Designing and Validating Displays & Controls

D&C design, development, test and evaluation is based on knowledge of goals, task and information requirements, system constraints, capabilities and limitations of the target user populations...

How to situate this in the context of commercial space systems is under discussion.

One example: Suppose NASA does V&V of commercial space concepts using a combination of model-based analysis and empirical testing
DDT&E Integrated Strategy

Model-Based Approaches

Results of model-based analysis can drive more targeted empirical studies

Improved models (e.g., increase fidelity or comprehensiveness)

Empirical HITL Studies

Example: Browser usability for novices

- Step 1: Small exploratory novice user study with think-aloud verbal protocols
- Step 2: Generate design alternatives
- Step 3: Predict expert performance with CORE cognitive model for all three alternatives
- Step 4: Empirical validation of model
- Step 5: Refinement and analysis
- Step 6: Final user studies with both experts and novices

Some Models Focus on Specific Genres of Tasks or Processes

- Signal detection theory
- Fitts Law
- Hick-Hyman Law
- **Spatial Standard Observer**

Assuming you can map the problem of interest into that framework

Spatial Standard Observer: predicting visibility

- Simple engineering tool to measure target visibility
- Replaces human observer in systems engineering
- Based on science model
- [http://vision.arc.nasa.gov/sso/](http://vision.arc.nasa.gov/sso/)
- US Patent #7,783,130 B2 (8/24/10)
- Users include FAA, ARL, industry


predictions of visibility range as a function of aircraft contrast for various craft.

Other Models are “architectural”

MIDAS - task network architecture

CORE - cognitive architecture
**MIDAS Flight Deck Application Model**

**Microsaint Environment Traffic Model**
- Simulated aircraft movement in air/on ground
- Sends position data to MIDAS model

**MIDAS Task Network and Behavioral Model**
- Crew procedures
- Visual attention
- Perception
- Memory
- Task workload primitives
- Workload by phase of flight
- Workload / SA timelines

**Crewstation and Anthropometric Model**
- Boeing 777 cockpit
- Anthropometric representation of Captain, First Officer, ATC

---

**CORE: Constraint-Based Optimal Reasoning Engine.** Predicts time and speed/accuracy trades

NASA Ames Human-Computer Interaction Group
http://hci.arc.nasa.gov/pages/2004/10/corexprt_1.html
Distinctions in Modeling

- Level of Detail
  - Conceptual - Computational - Mathematical
- Level of Task Specificity
  - Task-Independent - Task-Dependent - Device-Dependent
- Discipline Focus
  - e.g., Physiological, visual, cognitive, motor, social...

A spectrum of Human Health and Performance

<table>
<thead>
<tr>
<th>Survivability (Biomedical Perspective)</th>
<th>Mission Success: Task Performance (HSI/HF Perspective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone</td>
<td>Anthropometry</td>
</tr>
<tr>
<td>Muscle</td>
<td>Biomechanics</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>Visual perception</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Auditory perception</td>
</tr>
<tr>
<td>Radiation</td>
<td>Tactile perception</td>
</tr>
<tr>
<td>Immunology</td>
<td>Attention, Memory</td>
</tr>
<tr>
<td>Neurovestibular</td>
<td>Decision making</td>
</tr>
<tr>
<td>Spatial disorientation</td>
<td>Motor control</td>
</tr>
<tr>
<td>Space motion sickness</td>
<td>Communication</td>
</tr>
<tr>
<td>Space Adaptation Syndrome</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
</tr>
<tr>
<td>Behavioral health</td>
<td></td>
</tr>
</tbody>
</table>

Human Processes

- Life support
- Environmental monitoring and control
- Dust containment

- Habitability
- Ergonomics
- Comfort
- Reachability
- Waste systems
- Food systems
- Stowage

System design

- Performance Readiness
- Fitness for Duty
- Situation awareness
- Workload
- Planning
- Response execution

- Legibility
- Intelligibility
- Usability
- Maintainability
- Human-automation interaction
- Advanced multimodal interfaces