This is an example text for natural text representation.
Toward a Framework for Assessing Human Systems Integration Efficacy

NDIA Human Systems 2016
Springfield, VA

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U.S. Coast Guard
HSI Division (CG-1B3)
"The Coast Guard relies on cutters, boats, and aircraft to operate in the maritime environment, but it is our people who deliver truly unique capabilities to the Nation."

- ADM Paul Zukunft, Commandant's Direction (2014)
HSI balances human capabilities and limitations with the affordances and constraints presented by system technology to accomplish system goals.  

(Shattuck, O'Neil & Sciarini 2014)
How do we place **humans** on par with **tech** during system development?
Management Indicators (CHIEF)

Program Executive
- Lead System Engineer, Senior HSI Practitioner
- Systems Engineer, HSI Practitioner
- Engineer, Programmer, HSI Domain Practitioner
- Domain SME
- Analyst, Researcher

Measures of HSI Performance
Human-Technology Interaction Characteristics (specific HSI domain performance)
Manifested System Attributes
HSI Policies & Standards
Underlying Science
Selective borrowing from TRL

NASA/DOD Technology Readiness Level

- TRL 1: Basic principles observed and reported
- TRL 2: Technology concept and/or application formulated
- TRL 3: Component and/or breadboard validation in laboratory environment
- TRL 4: Component and/or breadboard validation in relevant environment
- TRL 5: System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)
- TRL 6: System prototype demonstration in a space environment
- TRL 7: System/subsystem completed and “flight qualified” through test and demonstration (Ground or Flight)
- TRL 8: Actual system completed and “flight proven” through successful mission operations
- TRL 9: Actual system “flight proven” through successful mission operations

- ✔ simple language
- ✔ discipline
- ✔ independent
- ❌ uni-variate scale for multiple HSI domains
Re-framing the discussion...

This is how HSI is effecting your system.
Basic idea...

HFE Evaluation Criteria

<table>
<thead>
<tr>
<th>TSPI</th>
<th>Analyze/Select (Preliminary Design)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Optimizing</td>
</tr>
<tr>
<td>4</td>
<td>Enhancement</td>
</tr>
<tr>
<td>3</td>
<td>Minimal Degradation</td>
</tr>
<tr>
<td>2</td>
<td>Moderate Degradation</td>
</tr>
<tr>
<td>1</td>
<td>Severe Degradation</td>
</tr>
</tbody>
</table>

Comprehensive Human Integration Evaluation Framework (CHIEF) DRAFT

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Manpower</td>
<td>-</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>+</td>
<td>4</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Training</td>
<td>+</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Human Factors</td>
<td>+</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>+</td>
<td>4</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Systems Safety</td>
<td>+</td>
<td>2</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Survivability</td>
<td>+</td>
<td>3</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Habitability</td>
<td>+</td>
<td>4</td>
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<td></td>
</tr>
</tbody>
</table>

integrated HSI assessment

selected measures

unifying scale for each HSI domain
Step Seven: Briefing

Step Six: Analysis

Step Five: Collection and Assessment

Step Four: Socialization

- Framework for understanding HSI
- Overview of HSI measures
- Range of acceptable performance

Step Three: Calibration

- What level of assistance would you consider ‘minimally acceptable’ for this system?

Step Two: Anchoring

Step One: Select Measures

Re-training the discussion...

This is how HSI is effecting your system.
Entering Arguments: Users, Work Context, System Config
Step One: **Select Measures**

- **System Concept**
- **Practitioner Knowledge**

Relevant Measures:

- NASA Task Load Index
  - Mental Demand
  - Physical Load
  - Temporal Demand
  - Performance
  - Effort
  - Frustration

![Helicopter cockpit image](image)
### Step Two: Anchoring

<table>
<thead>
<tr>
<th>What is the implication of what you've learned about this topic?</th>
<th>Project ID (Steps)</th>
<th>Assignments (Preclinical Stage)</th>
<th>Guest &amp; Sponsor (Lifestyle Phase)</th>
<th>Outcome (Pre-OP) (Preclinical Stage)</th>
<th>Outcome (POST-OP) (Preclinical Stage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing - Impacts on clinical performance are consistently positive with no exceptions listed or observed. Engineering changes, delivered by a focused human systems integration team, are relatively modest. Performance improvements are usually modest and sustained.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td></td>
</tr>
<tr>
<td>Enhancing - Impacts on system performance are not positive with rather negative feedback. Engineering design changes, driven by a broader human systems integration team, are relatively modest. Performance improvements are usually modest and sustained.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td></td>
</tr>
<tr>
<td>Mineral Degradation: Impacts on body systems performance to maintain natural body systems performance. Impacts on body systems performance to maintain natural body systems performance.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td></td>
</tr>
<tr>
<td>Moderate Degradation: Impacts on body systems performance and body systems performance and body systems performance and body systems performance.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td></td>
</tr>
<tr>
<td>Severe Degradation: Uncomfortable impact on body systems performance and body systems performance and body systems performance and body systems performance.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td>[Step Developed]</td>
<td>Based on the estimated design. [Intermediate]: Based on the estimated design.</td>
<td></td>
</tr>
</tbody>
</table>

