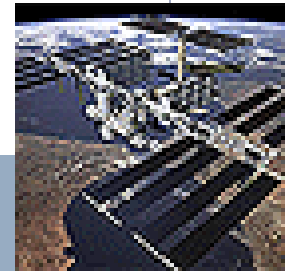


Systems Engineering at The University of Alabama in Huntsville

Paul J. Componation
Sue O'Brien



Huntsville Alabama



Aviation and Missile Command (AMCOM)

Aviation and Missile Research,
Development and Engineering Center

Program Executive Office, Aviation

Program Executive Office, Missiles and Space

Space and Missile Defense Command

Ground – Based Midcourse Defense
Joint Project Office

Missile And Space Intelligence Center (MISC)

Army Logistics Support Activity (LOGSA)

US Army Engineering and Support Center

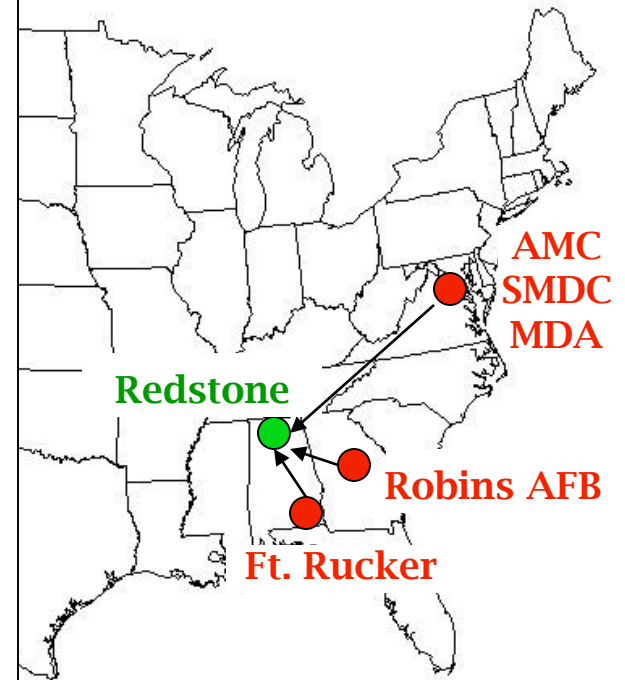
Redstone Technical Test Center

NASA Marshall Space Flight Center

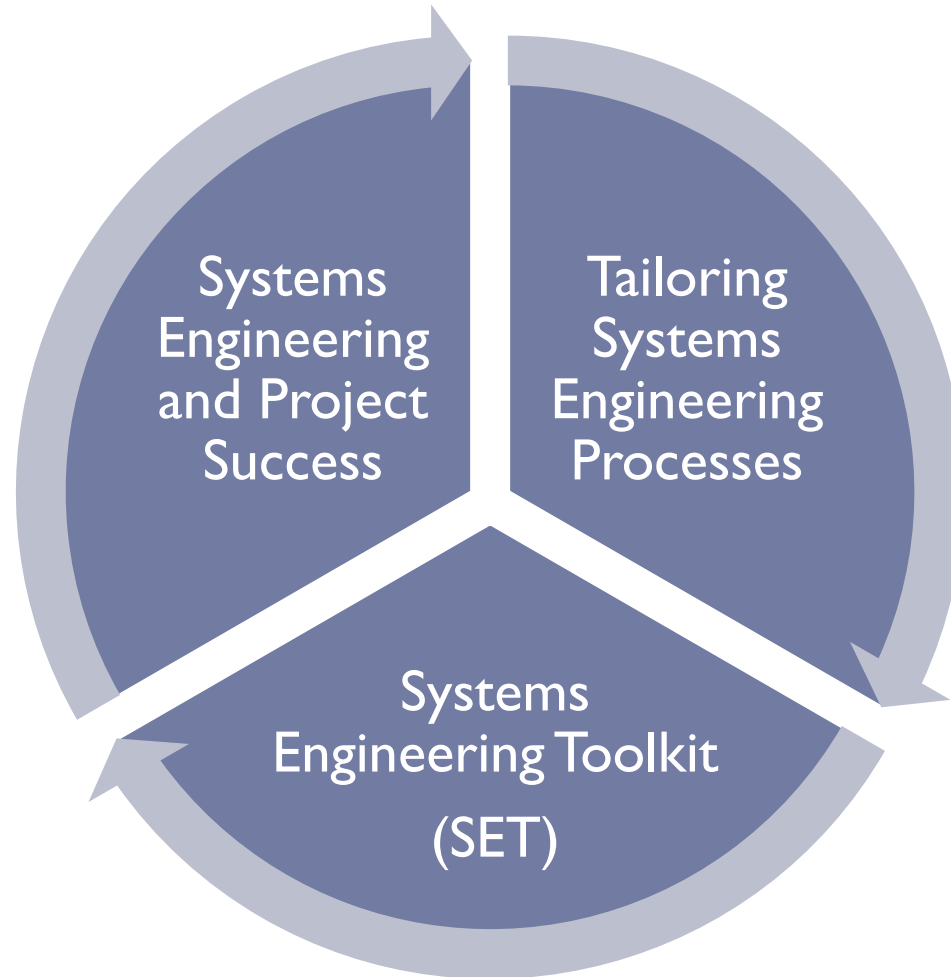
Defense Acquisition University – South

BRAC Decisions

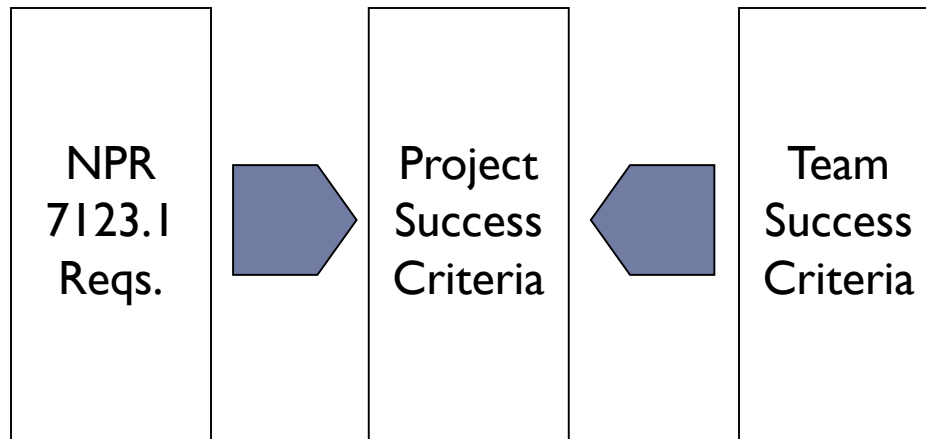
- Relocate HQ Army Materiel Command
