



# Enhancing Systems Engineering Planning and Practices

Sue O'Brien

Acting Director - RSESC

Rotorcraft Systems Engineering and Simulation Center

256-824-6133

[obriens@uah.edu](mailto:obriens@uah.edu)

Dawn Sabados, Ph.D.  
Research Engineer III



# RSESC/Army – Cost Sharing Cooperative Agreement Initial Goals

- In August 2002 UAH was competitively awarded cooperative agreement – AMRDEC/PEO Aviation and UAHuntsville
  - Establish a technical center to elevate rotorcraft knowledge and skill levels in Northern Alabama headquartered at UAHuntsville.
  - Establish degreed SE academic programs
  - Provide System Engineering Support to Redstone agencies
  - Support the sustaining engineering needs of the Army Aviation
  - Life Cycle Management
    - Systems Engineering
    - Reliability Centered Maintenance
    - Helicopter Aerodynamics

**\$1.1 Million Investment by UAH**



# RSESC

- Multifaceted Organization Focused on Applied Systems Engineering
- Independent Assessments
- Systems Engineering Support
- Hardware Design, Analysis, Fabrication and Testing
- Non Destructive Testing and Evaluation
- Reverse Engineering
- Health Monitoring
- Damage Tolerance
  
- Projects funded through NASA, PEO Aviation, PEO Missiles and Space, OSD, and Industry

# Education and Training

- Developed two new Master of Science Programs
  - Rotorcraft Systems Engineering
  - Missile Systems Engineering
- 56 Master of Science Degrees Conferred – Redstone Engineers
- 2 Current PhD students
- Developing two new AMRDEC / PEO related curricula
  - Reliability Engineering
  - Acquisition Engineering

# RSESC Curriculum

## MSE–Rotorcraft & Missile Systems Eng.

### 1<sup>st</sup> Semester

- Selected Topics in Mathematics
- Statistical Methods for Engineers
- Aircraft Stability and Control

### 3<sup>rd</sup> Semester

- Rotorcraft Design II
- Performance Flight Testing
- Modeling and Simulation

### 2<sup>nd</sup> Semester

- Helicopter Theory
- Aerospace Systems Engineering
- Rotorcraft Design I

### 4<sup>th</sup> Semester

- Engineering Reliability
- System Safety
- Aviation Systems Simulation

---

---

### 1<sup>st</sup> Semester

- Missile Aerodynamics
- Rocket Propulsion
- Aero Systems Engineering

### 3<sup>rd</sup> Semester

- Stability and Control
- Performance Flight Testing
- Reliability Engineering

### 2<sup>nd</sup> Semester

- Missile Design
- Graduate Engineering Analysis
- Statistical Methods

### 4<sup>th</sup> Semester

- System Simulation
- System Modeling & Analysis
- Integrated Product & Process Design

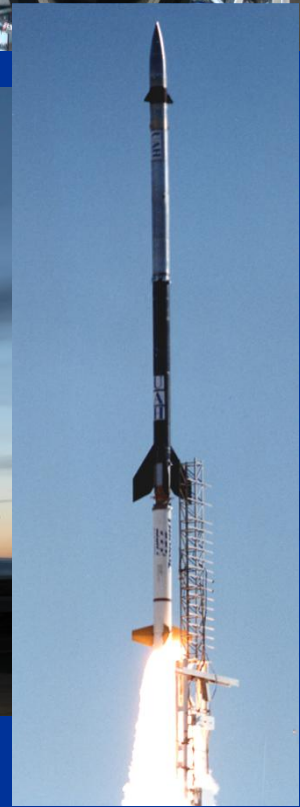
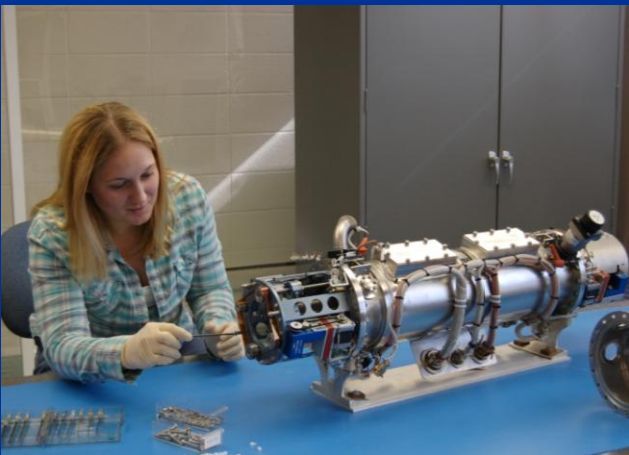


