Panel: Systems Engineering Considerations in Practicing Test & Evaluation

A Perspective from DoD

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Office of the Director, Defense Research and Engineering

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Support from the Top for Change

Weapon Systems Acquisition Reform Act of 2009
(Public Law 111-23)

- Establishes Director, Systems Engineering (D, SE) and Director, Developmental Test and Evaluation (D, DT&E) as principal advisors to the SECDEF and the USD(AT&L)
- Mandates documented assessment of technological maturity and integration risk of critical technologies for MDAPs
- Establishes D, DT&E and D, SE Congressional reporting on MDAP achievement of measurable performance criteria
- Mandates competitive prototyping and MDA completion of a formal Post-Preliminary Design Review Assessment for all MDAPs before MS B
- Strengthens technical analysis of cost and schedule breaches during Technology Development (pre-MS B) and Engineering and Manufacturing Development (post-MS B)


MDAP - Major Defense Acquisition Program (USC 2430)
MDA – Milestone Decision Authority
We execute substantive technical engagement throughout the acquisition life cycle with major and selected acquisition efforts across DoD.

We apply best engineering practices to:

- Help program managers identify and mitigate risks
- Shape technical planning and management
- Support and advocate for DoD Component initiatives
- Provide insight to OSD stakeholders
- Identify systemic issues for resolution above the program level
- Support Knowledge Based Decision Making

We are the “E” in DDR&E
Pre-MS A Technical Engagement and Authority

• Major acquisition programs are being initiated without adequate technical foundation, resulting in cost and schedule growth

• Acquisition policy has been updated to require Pre-MS B systems engineering engagement and technical risk reduction activity (e.g. Preliminary Design Review, prototyping)

• There remains a Gap in pre-MS A and pre-MDD engagement

• WSARA directed the D, SE to oversee Component Development Planning which can address this gap

• Solution strategy:
  – Clear policy and guidance for Component Development Planning activities
  – Identify resources to perform these activities

• The goal
  – Informed investment decision and engineered alternatives with sufficiently understood technical risk
  – Improved technical planning for post-MS A risk reduction and system solution development activities resulting in more accurate early cost and schedule estimates
Development Planning

- OSD Development Planning leadership is required by WSARA
  - The D, SE shall oversee Development Planning activities of major defense acquisition programs, and periodically assess Component Development Planning capabilities

Analysis of future user needs and engineering of new system concepts in a System of Systems (SoS) operational environment

Multiple sufficiently robust materiel options to address gap

Defined costs and benefits of the options

Preferred solution with clear evidence and understanding of risk

Sufficiently robust materiel solution and solid TD planning

Development Planning

Development Planning is the upfront technical preparation to ensure successful selection and development of a materiel solution
Development Planning

Translating User Needs and Opportunities Into Viable Solutions

Concept Development and Engineering

Concept Evaluation and Refinement

Strategic Guidance
Joint Concepts
CBA
ICD

MDD
Analysis of Alternatives
Engineering Analysis
ASR
Materiel Solution Analysis
Technology Development

DoD 5000
### Significant Technical Issues Pre-MS A

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<th>ISSUE</th>
<th>IMPACTS</th>
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| • Lack of technical engagement with the operational user  
  o To make user aware of potential solutions  
  o To ensure technical developer fully understands user performance needs | • Missed solution opportunities  
• System requirements growth due to lack of understanding |
| • Program-focused analysis, when solutions will impact broad sets of systems and SoS | • Delivery of capability that will not integrate, or that has reduced benefit because of external system issues |
| • Lack of technical modeling and assessment of concepts that enter into the AoA | • Increased AoA time and cost |

![Diagram showing MDD, Analysis of Alternatives, Engineering Analysis, ASR, Materiel Solution Analysis, Technology Development, and DoD 5000]

- Strategic Guidance  
  - Joint Concepts  
  - CBA  
  - ICD
Benefit of Development Planning Engagement

