HCI Design Patterns for C2

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DoD Requirement

• Command & Control (C2)
  – Planning, coordinating, executing, monitoring, replanning

• Network-Centric Operations
  – Increased information access for C2
  – Can increase effectiveness & efficiency
    But introduces new cognitive demands
  – Human Computer Interface (HCI)
    critical element of system
Two Interaction Domains in HCI Design

Work / Mission Domain

The Operator **Accomplishes Mission-Relevant Goals within the Work Domain**
- Human-Work Interoperability

Information Technology Domain

The Operator **Acts** within the **IT Domain**
- Human-IT Interoperability

**Existing HCI Guidelines**
- MIL-STD-1472E
- MIL-STD-1801
- ISO 9241

**Work-Centered HCI Guidelines**
What Do We Mean by Work and Work-Centered?

- **Purposeful activity performed in a context**

- Activity performed by organic (human) and inorganic (technology) entities to achieve organizational objectives

- Individuals, groups, organization

- Human work benefiting by Information Technology (IT)
  - Building & Maintaining Situation Awareness
  - Team Coordination & Collaboration
  - Decision Making
  - Problem Identification & Resolving
  - Work (Load) Management
  - Product Development

- Effective IT mechanisms for aiding human work
  - Visualizations reflecting operator’s mental models of own work
  - Automated data retrieval, fusion, and alerting
Halloween Costume Solutions

Off-the-Shelf    Custom Design    Design Pattern
Three Paths to Work-Centered HCI

Off-The-Shelf
- Modern approach
- Low-Cost
- Low Risk (short term)
- Clumsy Fit to Work

Custom Design
- Reflects Cognitive Systems Engineering
- Very Expensive
- Higher-Risk
- “Perfect Fit” to Work

Design Pattern
- Practical HCI design
- Lower Expense than Custom
- Lower Risk than Custom
- Tailored Fit to Work

Augmented MS Excel

Original HCI

Design Pattern
- Summary
- Mission A
- Mission B
- Time To Deadline
- Alert
Case Study: HCI Design Pattern Return On Investment


- ASW Human-Computer Interface developed using cognitive systems engineering methodology
- HCI Solution is “patternized” and reapplied in EW domain

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<thead>
<tr>
<th></th>
<th>ASW</th>
<th>EW</th>
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<tbody>
<tr>
<td><strong>Time to design:</strong></td>
<td>72 month</td>
<td>6 months</td>
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<tr>
<td><strong>E6-E9 SMEs involved</strong></td>
<td>44</td>
<td>1</td>
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<tr>
<td><strong>Payroll costs to Navy</strong></td>
<td>75 man-days</td>
<td>0 man-days</td>
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<tr>
<td><strong>HCI man-years</strong></td>
<td>11.0</td>
<td>0.5</td>
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<tr>
<td><strong>Cost to Program Office</strong></td>
<td>&gt;$2,000K</td>
<td>$70K</td>
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• Design Patterns
  – Physical architecture (Alexander, 1977)
  – Software coding (“Gang of Four”, 1994)

• HCI Design Patterns
  – “…a structured textual or graphical description of a proven solution to a recurring design problem” (Borchers, 2001)
  – Several online pattern libraries www.welie.com
  – Framed around common interactions with a general class of IT
  – Applicable work domains are infinite
Two Varieties of HCI Design Patterns

The Operator Accomplishes Mission-Relevant Goals within the Work Domain
- Human-Work Interoperability

“Work-Centered Design Patterns”

The Operator Acts within the IT Domain
- Human-IT Interoperability

“IT-Centered Design Patterns”

Need Set for C2

Existing HCI DP
Scientific Objective
Identify HCI Design Patterns for C2

Hypothesis: Similar environments benefit from similar HCIs

Similar
≈
Work

Tailored
 HCI
Reusable

Question: Where do we get the HCI design patterns to reuse?
Hypothesis: Existing “Work-Centered” HCI can be reverse-engineered to uncover HCI Design Patterns

Functional HCI Design

1. **HCI Design Pattern Hierarchies**
   - a. Work-Centered DP
   - b. IT-Centered DP

2. **HCI Design Pattern Applications**
   - a. Work Field Representation DP
   - b. Automation DP
   - c. Interaction DP

*Question: What will we do with the HCI design patterns?*
Vision: Tools for Software Developers

- HCI Builder within an Integrated Development Environment
  - HCI Design Patterns embedded in software modules for IDE
  - Software developer navigates C2 work function taxonomy
  - Reviews potential, relevant HCI Design Patterns per work functions
  - Selects, assembles, & populate HCI DP for specific project
  - Output: Notional HCI Design, Skeletal HCI Specification
Vision: Design Reference Library to Improve Joint Operations & Training

• DOD Design Reference Library based on HCI Design Patterns
  “Flexible standardization” of HCI in C2 across armed services
  “Human-Human Interoperability” across armed services
  Facilitates C2 operator training

One Example: Joint AF-Navy Strike Operation

Net-Centric Architectures

Navy Operator

Air Force Operator
When Designers are faced with new problems…

Patterns fill a significant gap in the design process…

HCI Guidelines = too generic…
only GUI look & feel

Completed HCI = too complex,
difficult to abstract
back into new task domains…

HCI Pattern = Usable for multiple task and
mission domains

Mission context application

Tomahawk
Guns
Damage Control
Patterns fill a significant gap in the design process...

HCI Pattern = Usable for multiple task and mission domains

**Step-based Task Navigation Pattern**

Mission context application

- **Tomahawk**
- **Guns**
- **Damage Control**
HCI Design Patterns for C2 Recap & Examples

The Operator Accomplishes Mission-Relevant Goals within the Work Domain
• Human-Work Interoperability

“Work-Centered Design Patterns”

Need Set for C2

The Operator Acts within the IT Domain
• Human-IT Interoperability

“IT-Centered Design Patterns”

Existing HCI DP
Tomahawk Launch Sequence Task Navigator

1. Initiation (triggering)

2. Orientation

3. Review

4. Decision & Action

5. Confirmation

Sequential Task Navigation Pattern

AF Mission Monitoring Tool

Timeline Pattern

Time-Line Display for In-flight Missile Management

Sequence Display for Aircraft Maintenance Check
Tomahawk Launch Sequence
Task Navigator

1. Initiation (triggering)
2. Orientation
3. Review
4. Decision & Action
5. Confirmation
6. Transition

AF Mission Monitoring Tool

Detailed Examples in Conference Paper
Questions?

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