 - Relocate HQ Security Assistance Command
 - Relocate HQ Space and Missile Defense Command
 - Relocate Missile Defense Agency (-)
 - Relocate Aviation Technical Test Center
 - Consolidate Rotary Wing Development, Acquisition, Test and Evaluation
-
- *Center for Army Acquisition*
 - *Center for DoD/Army Space Programs*
 - *Center for Army International Programs*
 - *Largest Army Contracting Agency*
 - *Largest Army Weapon System Concentration*



Outline



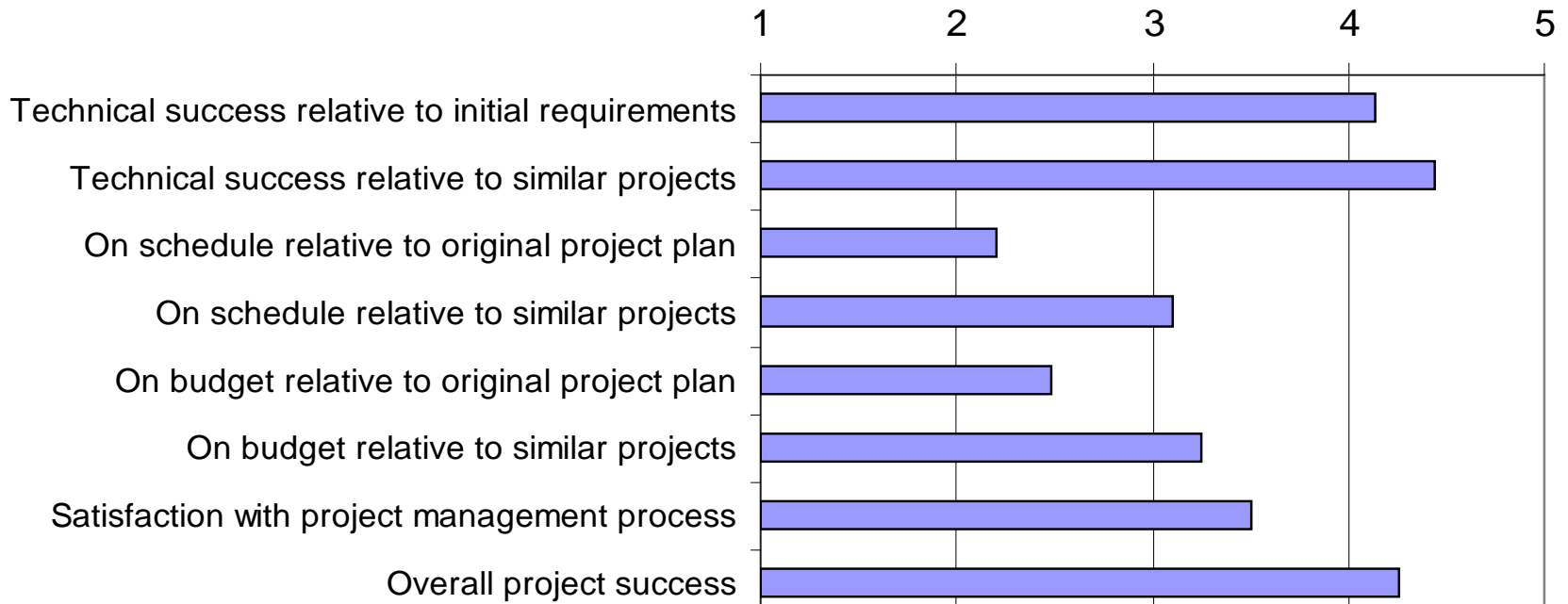
Systems Engineering and Project Success



- ▶ International Space Welding Experiment (ISWE)
- ▶ Chandra
- ▶ Solid Rocket Booster (SRB)
- ▶ Reusable Solid Rocket Motor (RSRM)
- ▶ X37
- ▶ Express Rack
- ▶ Gravity Probe B (GP-B)
- ▶ ECLSS
- ▶ External Tank
- ▶ SME Advanced Health Monitoring System
- ▶ AXAF
- ▶ Saturn Booster
- ▶ IML