1. Iterative, rapid, anticipatory interface between operational and technical community

- Lack of technical engagement with the operational user
  - To make user aware of potential solutions
  - To ensure technical developer fully understands user performance needs
- Missed solution opportunities
- System requirements growth due to lack of understanding of the CONOPS

2. Mature, valid concepts and technical models from broad set of options to enter and bolster the AoA

- Program-focused analysis, when solutions will impact broad sets of systems and SoS

3. Engineering analysis that considers strategic direction, operational context, SoS and legacy integration

- Lack of technical modeling and assessment of concepts that enter into the AoA
- Increased AoA time and cost due to evaluation of solutions that are not feasible

Strategic Guidance Joint Concepts

CBA ICD

MDD Analysis of Alternatives Engineering Analysis ASR

Materiel Solution Analysis Technology Development

DoD 5000
Development Planning

Translating User Needs and Opportunities Into Viable Solutions

Concept Development and Engineering

Concept Evaluation and Refinement

Development Planning

Concept Engineering

Concept Evaluation

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Materiel Solution Analysis

Technology Development

DoD 5000

Strategic Guidance

Joint Concepts

CBA

ICD

MDD

ASR

A
Opportunities

• Acquisition reform efforts have recognized criticality of strong Systems Engineering focus for program success
  – Systems Engineering toolkit focused on identifying and managing risk – development risk, production risk and life-cycle

• Growing focus on addressing “early-acquisition” phases - requirements definition, development planning, and early acquisition system engineering support
  – Leading to more informed decisions at MS B

• Our development processes need to evolve to provide faster product cycles, more adaptable products and address emerging challenges

• Future US Defense capabilities depend on a capable US engineering workforce in and out of government
  – Need to create opportunities to grow future “Engineering Heroes”
The Way Ahead

• Quadrennial Defense Review Executive Summary, February 2010
  – Further rebalance the capabilities of America’s Armed Forces to prevail in today’s wars, while building the capabilities needed to deal with future threats
  – Further reform the Department’s institutions and processes to better support the current needs of the war fighter; buy weapons that are usable, affordable and truly needed; and ensure that taxpayer dollars are spent wisely and responsibly
  – Preserve and enhance the All-Volunteer Force
  – Improve how it matches requirements with mature technologies, maintains disciplined systems engineering approaches, institutionalizes rapid acquisition capabilities, and implements more comprehensive testing

• Quadrennial Defense Review Report Preface
  Secretary of Defense Robert M. Gates, February 2010
  – United States needs a broad portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict
Systems Engineering: Critical to Program Success

Innovation, Speed and Agility
Director, Systems Engineering

Steve Welby

Terry Jaggers, Principal Deputy

Director, Systems Engineering

Mission Assurance
Nicholas Torelli

System Analysis
Kristen Baldwin

Mission Assurance
Nicholas Torelli

Major Program Support
James Thompson

- System Complexity Analysis
- Red Teaming
- Modeling & Simulation Coordination Office
- Development Planning
- SE for Systems of Systems
- Program Protection/Acquisition Cyber Security
- SE Research Center

- Systems Engineering Policy, Guidance, Standards
- System Safety
- Reliability, Availability, Maintainability
- Quality, Manufacturing, Producibility
- Human Systems Integration (HSI)
- Technical Workforce Development
- Organizational Capability Assessment (WSARA)

- Program Support Reviews
- Systems Engineering Plans
- Program Technical Auditing
- OIPT/DAB/DSAB Support
- DAES Database Analysis and Support
- Performance Measurement
- Systemic Root Cause Analysis

Responsible to provide technical support, systems engineering oversight, program development and mission assurance certification to USD(AT&L) in support of planned and ongoing acquisition programs
1. Accelerate delivery of technical capabilities to win the current fight.

2. Prepare for an uncertain future.

3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.

