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The SERC Effectiveness Measures Task: Assessing SysE Effectiveness in Major Defense Acquisition Programs (MDAPs)

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Outline

- What is the SERC?
- Effectiveness Measures Task Statement of Work
- Definition of “Systems Engineering Effectiveness”
  - SE contribution to program success
- Candidate Measurement Methods, Evaluation Criteria, Evaluation Frameworks
- Evaluation frameworks OpCon and tools
- Pilot tools usage, feedback, and refinement
- Expected benefits

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SERC Organization

Lead organizations

STEVENS Institute of Technology

USC UNIVERSITY OF SOUTHERN CALIFORNIA

Members

- Auburn University
- Air Force Institute of Technology
- Carnegie Mellon University
- Fraunhofer Center at UMD
- Massachusetts Institute of Technology
- Missouri University of Science and Technology (S&T)
- Naval Postgraduate School
- Pennsylvania State University
- Southern Methodist University
- Texas A&M University
- Texas Tech University
- University of Alabama in Huntsville
- University of California at San Diego
- University of Maryland
- University of Massachusetts
- University of Virginia
- Wayne State University

As the DoD *Systems Engineering Research-University Affiliated Research Center*, SERC will be responsible for systems engineering research that supports the development, integration, testing and sustainability of complex defense systems, enterprises and services. Its members are located in 11 states, near many DoD facilities and all DAU campuses.

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EM Task Statement of Work

- Develop measures to monitor and predict system engineering effectiveness for DoD Major Defense Acquisition Programs
  - Define SysE effectiveness
  - Develop measurement methods for contractors, DoD program managers and PEOs, oversight organizations
    - For weapons platforms, SoSs, Net-centric services
  - Recommend continuous process improvement approach
  - Identify DoD SysE outreach strategy
- Consider full range of data sources
  - Journals, tech reports, org's (INCOSE, NDIA), DoD studies
    - Partial examples cited: GAO, SEI, INCOSE, Stevens/IBM
- Deliverables: Report and presentation
  - Approach, sources, measures, examples, results, recommendations

Defining SE Effectiveness

- Good SysE correlates with project success
  - INCOSE definition of systems engineering, “An interdisciplinary approach and means to enable the realization of successful systems”
- Goodness of a candidate SE effectiveness measure (EM)
  - Whether it can detect when a project’s SysE is leading the project more toward success than toward failure
- Build up database of best-available SE EMs
  - Review literature, select best sources of EMs
  - Analyze their comparability
  - Structure them into an EM assessment framework
  - Correlate with measures of program success and failure
    - Pilot framework usage on projects, Systemic Analysis Database
- Provide useful tools for DoD projects

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Effectiveness Measures Based on Synthesis of Best Available Knowledge

- NRC Pre-Milestone A & Early-Phase SysE top-20 checklist
- Air Force Probability of Program Success (PoPS) Framework
- INCOSE/LMCO/MIT Leading Indicators
- Stevens Leading Indicators (new; using SADB root causes)
- USC Anchor Point Feasibility Evidence progress
- UAH teaming theories
- NDIA/SEI capability/challenge criteria
- SISAIG Early Warning Indicators/ USC Macro Risk Tool
- OUSD(AT&L)/SSE DACS Program Support Review Guide
- DoD Systems of Systems Engineering Guide
- DoD SE Plan Preparation Guide