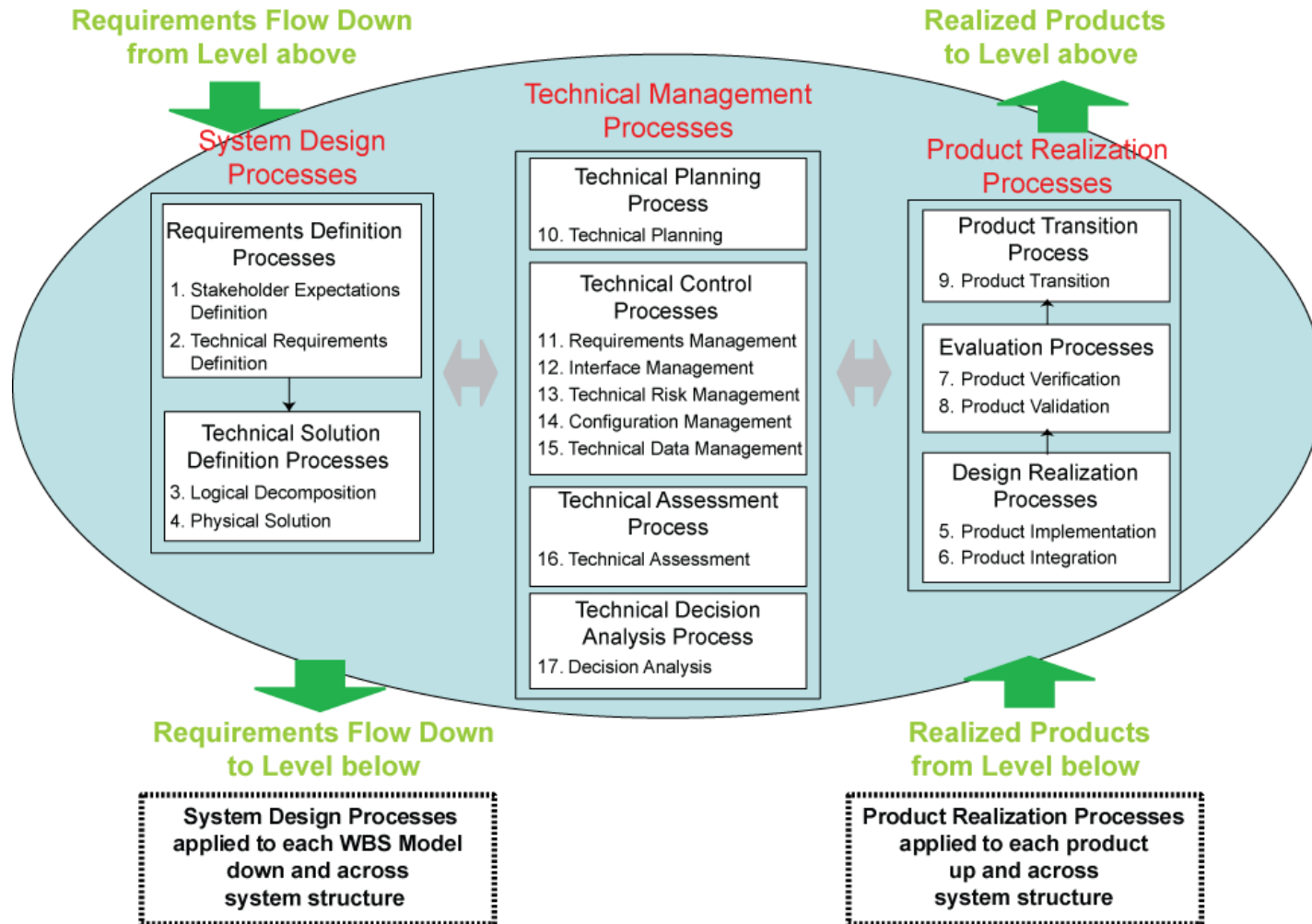
Success Criteria

Rating



System Engineering Processes

NPR 7123.1



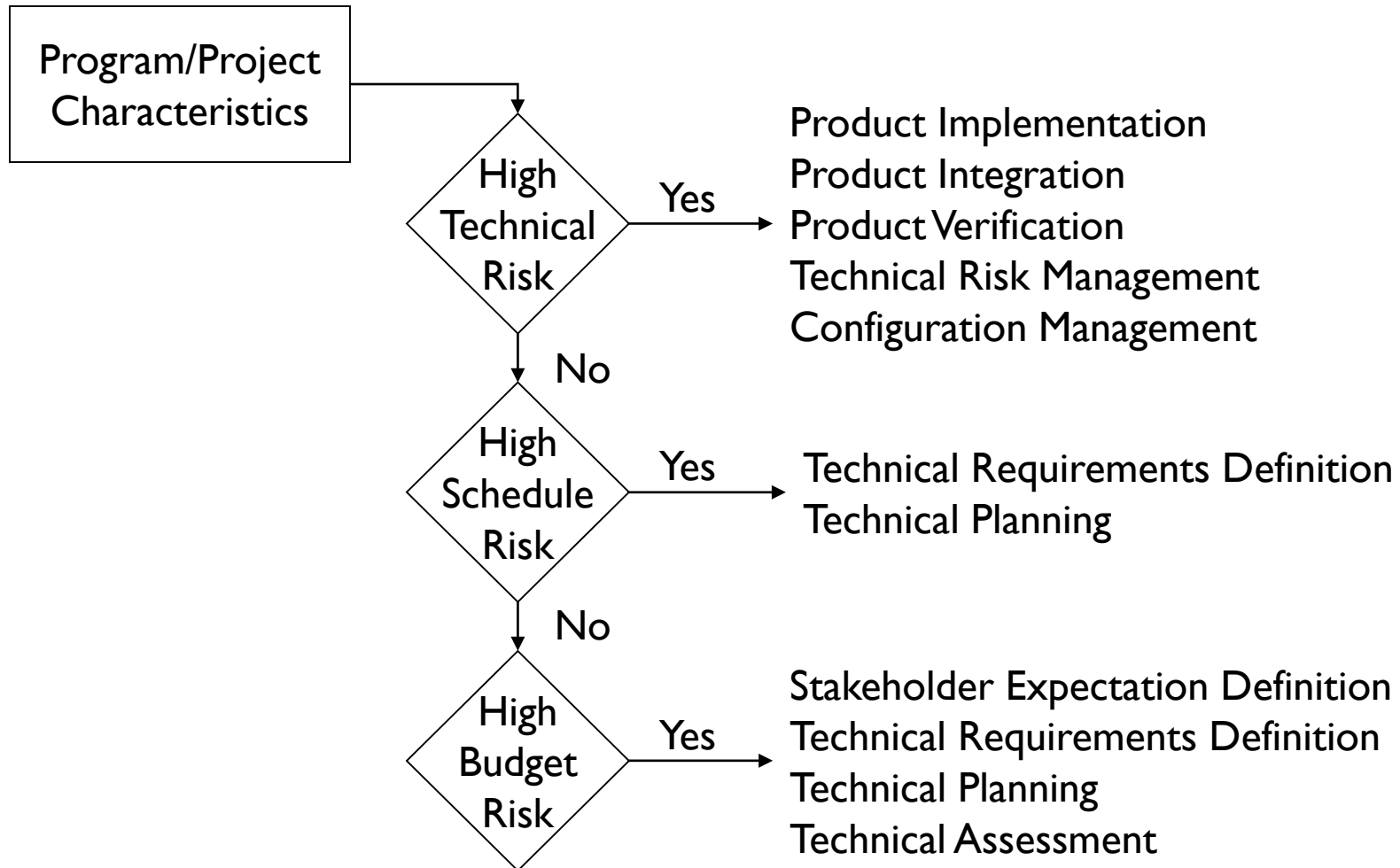
Presence of the SE Process supports Project Success (Motivators)