# RSESC Labs

- Two System Engineering Labs w/ full SE software resources
- Aero Simulation Lab
- Electrical and Mechanical Design and Manufacture Lab with a Machine Shop
- Modal Testing
- Environmental Testing
- Systems Design and Testing Lab
- NDE/NDT



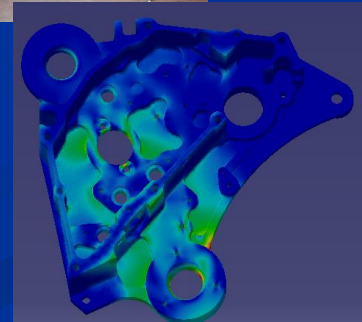
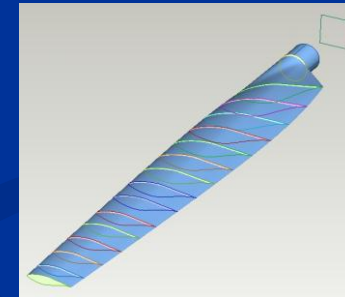
# SE Planning, Design, Simulate, Develop, Fabricate and Test



UAHuntsville  
Rotorcraft Systems Engineering and Simulation Center



# Design and Analysis



- Prototype Designs
- Independent Analysis
- Specialty Analysis



# Systems Engineering Labs



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

KEY PERFORMANCE PARAMETERS [GO / NO GO CRITERIA]		COMPANY 1			
K.P.P. 1		9780-0095/0129		9780-0073 / -0074	
	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/min @ 30-50 psig	-	-	-	-

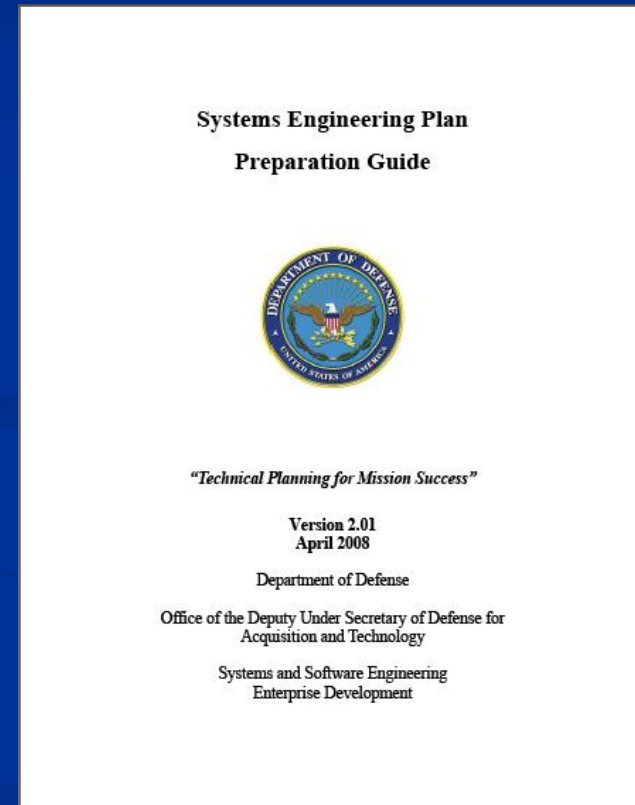
KEY SYSTEM ATTRIBUTES		Yes/No	COMMENTS
K.S.A. 1	Simultaneous Operations	YES	A/C, DC, Hydraulic and Pneumatic
K.S.A. 2	Mobility	?	Trailer L X W X H = 13' X 6.9' X 6.9'
K.S.A. 3	Transportability	YES	Weight = 7,700 lbs (wet)
K.S.A. 4	Reliability	?	



# Systems Engineering Toolkit & System Engineering Projects

# Revitalization of SE in DoD

- In February 2004, the Department of Defense mandated the revitalization of systems engineering throughout all the services
- All acquisition category level programs were required to create system engineering plans (SEP)
- From this mandate the Office of the Deputy Under the Secretary of Defense (OSD) created a SEP Preparation Guide for all programs to follow.