Initial EM Coverage Matrix

SERC EM Task Coverage Matrix V1.0

	NRC	Probability of Success	SE Leading Indicators	LIPSF (Stevens)	Anchoring SW Process (USC)	PSSES (U. of Alabama)	SSEE (CMU/SEI)	Macro Risk Model/Tool
Concept Dev								
Atleast 2 alternatives have been evaluated	X			x	x	x (w.r.t NPR)	(x)	
Can an initial capability be achieved within the time that the key program leaders are expected to remain engaged in their current jobs (normally less than 5 years or so after Milestone B)? If this is not possible for a complex major development program, can critical subsystems, or at least a key subset of them, be demonstrated within that time frame?	X		(x)	x	x (5 years is not explicitly stated)		(x) (seems to be inferrable from the conclusions)	(x) (implies this)
Will risky new technology mature before B? Is there a risk mitigation plan?	x	x	x		(x)		x	x
Have external interface complexities been identified and minimized? Is there a plan to mitigate their risks?	x		x		x	x	x	x
KPP and CONOPS								
At Milestone A, have the KPPs been identified in clear, comprehensive, concise terms that are understandable to the users of the system?	x	(x)	x	(x)	x (strongly implied)	(x) (implied)	x	x
At Milestone B, are the major system-level requirements (including all KPPs) defined sufficiently to provide a stable basis for the development through IOC?	x	x	(x)	x	x	(x)	(x) (There is no direct reference to this but is inferrable)	x
Has a CONOPS been developed showing that the system can be operated to handle the expected throughput and meet response time requirements?	x	x	(x)	(x)	x	(x) (there is a mention of a physical solution. That's the closest in this regard)	x	x

Legend:
x = covered by EM
(x) = partially covered (unless stated otherwise)

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Structuring the 51 EM Elements

Systems Engineering Effectiveness Measurement Proposed New Framework	SEPP-Guide-Based Eval. Framework	SISAIG/ Macro Risk Framework	Coverage Matrix Items
1. Concurrent Definition of System Requirements & Solutions			
1.1 Understanding of stakeholder needs: Capabilities, Operational Concept, Key Performance Parameters, Enterprise fit (legacy)	1.1, 1.4, 3.1	1.1, 1.4	5, 7, 22, 36, 37
1.2 Concurrent exploration of solution opportunities; AoA's for cost-effectiveness & risk (Measures of Effectiveness)	4.1, 4.2	1.2	1, 14, 26, 27, 28
1.3 System scoping & requirements definition (External interfaces; Memoranda of Agreement)	1.2, 1.4	3.2	4, 6, 13, 50
1.4 Prioritization of requirements & allocation to increments	1.3	1.5	2, 11, 31