Project Success and System Engineering Processes	17. Decision Analysis	16. Technical Assessment	15. Technical Data Management	14. Configuration Management	13. Technical Risk Management	12. Interface Management	11. Requirements Management	10. Technical Planning	9. Product Transition	8. Product Validation	7. Product Verification	6. Product Integration	5. Product Implementation	4. Design Solution	3. Logical Decomposition	2. Technical Requirements Definition	1. Stakeholder Expectations Definition
	Observed Data																
Technical success relative to initial req.				√	√						√	√	√				
Technical success relative to similar projects				√	√						√	√	√				
On schedule relative to original project plan																	
On schedule relative to similar projects								√								√	
On budget relative to original project plan																	
On budget relative to similar projects								√								√	√
Satisfaction with project management process																	
Overall project success				√	√						√	√	√				

Absence of the SE Process hinders Project Success (Hygiene Factors)

Project Success and System Engineering Processes	17. Decision Analysis	16. Technical Assessment	15. Technical Data Management	14. Configuration Management	13. Technical Risk Management	12. Interface Management	11. Requirements Management	10. Technical Planning	9. Product Transition	8. Product Validation	7. Product Verification	6. Product Integration	5. Product Implementation	4. Design Solution	3. Logical Decomposition	2. Technical Requirements Definition	1. Stakeholder Expectations Definition
	Observed Data																
Technical success relative to initial req.																	
Technical success relative to similar projects																	
On schedule relative to original project plan								√	√		√				√		
On schedule relative to similar projects																	
On budget relative to original project plan								√	√		√				√		
On budget relative to similar projects																	
Satisfaction with project management process																	
Overall project success																	

Support for Future Projects



Team Characteristics for Successful Projects

Common

- ▶ Team members assigned 100% on the project
- ▶ Integration responsibility was either with contractor or shared jointly
- ▶ Teams met at least weekly, several daily
- ▶ Agendas and action item lists were used
- ▶ Teams consisted of good skill mix
- ▶ Unified commitment was shared among team members
- ▶ Project celebrated successes

Not Common

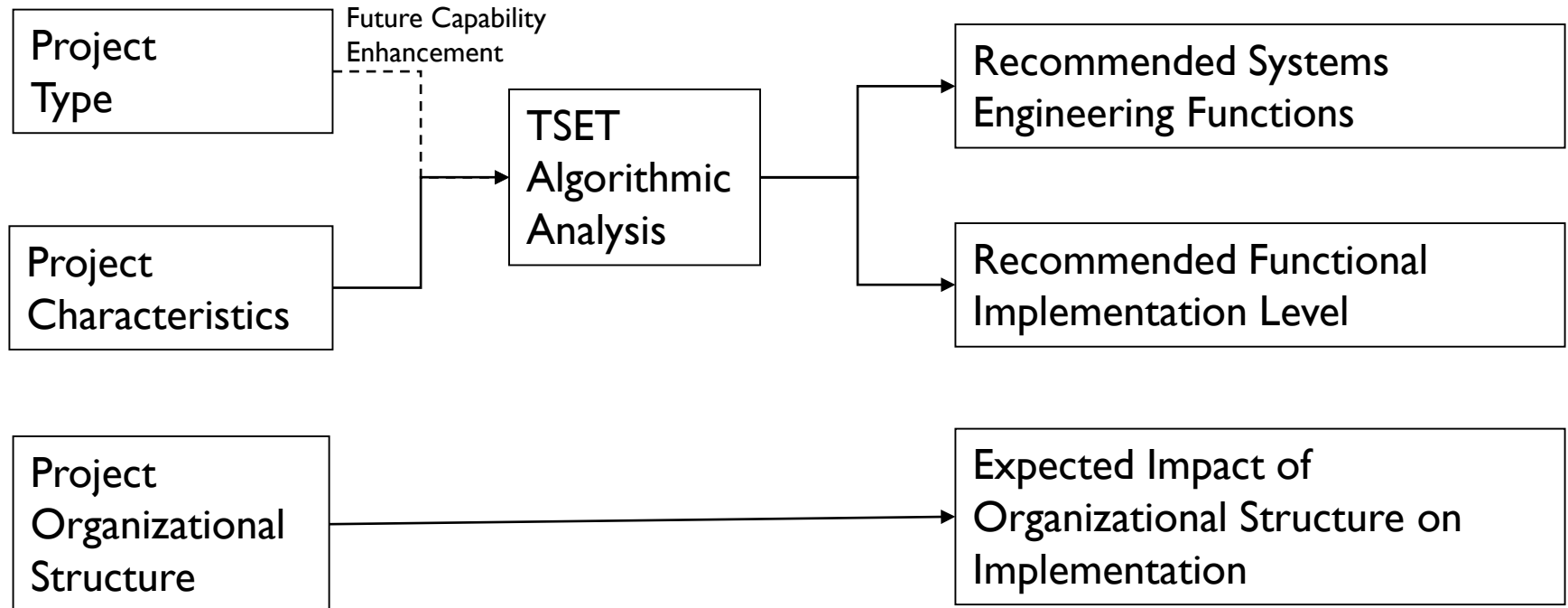
- ▶ Co-location of team members
- ▶ Common vision and common values not consistent
- ▶ Scope creep or number of changes were not consistent
- ▶ Reward structure not consistent
- ▶ Project size not consistent
- ▶ Leadership style not consistent
- ▶ Working approach not consistent

