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

Empirical HITL Studies

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

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

![Algorithm Overview](image)


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

Task Analysis:
10K’ to Gate (500+ tasks)

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

- Life support
- Environmental monitoring and control
- Dust containment
- Habitability
- Ergonomics
- Comfort
- Reachability
- Waste systems
- Food systems
- Stowage
- Legibility
- Intelligibility
- Usability
- Maintainability
- Human-automation interaction
- Advanced multimodal interfaces