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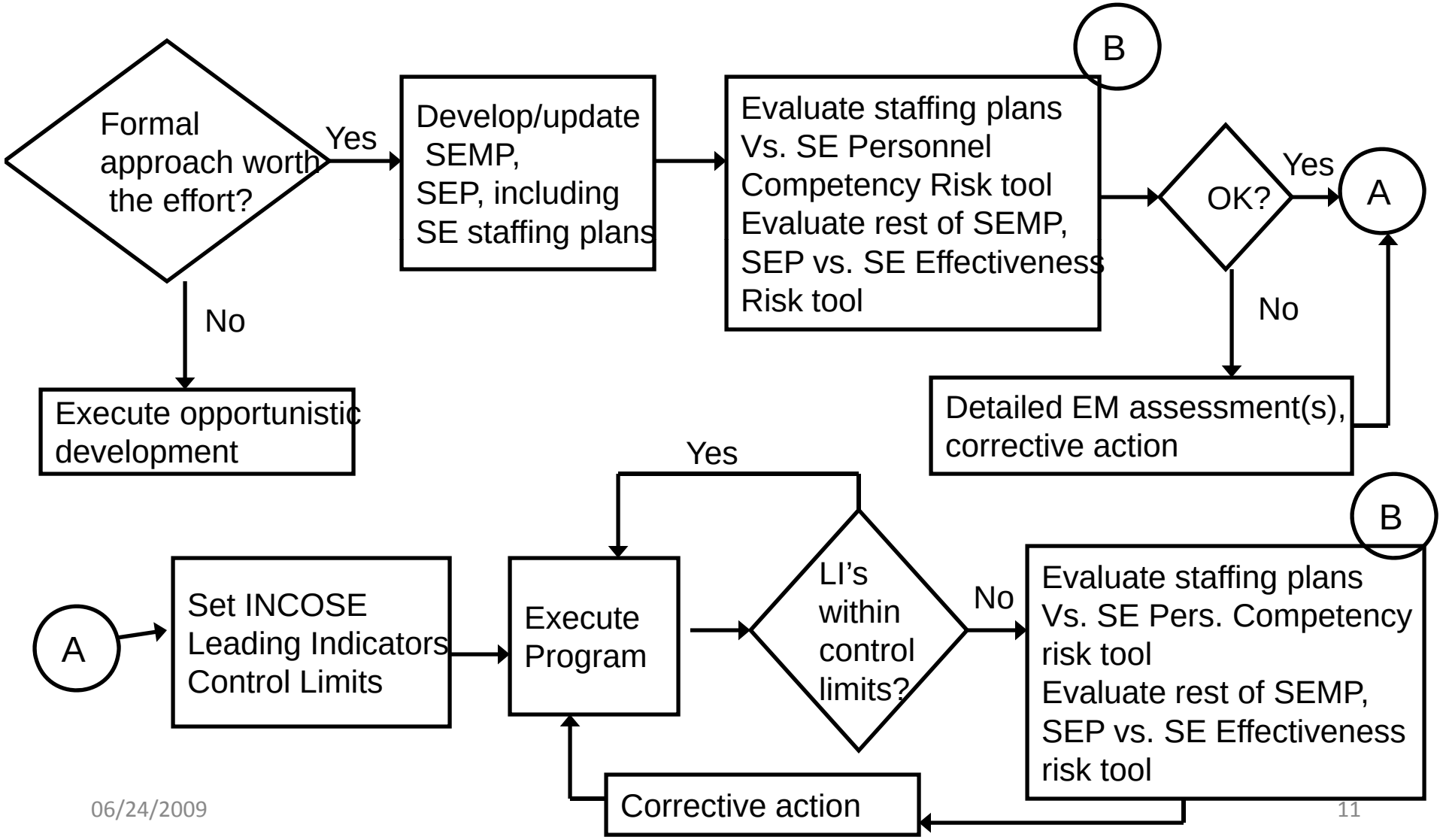
Draft EM Operational Concept(s)

- Primary responsibilities, authority, accountability (RAA)
  - Primary assessment consumers: Persons with management responsibility for program results
    - Contractor PM, DoD PM/PEO, oversight personnel
  - Primary assessment conveners, monitors: Chief Engineers, Chief Systems Engineers
  - Primary assessors: Independent experts

JAL2

Draft SysE EM Operational Concept(s)

(for each stage of system definition and development)



Slide 11

JAL2 Modify this chart so that it reflects the anticipated end state. May also want to re-do using swim lanes to show the different orgs involved.

Jo Ann, 4/1/2009

Personnel Competency: Commonality of Frameworks

SERC EM Framework	NDIA Personnel Competency FW	SEI Architect Competency FW
Concurrent Definition of System Requirements & Solutions	Systems Thinking	Stakeholder Interaction
System Life Cycle Organization, Planning, Staffing	Life Cycle View	Other phases
Technology Maturing and Architecting	SE Technical	Architecting
Evidence-Based Progress Monitoring & Commitment Reviews	SE Technical Management	Management
	Professional/ Interpersonal	Leadership, Communication, Interpersonal

Example Personnel Competency Goals, Critical Success Factors, Questions

1. Concurrent Definition of System Requirements & Solutions
1.1 Understanding of stakeholder needs: Capabilities, Operational Concept, Key Performance Parameters, Enterprise fit (legacy). Ability to analyze strengths and shortfalls in current-system operations via: a. Participatory workshops, surveys, focus groups b. Operations research techniques: operations data collection and analysis, modeling c. Prototypes, scenarios, stories, personas d. Ethnographic techniques: Interviews, sampled observations, cognitive task analysis
1.2 Concurrent exploration of solution opportunities; Analysis of Alternatives for cost-effectiveness & risk (Measures of Effectiveness). Ability to identify and assess alternative solution opportunities via experimentation and analysis of: a. Alternative work procedures, non-materiel solutions b. Purchased or furnished products and services c. Emerging technology d. Competitive prototyping

