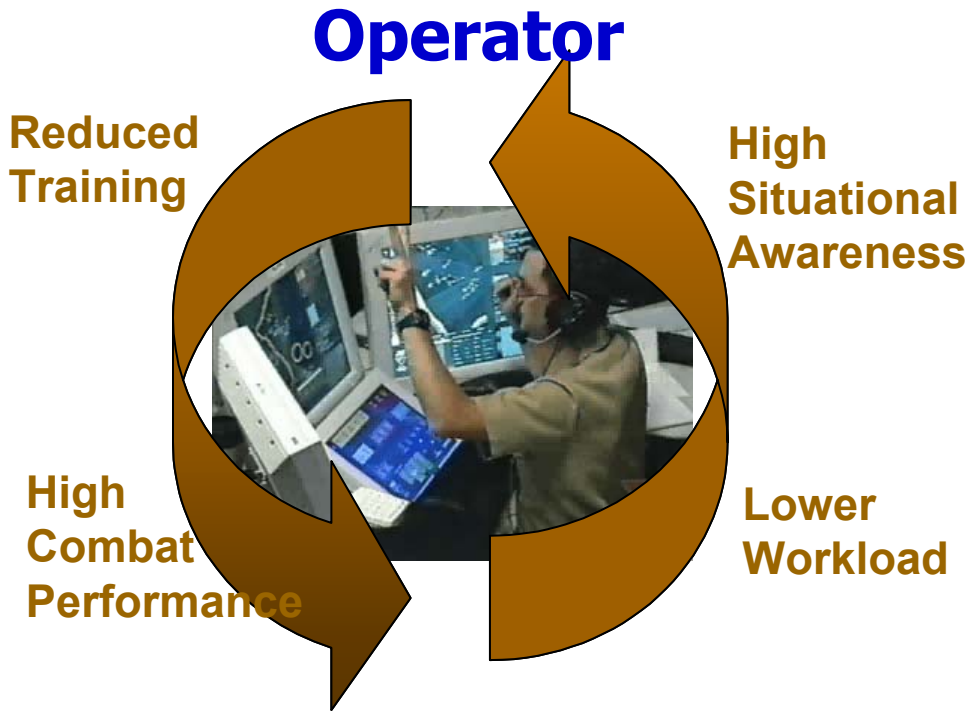



Conduct *exploratory testing* to iterate on initial designs and evaluate alternative design concepts.

# Usability Evaluation Objectives

**OPNAV Guidance**

**". . . our ability to effectively and successfully employ Land Attack Warfare systems will directly reflect our commitment to Human Centered Design, Human Systems Integration and Optimal Manning . . ."**




➔ Increase the combat effectiveness of Fleet Land Attack operators without increasing their workload, providing high situational awareness while reducing training time.

# Why is Usability Important?

- Systems need to be "user-friendly" to increase:
  - User efficiency
  - Productivity and Timeliness
  - Situational Awareness
  - User trust
- Workload reduction
- Training reduction
- Can determine success or failure of a system

***Fleet Buy-in!***

# Quarterly Usability Evaluations

- Focus of User Taskings Per Quarter
  - Q1 – Call For Fire (CFF), Mission Data Update (MDU), and a prepare pooled missiles task
  - Q2 – In-Flight Missile Health and Status monitoring screen
  - Q3 – Post Launch Monitor Phase
  - Q4 – Year-end Operability Test
- HCI constantly evaluated every quarter
- Improvements are made and re-tested the following quarter
- Validate design changes

# Usability Evaluation Methodology

- Heuristic Evaluation (HE)
  - HSI engineers individually evaluate the RPT against a set of usability criteria (called heuristics).
- Usability Testing (UT)
  - An inspection method of usability evaluations. Includes formal testing with fleet participants.

# Types of Usability Studies

**1.Exploratory**
Explore concept of design & "user's mental model"

Paper prototype, Power Point, or Simulated system

**2.Assessment**
How well can user perform full-blown realistic task

Simulated system

**3.Validation**
Verification of product's usability, compares to established benchmark

Simulated or Real system

**4. Comparison**
Compare to alternative design

Paper, Power Point, Simulated or Real System


Rubin, 1994, Handbook of Usability Testing

# Heuristic Evaluation Process

- Compare the LACS interface to established usability criteria ("heuristics")
- Conducted by HSI Engineers from SSC-SD, NSWCDD, and NAVAIR Orlando independent evaluated the LACS interface
- Report with prioritized usability issues
- Over 200 improvement recommendations
  - Many implemented and others require additional research

# Heuristics

1. **Visibility of system status**
2. **Match between system and the real world**
3. **User control and freedom**
4. **Consistency and standards**
5. **Error prevention**
6. **Recognition rather than recall**
7. **Flexibility and efficiency of use**
8. **Aesthetic and minimalist design**
9. **Help users recognize, diagnose, and recover from errors**
10. **Help and documentation**

Nielsen, J. (1994). Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), Usability Inspection Methods. John Wiley & Sons, New York, NY.