Tailoring Systems Engineering Processes

Program Team Inputs

TSET Internal

TSET Output



Project Characteristics* Input (Sample)

General Characteristics

Schedule Risk
Cost Risk
Other Personnel and Material Resources available to project
Experience of R&D Project Management
Organizations Involved: those participating in the project as stakeholders
Project planning
Impact of Project Results Outside of the Project Organization:

Project Characterization/Systems Engineering Map

Project Characteristics	SE Functions													
	Quality Management	Reliability Management	Systems Requirements Development Management	Risk Management	Concept Alternatives Management	Test Planning and Evaluation (T&E)	Human Systems Integration (HSI)	Systems Operations Support	Systems Safety Management	Systems Management	Subsystem Integration Management	Systems Integration Management		
Preliminary SE-PC Mapping (This version is controlled by SE Functions Team. Contact Paul Gradl or SE Team member for latest version.) Rev B (10/17/04)														
Time to Deliver	1	1	1	1	0	0	0	0	0	1	1	1	0	0
Budget/Cost	1	1	1	0	0	0	0	0	0	1	1	0	0	0
Other Personnel and Material Resources	0	0	0	1	0	0	0	1	0	1	1	1	0	0
Experience of R&D Project Management	0	0	1	1	0	0	0	0	0	1	0	1	0	1
Organizations Involved	0	1	1	1	0	0	0	1	0	0	0	0	1	1
Project planning	1	1	1	1	0	1	1	1	1	1	1	1	1	1
Impact of Project Results Outside of the Project Organization	0	1	1	0	0	0	0	1	0	1	0	0	0	0
Uniqueness of Requirements	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Design/Requirements stability	1	1	1	1	0	0	1	1	1	1	1	1	1	1
Scope of Requirements	0	1	1	1	1	0	1	1	1	1	1	1	1	1
Consistency standards	1	1	1	1	0	1	1	1	1	1	1	1	1	1
Project baseline control/flexibility	1	1	1	1	0	1	1	0	1	1	1	1	1	1
Constraints of the project or project organization	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Degree of Anticipated Technical Task Outsourcing	0	1	1	1	0	0	1	1	1	1	1	1	1	1
Degree of Project/System Concept Dependence on New Technology	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Project Design Organization's Technological Maturity/Risk	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Number of Technology Design Disciplines Involved in the Design Effort	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Diversity of New Technology Required	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Degree of System Complexity	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Degree of System Coupling	1	1	1	1	1	1	1	1	1	1	1	1	1	1
External or Environmental Interface Dependence	1	1	1	1	1	1	1	1	1	1	1	1	1	1

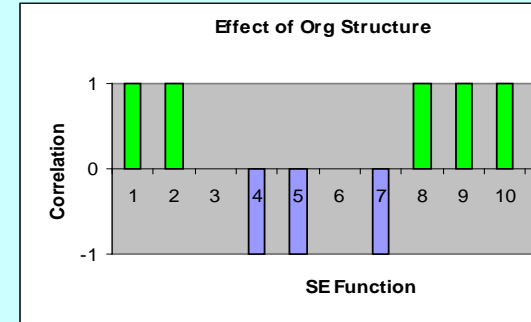
Quality Management

- ▶ Level 1 - Establish basic processes for inspection and verification of product conformance to specifications. Monitor variation in production units to identify product improvements.
- ▶ Level 2 - Establish efficient production methods for the Apply continuous improvement process methodology to identify performance issues and improvements. Determine root causes or production problems.
- ▶ Level 3 - Develop performance metrics and apply statistical methods to ensure product meets requirements. Establish processes to ensure customer feedback is collected and acted on. Evaluate supplier quality plans and suggest improvements where needed.

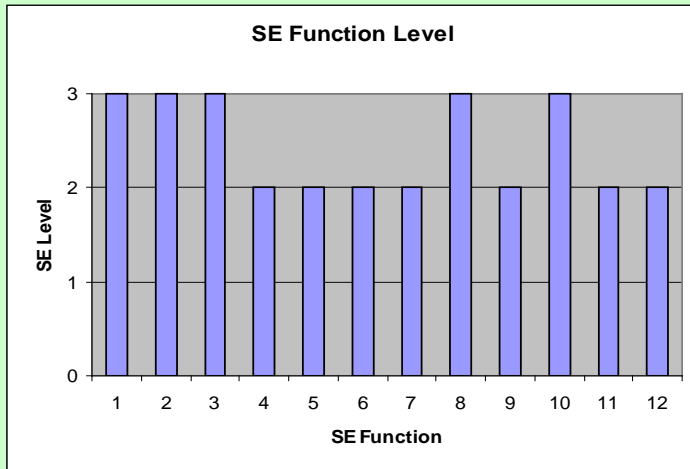
New Technology Project Output

Electronic Device Development

Recommended System Engineering Functions (SEF)			Org Structure Effect on SE Function
	SEF #	SEF Level	
Quality Management	1	3	1
Reliability Management	2	3	1
Systems Requirements Development Management	3	3	0
Risk Management	4	2	-1
Concept Alternatives Evaluation	5	2	-1
Test and Evaluation (T&E)	6	2	0
Human Systems Integration (HIS)	7	2	-1
System Operational Support	8	3	1
Systems Safety Management	9	2	1
Systems Management	10	3	1
Subsystem Integration Management	11	2	-1
Systems Integration Management	12	2	0



- 1 Your organizational structure facilitates this SE Function.
- 0 There is neither a positive or negative relationship between this Function and the organizational structure.
- 1 Due to your organizational structure additional coordination will be required to ensure that this SE function



This page contains your primary output:

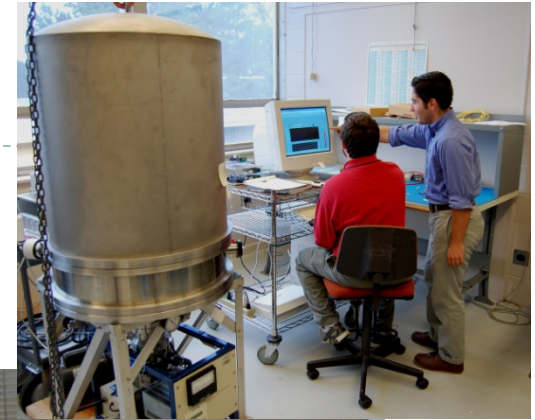
- 1 - Prioritized SE Functions by importance to your project. Higher SE Level indicates higher p
- 2 - Your SE Functions recommended levels of rigor. Push button below for details.
- 3 - The affect of your organization structure to accomplishing these SE Functions

Push to Review
SE Function & Rigor Level
Definitions

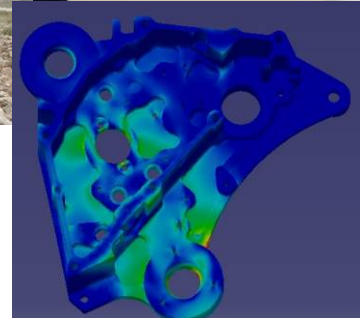
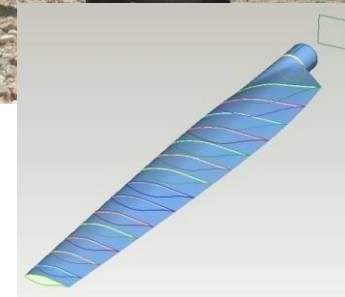
Start Over

Engineering Labs

- ▶ System Engineering Labs w/ full SE Software
- ▶ Electrical and Mechanical Design
- ▶ Manufacturing Labs
- ▶ Research Machine Shop
- ▶ Multiple System Design/Fabrication Labs
- ▶ Flight Simulation Labs
- ▶ Flight Test Research
- ▶ NDE/NDT

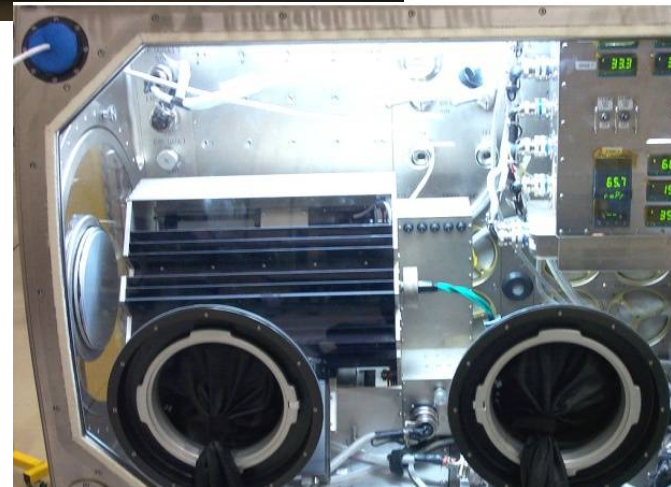
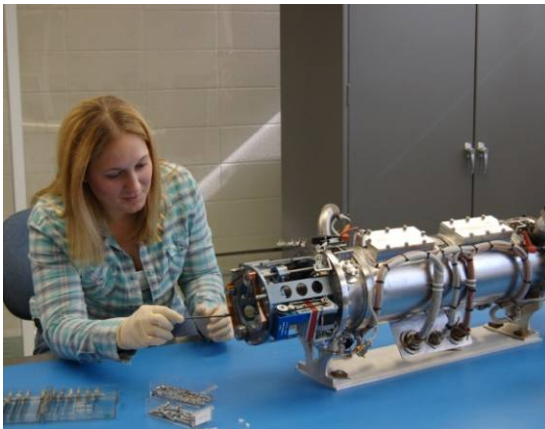
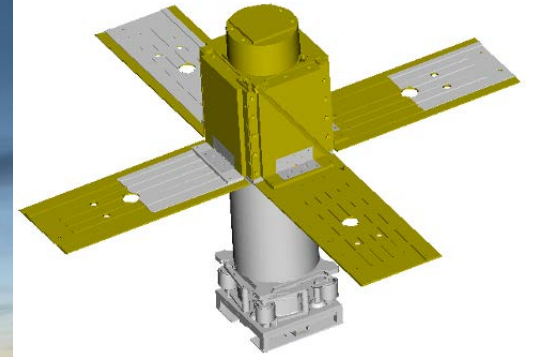


Engineering Design and Analysis



- ▶ **Design and Development**
- ▶ **Structural Analysis**
- ▶ **Testing**
- ▶ **Independent Analysis, Modeling and Simulation**

Design, Analysis, Development, Fabrication, and Test



19 ***All of these Projects Involve Systems Engineering at Different Levels***

Systems Engineering Lab

Fully Integrated SE Lab
 Analysis and System
 Engineering Software
 Integrated with CAD Lab,
 Computer Cluster, Rapid
 Prototyping Machines

KEY PERFORMANCE PARAMETERS		COMPANY 1			
[GO / NO GO CRITERIA]		9780-0095/0129		9780-0073 / -0074	
K.P.P. 1	AC: 400HZ, 3 Phase, 115/200V, 47kVA Cont., 69kVA Peak	-	-	-	-
	DC: 28V, 210A Cont., 500A Peak	-	-	-	-
	HYD.: 12gpm @ 3350psig (start), 15gpm @ 3000psig (service)	GO	-	GO	-
	PNEU.: 30lb/mm @ 30-50 psig	-	-	-	-

