Toward an HSI Assessment Methodology for U.S. Coast Guard Systems

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Springfield, VA

CDR Mike O'Neil, USCG
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 tech?
The challenge: convey a useful understanding of HSI efficacy across the acquisition life cycle
What can we learn from TRL?

**NASA/DOD Technology Readiness Level**

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

Strengths:
- simple & elegant
- discipline-independent
- broadly applicable

Weaknesses:
- level of abstraction
- process-oriented
- integration?
How can we apply the lessons of TRL to develop an HSI measure?

- suitable for broad audience
- performance-focused
- evaluation beyond risk
central question:

how is HSI affecting total system performance?
**CHIEF** approach:

![Diagram showing HFE Evaluation Criteria]

- **HFE Measure 1**
- **HFE Measure 2**
- **HFE Measure 3**
- **HFE Measure 4**

**Unifying scale for each HSI domain:**

- **Integrated HSI assessment**

**Domain-specific measures:**
Start:

Entering Arguments: Users, Work Context, System Config
Step One: Tailoring

system concept

practitioner knowledge

relevant measures

NASA Task Load Index

How and Dowley's NASA Task Load Index (TLX) method assesses work load on five 7 point scales. Increments of high, medium and low estimates for each point result in 27 gradations of the scale.

<table>
<thead>
<tr>
<th>Name</th>
<th>Task</th>
<th>TLX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Demand</td>
<td>How mentally demanding was the task?</td>
<td>Very Low</td>
</tr>
<tr>
<td>Physical Demand</td>
<td>How physically demanding was the task?</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

[Diagram of a cockpit and a helicopter]
## Step Two: Anchoring

<table>
<thead>
<tr>
<th>TSPI</th>
<th>Analyze/Select (Preliminary Design)</th>
<th>Obtain (pre CDR) (Detailed Design)</th>
<th>Obtain (Post CDR) (Prototype/LRIP)</th>
<th>Produce, Deploy, Support (Full-rate Production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Optimizing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Enhancement</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Minimal Degradation</td>
<td></td>
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<tr>
<td>2</td>
<td>Moderate Degradation</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Severe Degradation</td>
<td></td>
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</tbody>
</table>

**selected measure:** anthropometrics

For the practitioner: "Which anthropometric results do you associate with a ________________ of system performance?"
Step Three: Calibration

- 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 [fill in] for critical tasks.
- Human Reliability Rating: HRR score of greater than 96% or better modelled/predicted for critical systems.

Optimizing

- Antropometrics: Grid to be across all critical tasks accommodated by design.
- Workload: Critical task capacity (20% reserve spec/manpower KPP).
- Time on Task: Time on task predicted to exceed objective requirements for requisite manpower limitation (reference spec/manpower KPP).
- Spatial Analysis: Spatial Analysis Link Tool (SALT) scores do not exceed [fill in] for critical tasks, given preliminary system design.
- Human Reliability Rating: The Human Reliability rating of 96% percent (objective).

Enhancement

- Antropometrics: Greater than 90% of user population accommodated across critical tasks; less than 1 in 36 users are not accommodated by design.
- Workload: Workload predicted to require less than 90% of user capacity for critical tasks (20% reserve capacity) given preliminary system design.
- Time on Task: Time on task predicted to meet objective requirements for requisite manpower mix (reference spec/manpower KPP) given preliminary system design.
- Spatial Analysis: Spatial Analysis Link Tool (SALT) scores do not exceed [fill in] for critical tasks, given preliminary system design.
- Human Reliability Rating: The Human Reliability rating of 96 percent (objective).

Table(s) and Data

- [Fill in table with relevant data]

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 assessing HSI Impact to the program
- Overview of HSI measures relevant to program
- Range of acceptable performance for given measures
Step Five: Collection and Assessment

HSI performance

HSI performance data

HSI domain rating
Step Six: Analysis

Comprehensive Human Integration Evaluation Framework (CHIEF):

- MANPOWER
- PERSONNEL
- HFE

<table>
<thead>
<tr>
<th>HSI Domain</th>
<th>HSI Characteristics</th>
<th>Total System Performance Implication</th>
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</thead>
<tbody>
<tr>
<td>Manpower</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Personnel</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>Training</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>Human Factors Engineering</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>Systems Safety</td>
<td>+</td>
<td>2</td>
</tr>
<tr>
<td>Survivability</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Habitability</td>
<td>+</td>
<td>4</td>
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Step Seven: **Briefing**

<table>
<thead>
<tr>
<th>HSI Domain</th>
<th>HSI Guidebook</th>
<th>Rating</th>
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<tbody>
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<td>4</td>
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<td>3. Mild Degradation</td>
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<td>4. Enhancement</td>
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C.H.I.E.F. Attributes

Advantages

- Assessment of HSI available at any phase
- Tracking of domain performance across phases
- Responsive to changing program realities
- Facilitates ROI calculation

Limitations

- Dependent on experts (HSI & domain-specific)
- Limited by availability of HSI performance measures
- Yields ordinal data
Contact:  CDR Mike O'Neil

Performance Support & Training Team Lead
Human Systems Integration Division (CG-1B3)
U.S. Coast Guard Headquarters

Office:  202.475.5096
email:  michael.p.o'neil@uscg.mil

## HFE Evaluation Criteria

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### Comprehensive Human Integration Evaluation Framework (CHIEF)

<table>
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<th>HSI Objectives</th>
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