# Usability Testing Process

- Participants are real users
  - Total of 46 fleet participants individually tested. Include participants from FCTCPAC, FCTCLANT, USS Stethem DDG-63, USS Winston Churchill DDG-81, COMSECFLT
- Used real operational scenarios
  - Only 15 minutes spent explaining the scenario and minimum training on layout, symbology and color-coding
- Observed and recorded participants actions and comments
- Conducted low-fidelity usability tests using paper prototypes to explore design concepts and understand user needs
- Conducted high-fidelity usability tests using working prototypes to assess how well the sailors performed realistic tasks and to verify interface usability

# Video of Usability Tests

# Usability Evaluation Findings

- 9 heuristic evaluation reports
  - Tables summarized issue, location, heuristic violated, recommendation, and priority
- 6 usability testing reports
  - Tables included summary of design recommendations, and relevant operator comments

| Table 1. Post Launch Monitor Interface Design Recommendations | | |
|---|---|---|
| **Rec #** | **Design Recommendation** | **Comment # Referenced** |
| **Missile Timelines** | | |
| 1 | Recommend implementing a click and drag capability on the timebars (like the hand in Acrobat with pdf files). | A1:9 |
| 2 | Recommend duplicating the minute header at the bottom of the screen. It is tough to lineup timelines that are farther down on the page with the timescale at the top. | A1:9 |
| 3 | Recommend that the missile timeline still show flex options even though they have been passed and were not selected. Maybe gray it out and put a black "X" through it to denote that this flex was missed or not selected. | A1:10 |
| 4 | Recommend that the new timeline/aimpoint not appear on the timeline until the transmission has finished processing or . . .<br>**Alternate Recommendation:** For any option of redirecting an in-flight missile, instead of updating the original timeline after processing a request, have a new branch split off below the original timeline. This will help show the exact point in which the missile redirects and, most importantly, it will allow for quick and easy comparison of the new branch and the original branch. | A1:10 |
| 5 | Make the symbology clearer so the operator can more easily determine when the last possible second is to make a retargeting or flex decision. Is it the beginning of the tangent line? | A1:10 |

# Usability Testing Results

- Over 300 recommendations for new design ideas and improvements
- Implemented design changes were rolled into future builds for validation testing

# Usability Testing Results

1. Indicated interface effectively supports user taskings
   - Provided needed information to complete their taskings
   - Many operators launched missiles on time
   - One operator can accomplish same taskings than that of a team of Tomahawk operators
2. Met operators' approval

"I like this, this is sweet."

"Still impressed. Impressed every time we come out here."

"Like the displays, the layouts, the colors."

"A lot of data, but it's not too much, especially if there's only 1 operator. Everything is covered. Looks good to me."

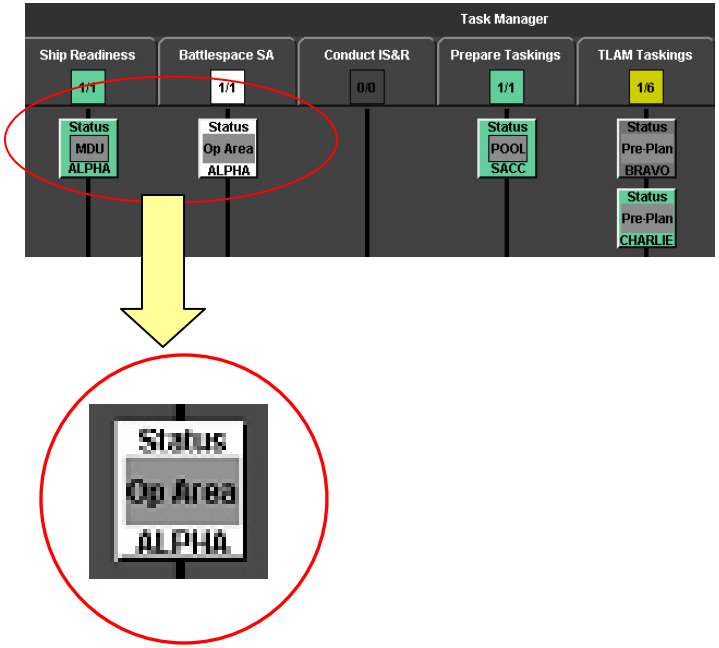
3. Raised additional research questions

# HCI Improvements

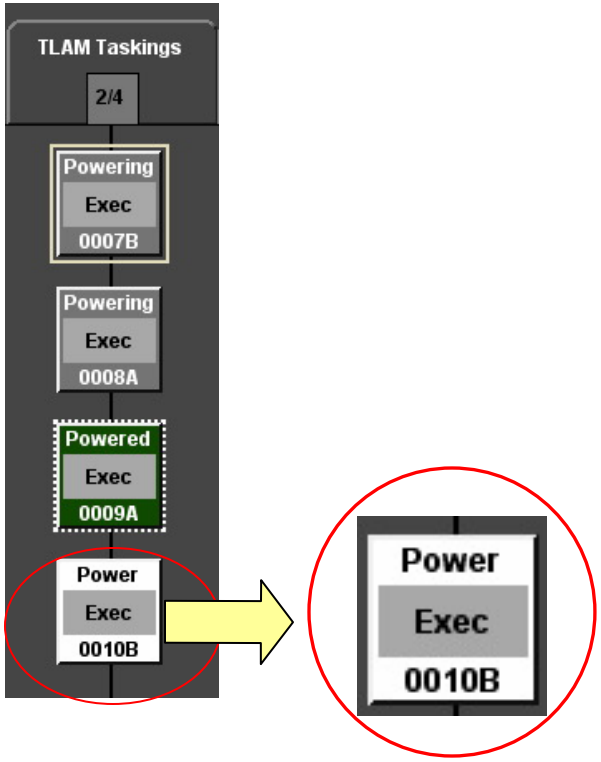
- Better understanding of operator's mental model, fleet CONOPS, and tasks
- Improved color coding scheme
- Provided better feedback as to what LACS is completing and what taskings operator needs to accomplish
- Provided needed information and better organization of information to support operator tasking
- Improved phraseology
- Improved navigation and less searching
  - Provided needed information at a higher level and detailed information in a lower level
  - Decreased number of drill down interfaces
- Provide improved attention management

# Example of Improvements

1. Improved color-coding




2. Provided better feedback as to what LACS is completing and what taskings operator needs to accomplish



# Example of Improvements

Provided needed information and better organization of information to support operator tasking

Thank you for your time

Any Questions?