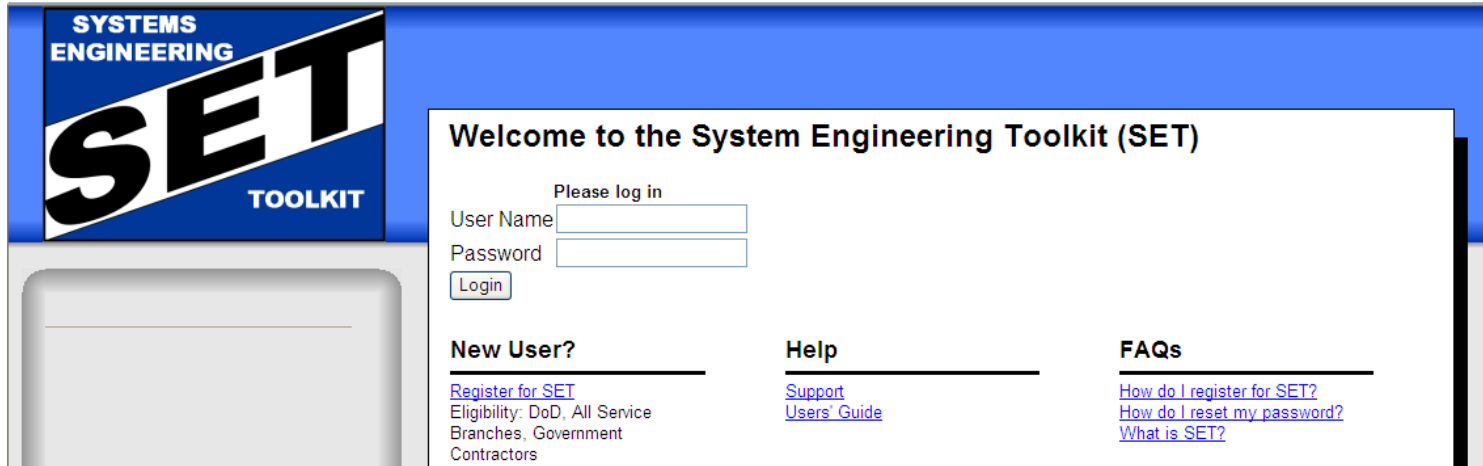
KEY SYSTEM ATTRIBUTES		Yes/No	COMMENTS
K.S.A. 1	Simultaneous Operations	YES	A/C, DC, Hydraulic and Pneumatic
K.S.A. 2	Mobility	?	Trailer L X W X H = 13' X 6.9' X 6.9'
K.S.A. 3	Transportability	YES	Weight = 7,700 lbs (wet)
K.S.A. 4	Reliability	?	



Systems Engineering Toolkit (SET)

- ▶ The tool is
 - ▶ Configuration Controlled with Global Access
 - ▶ Web based for generating Plans and Technical Documents
 - ▶ Modular/adaptable system to many different documents, applications, and phases
 - ▶ Allows team based planning development
- ▶ The Systems Engineering Toolkit presently assists in creating SEPs.
- ▶ It is anticipated that future versions will be composed of several systems engineering tools.

Systems Engineering Planning Tool



- Secure and controlled access to programs
- Foundation for metrics and statistical analysis
- Enhanced communications
- Global access to most up-to-date information
- Built in mapping of information
- Ability to strengthen planning process
- Tailoring for Phase, ACAT, project complexity and processes

Systems Engineering Tool

SYSTEMS ENGINEERING TOOLKIT

Account: Sue O'Brien ([Logout](#)) Active SEP: Tool Demo

Available Documents

Document	Permissions
Test SEP	Read, Approve, Write
TEST_SEP2V2	Write
LUH	Admin
Aviation Systems Test SEP	Admin
Tool Demo	Write, Admin, Version Control
Joint Air to Ground Missile (JAGM)	Write, Peer Approve, Admin
BlackHawk UH60M	Admin
JAVELIN	Admin

Messages

Date	From	Subject

Section Change Log

Section	Editor	Date
2.1 i Table of KPPs	Lisa Liever	22-APR-2008
3.5 a How will the program facilitate interaction among the SE Working-level Integrated Product Teams (WIPT), other government organizations, and contractors (as applicable) on technical tasks, activities, and responsibilities (e.g. requirements, technical baseline, technical reviews)? How will the program's organization and structure facilitate clear communication of technical guidance among these organizations engaged in SE activities? How will technical review entrance and exit criteria be handled between these organizations? How will the SE WIPT contribute to and document the technical and management approach?	Dawn Sabados	19-MAR-2008

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[Title & Coordination](#)
[Approval Sheet](#)

Based on OSD Guidance

- 1 Introduction
 - 1.1 Program Description and Applicable Documents
 - 1.2 Current Program Status
 - 1.3 Approach for SEP Updates
- + 2 Program Requirements
- + 3 Technical Staffing and Organizational Planning
- + 4 Technology Maturation and Planning
- + 5 Technical Review Planning
- + 6 Integration with Overall Management of the Program

[Attachments](#)
[Images](#)
[Acronym List](#)

Multiple Documents and Permission Levels Available to Users

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Systems Engineering Tool



SYSTEMS ENGINEERING
SET
TOOLKIT

Account: Sue O'Brien ([Logout](#)) Active SEP: Tool Demo

Section not complete. Cannot be submitted at this time.

Current Program Status

- a. Summarize the overall Acquisition Strategy emphasizing that it is event driven.
- b. Provide a program schedule which shows major milestones; SE technical reviews; and notional dates for major events (developmental, operational, and live fire test phases; deliveries; certifications; contract awards; training; site activation, etc.)
- c. Highlight the major activities that t independent reviews, risk reduction ac
- e. What technical refreshes are plan
- f. What are the top-level risks assoc and 6.3. Referencing these sections m
- g. How will the technical requiremen
- d. How does the Acquisition Strateg as the maturity of technologies to be us



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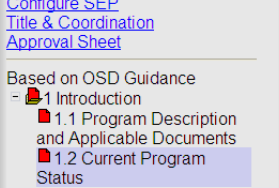
Based on OSD Guidance

- 1 Introduction
 - 1.1 Program Description and Applicable Documents
 - 1.2 Current Program Status
 - 1.3 Approach for SEP Updates
- + 2 Program Requirements
- + 3 Technical Staffing and Organizational Planning
- + 4 Technology Maturation and Planning
- + 5 Technical Review Planning
- + 6 Integration with Overall Management of the Program

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SYSTEMS ENGINEERING
SET
TOOLKIT

Account: Sue O'Brien ([Logout](#)) Active SEP: Joint Air to Ground Missile (JAGM)

b. Given the Requirements outlined in System Capabilities, Requirements, and Design Considerations, who are the appropriate technical authorities?