**Example question for the practitioner:** "What level of anthropomorphic accommodation would you consider minimally acceptable for this system?"
Minimal Degradation: Impacts on total system performance trend slightly toward degradation. Engineering changes driven by inadequate human system integration may emerge during sustainment to remedy minor system performance deficiencies. Human-system performance (time on task, error rates, availability, etc.) is marginally meeting threshold requirements.

Moderate Degradation: Impacts on total system performance are
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometrics</td>
<td>At least 90% of users accommodated across all critical tasks modeled; roughly 1 in 20 users are not accommodated in the preliminary system design.</td>
</tr>
<tr>
<td>Workload</td>
<td>Workload comfortable. Reduced spare capacity for additional tasks.</td>
</tr>
<tr>
<td>Time on Task</td>
<td>Time on task is predicted to meet threshold requirement for requisite manpower, across all mission-critical tasks.</td>
</tr>
<tr>
<td>Spatial Analysis</td>
<td>Minimal performance degradation noted of critical/non-critical tasks due to workstation layout, workspace design, system physical configuration.</td>
</tr>
<tr>
<td>Human Error</td>
<td>Human error predicted to occur in 5 in 100 critical tasks.</td>
</tr>
</tbody>
</table>

Based on the detailed design: [Anthropometrics] At least 85% of users accommodated across all critical tasks modeled; roughly 3 in 20 users are not accommodated in the preliminary system design. [Workload] Very high workload. Reduced spare capacity for additional tasks. [Time on Task] Time on task is predicted to meet threshold requirement for requisite manpower, across all mission-critical tasks. [Spatial Analysis] Minimal performance degradation noted of critical/non-critical tasks due to workstation layout, workspace design, system physical configuration. [Human Error] Human error predicted to occur in 10 in 100 critical tasks.
### Step Three: Calibration

#### Enhancements

<table>
<thead>
<tr>
<th>Task</th>
<th>Demand</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Physical</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

#### Optimizing

- Antropometrics: Greater than 99% of users are predicted to be accommodated across critical tasks; less than 1 in 100 users are not accommodated by design.
- Workload: Critical tasks are predicted to require less than 80% of user capacity (20% reserve capacity) given preliminary system design.
- Time on Task: Time on task are predicted to exceed objective requirement for requisite manpower limitation (reference spec/manpower KPP).
- Spatial Analysis: Spatial Analysis Link Tool (SALT) scores for preliminary design do not exceed ___ for critical tasks.
- Human Reliability Rating: HRR score of greater than 95% or better modelled/predicted for critical systems.

#### Cross-cutting across HSI domains

(e.g. HFE, System Safety, Manpower)

#### Within HSI domain

(e.g. Human Factors Engineering)
Step Four: Socialization

Awareness & Buy-in:

- Framework for understanding HSI
- Overview of HSI measures
- Range of acceptable performance
Step Five: Collection and Assessment

- **HSI performance**
- **HSI performance data**
- **HSI domain rating**
Step Six: Analysis
Step Seven: **Briefing**

![Comprehensive Human Integration Evaluation Framework (CHIEF) Table](image)

- **Manpower**: - 3
- **Personnel**: + 4
- **Training**: + 4
- **Human Factors Engineering**: + 4
- **Systems Safety**: + 2
- **Survivability**: + 3
- **Habitability**: + 4

**Total System Performance Implication**

- 1. Severe Degradation
- 2. Moderate Degradation
- 3. Mild Degradation
- 4. Enhancement
- 5. Optimizing

**Management Indicators (CHIEF)**

- Measures of HSI Performance
- Human-Technology Interaction Characteristics *(specific HSI domain performance)*
- Manifested System Attributes
- HSI Policies & Standards
- Underlying Science
what's next?

- ✔ thesis / initial concept (FY 14)
- ✔ conceptualize domain scales (FY 15)
- ✔ draft domain criteria & TSP scale
- ➡ calibration / TTX (FY 16)
- 🌹 brief to program (FY 16)
- beta test (FY 16)
- automation / software scaling
Contact: CDR Mike O'Neil

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