# Problem Statement

- Systems Engineering is highly complex subject
- Data is required in many engineering fields
- Metrics need to be determined to ensure systems engineering is performed effectively and efficiently
- One method to collect data and to create metrics was through a web based SE tool

# Solution

- The Rotorcraft Center's initial response to support PEO-Aviation and PEO-Missiles and Space in enhancing systems engineering planning was to create a checklist to ensure the requirements for systems planning were met in the SEP.
- This checklist evolved into the Systems Engineering Toolkit to ease the burden of creating a SEP and to create a means for metrics, sharing of information and application based learning to enhance systems engineering planning.

# Metric/Effectiveness

- Real time training
- Improved means to determine of areas of difficulty
- Clear Indication of the amount of time to create the document
- Ability to collect statistics on users and level of experience
- Time spent planning rather than formatting and issues with writing a complex document



# Systems Engineering Toolkit (SET)

- The Systems Engineering Toolkit presently assists in creating SEPs.
- It is anticipated that future versions will be composed of several systems engineering tools.
- The tool is
  - Configuration Controlled with Global Access
  - Web based for generating Plans and Technical Documents
  - Tailorable to the Projects Needs, Phase and ACAT Level
  - Modular/adaptable system to many different documents, applications, and phases
- Available to DoD agencies

# SEP Preparation

- SEP portion of the tool is created from:
  - OSD Preparation Guide
  - DAG Guide
  - Briefings from OSD on SEP content
- Beta Version of SET released June 2007
- SET Version 1.0 released March, 2008 based on SEP Guidance V. 2.01