Reset

Tool Example: Personnel Competency - I

Exposure	Question #	Impact: High	Impact: Medium	Impact: Low	Impact: No impact	Competency/Risk: No experience Hig risk	Competency/Risk: Some experience	Competency/Risk: Good experience	Competency/Risk: Expert experience	NOTE: Impact and evidence/risk ratings should be done independently. The impact rating should estimate the effect a failure to competently address the specified item might have on the program. The competency rating should specify the observed, historical experience and competency of the systems engineering staff on past programs with respect to the specified risk item.	Risk Exposure
	Goal 1:									**Concurrent definition of system requirements and solutions**	
	Critical Success Factor 1.1									**Understanding of stakeholder needs: capabilities, operational concept, key performance parameters, enterprise fit (legacy). Ability to analyze strengths and shortfalls in current-system operations via:**	
	1.1(a)									Participatory workshops, surveys, focus groups	
	1.1(b)									Operations research techniques: operations data collection and analysis	
	1.1(c)									Mission effectiveness modeling and simulation	
	1.1(d)									Prototypes, scenarios, stories, personas	
	1.1(e)									Ethnographic techniques: Interviews, sampled observations, cognitive task analysis	

Reset

Tool Example: Personnel Competency - II

Exposure	Question #	Impact: High	Impact: Medium	Impact: Low	Impact: No impact	Competency/Risk: No experience Hig risk	Competency/Risk: Some experience	Competency/Risk: Good experience	Competency/Risk: Expert experience	NOTE: Impact and evidence/risk ratings should be done independently. The impact rating should estimate the effect a failure to competently address the specified item might have on the program. The competency rating should specify the observed, historical experience and competency of the systems engineering staff on past programs with respect to the specified risk item.	Risk Exposure
	Goal 1:									**Concurrent definition of system requirements and solutions**	
	Critical Success Factor 1.1									**Understanding of stakeholder needs: capabilities, operational concept, key performance parameters, enterprise fit (legacy). Ability to analyze strengths and shortfalls in current-system operations via:**	3
3	**1.1(a)**									Participatory workshops, surveys, focus groups	
2	**1.1(b)**									Operations research techniques: operations data collection and analysis	
2	**1.1(c)**									Mission effectiveness modeling and simulation	
1	**1.1(d)**									Prototypes, scenarios, stories, personas	
1	**1.1(e)**									Ethnographic techniques: Interviews, sampled observations, cognitive task analysis	

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Pilot tools usage, feedback, and refinement

- Provide tools to pilot users
  - With Pilot Users' Guide, Feedback Form
  - For use on SE proposals, plans, status reviews, completed projects
  - Feedback only on framework/tool features, usage cost-benefit
    - Not on report assessment results
- Analyze framework/tool strengths and shortfalls
  - Content, missing coverage
  - Needs for framework/tool training, ease of use
- Refine framework and tools, associated support
- Evolve and extend framework and tool coverage, relevance
  - Domain-specific extensions, improved tailorability
- Build up knowledge base of effects on SE performance
  - For use in project decisionmaking, SE education

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Expected benefits from evolving framework and tools

- Significantly lower rates of project overruns, underperformance
  - Due to early project risk identification and mitigation
  - Through stimulation of evidence-based vs. schedule-based and event–based decision reviews
- Reduced friction and adversarial customer-developer relations
  - Due to mutual understanding of and commitment to project critical success factors, resulting decisions
- More rapid buildup of SE expertise
  - Via knowledge base buildup
  - Via use in SE education and training