B / I U 

[The SE Directorate is organized to support each JAMS Product and SE functional area. The JAGM system Division Chief is the JAGM system LSE and coordinates with the Navy counterpart LSE. The LSE's primary responsibility is the day-to-day application of systems engineering principles, processes, and products and coordinates with the SE Director, the JAGM system Product Manager, and JAMS Project Manager (PM) through joint IPT process.

← ⌚ ? 📧 📁 🔒

Notes

Para with reference to SEIT was moved to 2.2.1.

Reviewer Comments

Date	Reviewer	Comment



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Based on OSD Guidance

- 1 Introduction
- 2 Systems Engineering Application to Life Cycle Phases
 - + 2.1 System Capabilities, Requirements, and Design Considerations
 - + 2.2 Systems Engineering Organizational Structure
 - + 2.3 Systems Engineering Process
 - + 2.4 Technical Management and Control
 - + 2.5 Integration with Other Program Management Control Effects

[Attachments](#)
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Document Generation

- Configuration controlled with automatic change logs
- Creates two types of PDF documents

The screenshot displays the SET Toolkit web interface. On the left, a navigation menu includes links for 'Generate Reports', 'My Page', 'Manage Users', 'Configure SEP', 'Title & Coordination', and 'Approval Sheet'. Below these are sections for 'Based on OSD Guidance' with numbered items 1 through 6, and 'Attachments' with links for 'Images' and 'Acronym List'. The main content area shows a preview of a document titled '1 Introduction'. The document text includes: 'Introduce the purpose of the SEP, who will use it, and how it will be used to define the conduct, management, and control of technical aspects of the program from concept to disposal. What are the plans to link the contractor's Systems Engineering Management Plan (SEMP) to the SEP?'; 'Introduce the approach to update the SEP in the Technology Development phase and throughout the life cycle as a living document.'; '1.1 Program Description and Applicable Documents. Provide a top-level mission description summarizing user requirements documented in the Initial Capabilities Document (ICD) and draft Capability Development Document (CDD). Enter a top-level system description conveying overall key aspects of the program. Include a notional diagram of the system. Use the appropriate DoD Architecture Framework views (e.g. Operational View-1). (When referencing details in other documents, reference by section and page of the document.)'; a table titled 'Table 1.1 Table of Applicable Documents' with columns for Document Name, Date, Status, and Point of Contact; '1.2 Current Program Status. Summarize the overall Acquisition Strategy emphasizing that it is event driven. Provide a program schedule which shows major milestones; SE technical reviews; and notional dates for major events (development, operational, and live fire test phases; deliveries, certifications; contract awards; training; site activation, etc.)'; 'Highlight the major activities that the program conducted to date such as outcomes of technical reviews, test phases, independent reviews, risk reduction activities, trade studies, etc.'; 'What technical reviews are planned in the System Development and Demonstration (SDD) phase?'; 'What are the top-level risks associated with technology and risk closure plans? Note: there is discussion of risk in sections 4.5 and 6.3. Referencing these sections may be appropriate.'; and 'How will the technical requirements and technical risks be addressed given program funding and schedule constraints?'. The bottom of the preview shows '1 of 14' pages. On the right, a sidebar contains user information: 'Account: Sue O'Brien (Logout) Active SEP: Blac', a note 'The document generation engine is still in the for attachments.', 'Current Version' with a 'Generate Draft' button, 'Document with notes and comments' with a 'Generate Working Copy' button, and 'Previous Versions'. At the bottom right, there is a smaller version of the navigation menu and a 'Based on OSD Guidance' section with items 1 and 2.

SYSTEMS ENGINEERING SET TOOLKIT

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1 Introduction
Introduce the purpose of the SEP, who will use it, and how it will be used to define the conduct, management, and control of technical aspects of the program from concept to disposal. What are the plans to link the contractor's Systems Engineering Management Plan (SEMP) to the SEP?

Introduce the approach to update the SEP in the Technology Development phase and throughout the life cycle as a living document.

1.1 Program Description and Applicable Documents
Provide a top-level mission description summarizing user requirements documented in the Initial Capabilities Document (ICD) and draft Capability Development Document (CDD). Enter a top-level system description conveying overall key aspects of the program. Include a notional diagram of the system. Use the appropriate DoD Architecture Framework views (e.g. Operational View-1). (When referencing details in other documents, reference by section and page of the document.)

Table 1.1 Table of Applicable Documents

Document Name	Date	Status	Point of Contact
---------------	------	--------	------------------

Discuss the documents tabulated above. What is the relationship between the SEP and these documents? Detail the linkage to other program documents.

1.2 Current Program Status
Summarize the overall Acquisition Strategy emphasizing that it is event driven. Provide a program schedule which shows major milestones; SE technical reviews; and notional dates for major events (development, operational, and live fire test phases; deliveries, certifications; contract awards; training; site activation, etc.) Highlight the major activities that the program conducted to date such as outcomes of technical reviews, test phases, independent reviews, risk reduction activities, trade studies, etc. What technical reviews are planned in the System Development and Demonstration (SDD) phase? What are the top-level risks associated with technology and risk closure plans? Note: there is discussion of risk in sections 4.5 and 6.3. Referencing these sections may be appropriate. How will the technical requirements and technical risks be addressed given program funding and schedule constraints?

1 of 14

SYSTEMS ENGINEERING SET TOOLKIT

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+ 1 Introduction
- 2 Systems Engineering Application to Life Cycle Phase

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Systems Engineering Toolkit

▶ Benefits

- ▶ Most up-to-date information
- ▶ Increased communications
- ▶ Ability to leverage strengths of other projects/programs
- ▶ Disciplined/ Known Process
- ▶ Decrease Approval Timeline
- ▶ Team-Based SEP Generation = Consistent Execution of a Multi-Disciplined Plan
- ▶ Minimize “Shelf-Ware”
- ▶ Means to collect metrics and best applied practices including statistics on users and level of experience
- ▶ Hands-on real time training