## Title and Coordination Pages

### Table of Contents

#### 1. Introduction

##### 1.1 P

##### 1.2 P

##### 1.3 A

#### 2. Systems I

##### 2.1 S

##### 2.2 S

##### 2.3 S

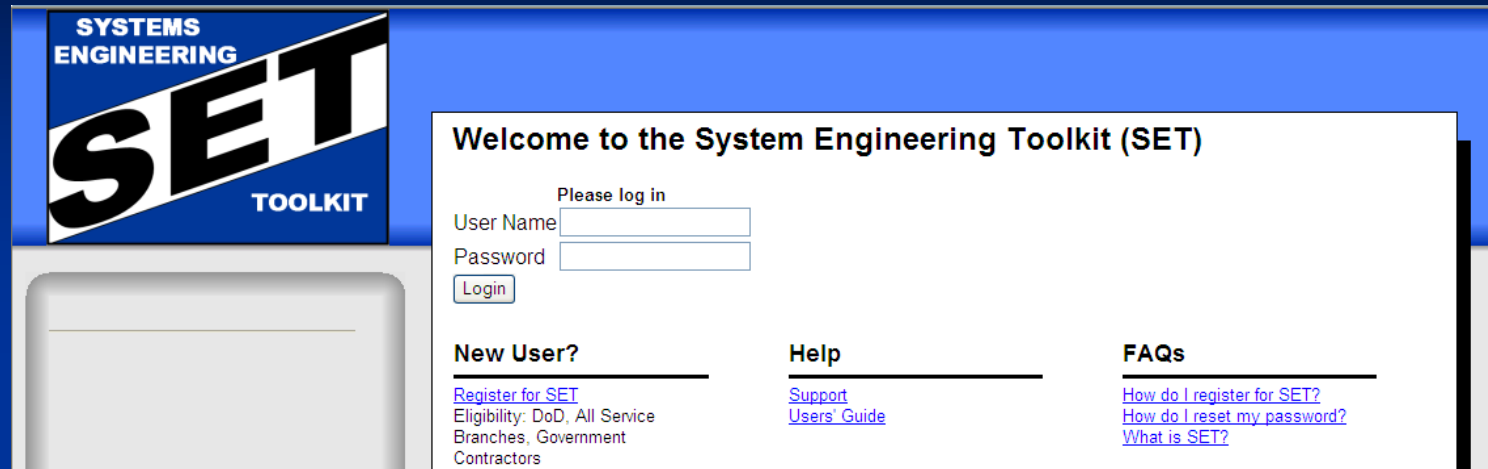
##### 2.4 T

##### 2.5 I

1	Introduction.....
1.1	Program Descriptions and Applicable Documents.....
1.2	Current Program Status.....
1.3	Approach for SEP Updates.....
2	Program Requirements.....
2.1	Capabilities, Requirements and Concept(s) of Operation.....
2.2	Other Requirements Linked to the Preferred Systems Concept.....
2.3	Critical Technologies.....
2.4	Technology Maturation Cost / Schedule Constraints.....
2.5	Technology Development and Evolving Acquisition Strategy.....
3	Technical Staffing and Organizational Planning.....
3.1	Lead/Chief Systems Engineer and Technical Authorities (Function).....
3.2	IPT Organization/Structure.....
3.3	IPT Staffing/Functional Skills.....
3.4	IPT Coordination.....
3.5	Integration with Contractors and External Organizations.....
4	Technology Maturation and Technical Planning.....
4.1	Technology Maturation Responsibility.....
4.2	Requirements Traceability and Verification.....
4.3	Technical Maturity and Risk.....
4.4	Mapping the Technical Baseline to the Preferred System Concept.....
4.5	Updating and Documenting the Preferred System Concept.....
5	Technical Review Planning.....
5.1	Event-Driven Technical Reviews.....
5.2	Technical Review Management.....
5.3	Independent Chairing of Technical Reviews.....
5.4	Stakeholder Participation in Technical Reviews.....
5.5	Peer Participation at Technical Reviews.....
6	Integration with Overall Management of the Program.....
6.1	Linkage with Other Program Plans.....
6.2	Use of Critical Paths and Technical Reviews.....
6.3	Risk Management Integration.....
6.4	Test and Evaluation and Life-Cycle Sustainment Integration.....
6.5	Contracting Considerations.....

ODUSD (A&T) Systems and Software Engineering/Enterprise Development  
[ATL-ED@osd.mil](mailto:ATL-ED@osd.mil)

# SEP Preparation Tool



The screenshot shows the login interface for the System Engineering Toolkit (SET). On the left is a logo with 'SYSTEMS ENGINEERING' above a large 'SET' and 'TOOLKIT' below it. The main content area has a title 'Welcome to the System Engineering Toolkit (SET)'. Below this is a login section with the text 'Please log in', followed by 'User Name' and 'Password' labels, each with a text input field. A 'Login' button is positioned below the password field. At the bottom, there are three columns of links: 'New User?' with links for 'Register for SET', 'Eligibility: DoD, All Service', 'Branches, Government', and 'Contractors'; 'Help' with links for 'Support' and 'Users Guide'; and 'FAQs' with links for 'How do I register for SET?', 'How do I reset my password?', and 'What is SET?'.

- Integrated review process
- Eight types of users
- Currently creates SEP into PDF documents, unchangeable only from within the SET preparation tool
- Secure and controlled access to programs
- Allows multiple users working on the same document at any time



# SEP Planning Tool

Navigation tree based on SEP Preparation Guide TOC

Colored Status Indicators



[Generate Reports](#)   [My Page](#)  
[Manage Users](#)  
[Configure SEP](#)  
[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](#)

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

## Account Options

[User Options](#)  
[Change Password](#)

©2007 All Rights Reserved UAH  
 Patent Pending

Multiple SEPs and Permission Levels Available to Users

Message Area

Change Log



[Webmaster](#)  
[Disclaimer](#)

[Contact Us](#)  
[FAQ](#)

©2007 All Rights Reserved UAH  
 Patent Pending

# SEP Planning Tool

SYSTEMS  
ENGINEERING

**SET**  
TOOLKIT

[Generate Reports](#) [My Page](#)  
[Manage Users](#)  
[Configure SEP](#)  
[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](#)



[Webmaster](#)  
[Disclaimer](#)

©2007 All Rights Reserved UAH  
Patent Pending



[Contact Us](#)  
[FAQ](#)

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 tie independent reviews, risk reduction activities, and milestones.
- ☒ e. What technical refreshes are planned?
- ☒ f. What are the top-level risks associated with the program and 6.3. Referencing these sections must be done.
- ☒ g. How will the technical requirements be managed?
- ☐ d. How does the Acquisition Strategy reflect the maturity of technologies to be used?

