Systems Engineering Advancement Research Initiative

Massachusetts Institute of Technology

Developing Strategies for Improving the Execution of Human Systems Integration

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Advisor: Dr. Donna Rhodes (MIT SEAri)

Objective and Motivation

Research Objective: Improve predictability of HSI programmatic and technical performance through augmentation of leading indicators with HSI considerations

Motivation: HSI - increasingly important in modern systems
Early consideration = fewer accidents, fewer errors, lower costs
Measuring HSI effectiveness on a program is essential

Research Scope: SE Leading Indicators. Widely used in industry. Currently contain weak characterizations in terms of HSI

What are SE Leading Indicators? Conventional systems engineering measures provide status and historical information. Leading indicators use an approach that draws on trend information to allow for more predictive insight

Research Sponsorship: US Air Force Office of Human Systems Integration (AFHSIO)

Rhodes, D.H., Ross, A.M., Gerst, K.J., and Valerdi, R., "Leading Indicators for Human Systems Integration Effectiveness," 7th Conference on Systems Engineering Research, UK, April 2009. Best Paper Award

Research Overview

MIT SEAri + Air Force HSI Office
Large research effort to more effectively address HSI considerations through the extension of the current leading indicator set

- Extensive literature review (complete)
- Gap analysis in current literature and leading indicators (complete)
  - Targeted industry interviews phase 1 (complete)
  - Targeted industry survey phase 2 (complete)
  - Enhance version 2.0 of Systems Engineering Leading Indicators Guide (complete; Appendix B)

Roedler. G, Rhodes, D., "Systems Engineering Leading Indicators Guide", Version 2.0, INCOSE Technical Product Number: INCOSE-TP-2005-001-03, January 2010

- Development of prescriptive information (complete)

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Biography

Kacy is a graduate student in MIT's System Design and Management Program and a Research Assistant at the Systems Engineering Advancement Research Initiative. Recently she was an intern at the headquarters of the U.S. Department of Energy assisting in the development of a strategic plan for the new administration. Prior to returning to school Kacy spent five years holding various engineering and strategic planning positions at Sikorsky Aircraft. She holds her undergraduate degree in Industrial Engineering from Virginia Tech.

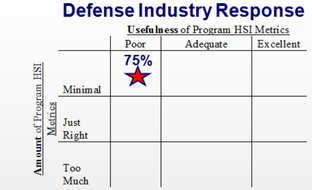
Related Publications

Gerst, K.J. and Rhodes, D.H., "Strengthening Systems Engineering Leading Indicators for Human Systems Integration Considerations – Insights from the Practitioner Community," 8th Conference on Systems Engineering Research, Hoboken, NJ, March 2010.

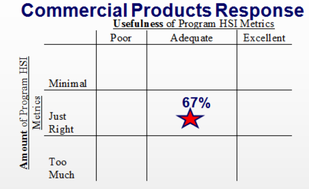
Rhodes, D.H., Ross, A.M., Gerst, K.J., and Valerdi, R., "Leading Indicators for Human Systems Integration Effectiveness," 7th Conference on Systems Engineering Research, Loughborough University, UK, April 2009. BEST PAPER AWARD

Preliminary Insights

Defense Industry Response



Commercial Products Response



DoD respondents strongly indicated a need for HSI measures displaying: higher visibility, increased standardization, full coverage of all domains, leading vs lagging

Strong Recommendation by Participants for HSI KPPs:

Participants strongly recommended that one or more Key Performance Parameters (KPPs) be required to relate to HSI

Participants discussed large difference in staffing, funding, and visibility given to HSI domains when an HSI measure had elevated KPP status

HSI design concerns given low priority, "placed on the back burner", and "the first to receive funding cuts"

Preliminary Survey Insights

Proposed HSI Specific Additions

Identified by over two-thirds of elicitation participants

A measure indicating frequency and quality with which end user is involved in design review process

User Involvement in Design Trends	
Information Need Description	
Information Need	• Evaluate the adequacy of user involvement in the system design process and early consideration of Human System Integration needs. • Understand the growth, change, completeness and correctness of the definition of the system requirements.
Measurable Concept and Leading Insight	
Measurable Concept	Evaluate the frequency and quality with which the end user is involved in the design review process.
Leading Insight Provided	• Indicates the extent to which user needs are considered in initial system design. • Indicates the level of programmatic focus on HSI concerns. • Indicates risks of change due to poor HSI execution in architecture, design, and implementation.
Proposed Measurements	1. % Design Reviews involving the user = (# design reviews involving the user / total # of design reviews)*100 as a function of time 2. % Design Reviews specifically focused on the user experience = (# design reviews conducted with the primary focus being evaluation of the user experience and HSI considerations / total # of design reviews)*100 as a function of time 3. % Quality of users involved in the design review process = (actual # of users with the specified experience level involved in the design review process / planned # of users with the specified experience level involved in the design review process)*100 as a function of time

Robey, D., Farrow, D., "User Involvement in Information Systems Development: A conflict model and empirical test," *Management Science, 20, 73-85, 1982.*

Preliminary Survey Insights

HSI Leading Indicator Subset

Informal validation of the utility of HSI LI subset

Current LI Set → **HSI instantiated LI's** *(Tailored for HSI Specific Use)*

	Current Leading Indicator Measure	Leading Indicators - Modified with HSI Characteristics
Staffing and Skills Trends	% of Effort (actual effort / total planned effort) - Planning vs. Actual	% of HSI Effort (actual HSI effort / total planned effort) - Planning vs. Actual
	% of Staffing per plan (actual staffing / total planned staffing) - Planned vs. Actual	% of HSI Staffing per plan (actual HSI staffing / total planned staffing) - Planned vs. Actual

Evaluated for Utility on a scale of 1 (low) to 5 (high)

Preliminary Findings:

Mean expert rating for all proposed indicators fell within 3 – 4 range (medium or better utility)

However, level of disagreement among experts surrounding utility of two indicators (Requirements Trends and Process Compliance Trends) was relatively higher than rest of the indicator set. *Based on the coefficient of variation.*

Final Recommendations

To Improve the Execution of HSI within the US Air Force and its Subcontractors

- Add three leading indicators to the SE Leading Indicators Guide, which received high average utility rankings by practitioners: *User Involvement in Design Trends, HSI Subject Matter Expert Indicator,* and *Prototype & Testing Speed*
- Add to the SE Leading Indicators Guide the HSI-instantiated leading indicators subset, developed in this research and evaluated to have medium to high utility
- Add to the SE Leading Indicators Guide a list and description of HSI-specific soft indicators. A soft indicator is defined as a piece of qualitative, difficult-to measure information, whose existence indicates early-on program success or failure. The identification and use of soft indicators increases the portfolio of tools available to management for predictive performance of HSI
- Require a minimum of one Key Performance Parameter focused on a HSI domain
- Require subcontractors to distribute the SE Leading Indicators Guide HSI Appendix to leadership within military subcontractors, as training material

For more information, please visit: http://seari.mit.edu