4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.
Systems Engineering Focus for Accomplishing DDR&E Imperatives

1. Accelerate delivery of technical capabilities to win the current fight
   – Support the current fight, manage risk with discipline

2. Prepare for an uncertain future
   – Grow engineering capabilities to address emerging challenges

3. Reduce the cost, acquisition time and risk of our Major Defense Acquisition Programs
   – Champion Systems Engineering as a tool to improve acquisition quality

4. Develop World Class Science, Technology, Engineering and Mathematics capabilities for the DoD and the Nation
   – Develop future technical leaders across the acquisition enterprise
DoD 5000.02 and PL 111-23 — the Changed Acquisition Landscape

Renewed Emphasis on Development Planning and Early Engineering Engagement

New 2366a & 2366b Certifications*

MS A → MS B

Materiel Solution Analysis → Technology Development → CDD → Engineering and Manufacturing Development → CPD → Production and Deployment → O&S

CBA → ICD → MDD

Development Planning

Materiel Development Decision (MDD)

Mandatory Competitive Prototypes

PDR, PDR Report to the MDA, and Post-PDR Assessment before MS B

PDR → CDR

System-level CDR with an initial product baseline and a Post-CDR Report to the MDA

Post-CDR Assessment by the MDA between EMD sub-phases

Full Rate Production Decision Review

Renewed emphasis on manufacturing across the lifecycle

“Knowledge-based” Decision Making . . . making acquisition decisions when you have solid evidence and acceptable risk

* Director, SE supports MDA certifications including PDR Report assessment at MS B
Perspective for the Next Decade


- Cold War
- Vietnam War

National Security Challenges

- Satellite comms
- ICBM

Defense Capabilities

- LGB’s
- GPS

- C4ISR
- Stealth

- UAV
- Robotics
- Night Vision

Enabling Technologies

- Transistor
- Solid state laser
- Space tracking
- Digital computing

- Composite Materials
- MEMS
- Superconductors
- VHSIC
- MIMIC

- IR Sensors
- High Performance Computing
- Web protocols

- Advanced Electronics, Photonics Algorithms, MEMS
  - Nano; Meta; & New Materials
  - Cognitive Computing
  - Bio-Revolution

Human Terrain
Ubiquitous Observation
Contextual Exploitation
Scaleable Action

Irregular/Hybrid Warfare

Collapse of Soviet Union
Desert Storm
Kosovo
Bosnia
OIF
OEF

OIF
OEF
Kosovo
Bosnia
Desert Storm
Collapse of Soviet Union
The Timeline has Collapsed!

**Conventional Warfare**

**USAF Capability**
- High Altitude Aircraft
- Electronic Countermeasures
- Endgame Countermeasures

**Adversary Capability**
- High Altitude SAM
- Monopulse SAM
- SAM with ECCM
- Engage SAM

**Response loop measured in years**

**Counter-Insurgency Warfare**

**US Capability**
- Jammers
- Mine Resistant Ambush Protected (MRAP)

**Adversary Capability**
- Advanced Technology

**Response loop measured in months or weeks**
Multi-Level Engagement

System Engineering

Policy & Guidance
- Systems Engineering
- Software Engineering

Program Support
- Program Support Reviews
- OIPT and SE WIPTs
- AOTR, Post-PDR/CDR Review & Assessment

Workforce Planning
- Competency Models
- Certification Requirements
- Education & Training

Emerging Concepts
- Systems of Systems
- SE Research

Outreach
- SE Forum
- Engagement Strategy

Education & Collaboration Infrastructure
- Professional/Industry Associations
- DAU, Academic Institutions, SERC, International Partners

Congress
- Statutory Direction

OSD
- Policy and Guidance

Requirement Developers
- ICD, CDD, CPD

Service Acquisition Executives

PEOs/Program Offices

Engineering Centers and Evaluation Commands

Prime Contractors and Supply Chain

Improved SE Methods, Processes, and Tools, International and National Standards

DAB, ITAB, DSAB, OIPT, PSR, SEP, PPP, Technical Reviews, SE WIPT

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