©2007 All Rights Reserved UAH  
Patent Pending

SYSTEMS  
ENGINEERING

**SET**  
TOOLKIT

[Generate Reports](#) [My Page](#)  
[Manage Users](#)  
[Title & Coordination](#)  
[Approval Sheet](#)

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



[Webmaster](#)  
[Disclaimer](#)

©2007 All Rights Reserved UAH  
Patent Pending



[Contact Us](#)  
[FAQ](#)

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

©2007 All Rights Reserved UAH  
Patent Pending

# Document Generation

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

**SYSTEMS ENGINEERING SET TOOLKIT**

[Generate Reports](#) [My Page](#)  
[Manage Users](#)  
[Configure SEP](#)  
[Title & Coordination](#)  
[Approval Sheet](#)

Based on OSD Guidance

- 1 Introduction
- 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](#)

**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 (developmental, 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 refreshes 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**

[Generate Reports](#) [My Page](#)  
[Manage Users](#)  
[Title & Coordination](#)  
[Approval Sheet](#)

Based on OSD Guidance

- 1 Introduction
- 2 Systems Engineering Application to Life Cycle Phases

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

The document generation engine is still in the for attachments.

**Current Version**  
[Generate Draft](#)

**Document with notes and comments**  
[Generate Working Copy](#)

**Previous Versions**  
©2007 All Rights Reserved UAH  
Patent Pending

Webmaster  
Disclaimer  
©2007 All Rights Reserved UAH

Contact Us  
FAQ

# Systems Engineering Toolkit

## ■ Benefits

- Most up-to-date information
- Ability to leverage strengths of other projects/programs
- Uniformity of Process
- Decrease Approval Timeline
- Team-Based SEP Generation = Consistent Execution
- Minimize “Shelf-Ware”
- Means to collect metrics and best applied practices

## ■ Ten Organizations interested in or using the tool

- |   |                                  |
|---|----------------------------------|
| ■ PEO Aviation                            | ■ TARDEC                         |
| ■ PEO Missiles and Space                  | ■ PEO IEW&S                      |
| ■ Joint PEO Chemical & Biological Defense | ■ PEO C3T                        |
| ■ NAVAIR in support of JPEO CBD           | ■ PEO CS&CSS                     |
| ■ AMRDEC                                  | ■ Marines in support of JPEO CBD |



# UAHuntsville's Involvement in SE

- Partnership created with AMRDEC in Huntsville to support Project offices in SEP development
- Training, educating and mentoring on tools, metrics and teaming in relation to systems engineering
- Active member of the Army Systems Engineering Forum since its inception
- Reviewing and creating workshops in Systems Engineering Planning for PEO-Aviation, PEO-Missiles and Space and NASA/MSFC
- Developing processes to assist in SE activities for NASA/MSFC
- Determining the effectiveness of SE
- Teaming
- Tailoring for the SEMP and SE Processes
- Modeling and Simulation of SE Processes



Center for Modeling, Simulation and Analysis



College of Engineering

Industrial and Systems Engineering and Engineering Management

Industrial and Systems Engineering and Engineering Management



# SER-UARC

- January 23, 2008 OSD sent a notice regarding creating a Systems Engineering Research (SER) University Affiliated Research Center (UARC).
- UAHuntsville partnered with Stevens Institute of Technology, Univ. of Southern CA and 14 other universities
- Two initial tasks have been identified that RSESC will be involved in
  - SE Effectiveness
  - Evaluating Methods, Processes and Tools (MPTs)



## **U.S. Department of Defense**

Office of the Deputy Under Secretary of Defense (Acquisition and Technology) Systems and Software Engineering

# Summary

- Vast experience in applied systems engineering processes, hardware and software development to add value to overall project success
- Experience in Systems Engineering and the practices of OSD and NASA
- Utilizing graduate and undergraduates on research projects to combine theory with practical applications and to help mentor engineers and scientists entering in the workforce
- Willing to partner with other universities and organizations bringing together the best assets to the community
- Systems Engineering Toolkit (SET) is available to the DoD PM offices and NASA

**UAHuntsville and the Rotorcraft Systems Engineering and Simulation Center is committed to becoming one of the top research centers for Systems Engineering**