How Systems Engineering Supports Developmental Test and Evaluation

Dr. James Streilein
Technical Director/Deputy Commander ATEC
How We Fit

Independent Reporting Mandated by US Code, OMB, and OSD

ATEC Mission
Plan, test, independently evaluate, and report throughout program lifecycles to advise combat developers/functional proponents, PEOs, and Senior Leadership

Army Proven
Battle Ready
**Systems Engineering**

**Capability Gap Identification**
- JCIDS
  - FAA, FNA, FSA

**Inputs**
- ICD/CDD, O&O, ASR, SEP, CDD

**Interpret User Needs, Develop & Refine SoS Performance Spec & Functional Specs**

**System of System Specification**

**Prime Item & CI Development Specs**

**Develop System Functional Specs into PID’s / PCD’s and CI Functional (design to) Specs**

**Preliminary Design**

**Evolve Functional Specs into Product (build to) Documentation**

**Component Verification**

**Build**

**Integration and Verification**
- System Integration Verification
- Subsystem Integration Verification

**Analysis and Simulation**

**Test**

**Verification**

**Early T&E Involvement**

**OT&E Validation**
- Army Operational Validation
  - Combined DT&E / OT&E / LFT&E Demonstrate SoS Compliance to Specs

**Capabilities, Limitations**
- ATEC FAA, FNA, FSA results

**Context Dependence**

**Mission-Task, SoS-Task**

**INPUTS**

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**Mission-Task, SoS-Task**

**INPUTS**
Mission-Based Systems Engineering

• Unlike the commercial arena, systems engineering for military applications must be more rigorous to ensure effectiveness, suitability, and personnel survivability in the harshest environments.

• As such, effective systems engineering must expand requirements analysis into the mission context.

• The expansion requires an understanding of the engineered attributes (function and performance) of the system. Part of that understanding is learned through DT.

• Mission-based approach can lead the way to research, develop, test and verify mission capabilities.
  – Goal is robust application for SoS, commercial-off-the-shelf intensive systems, and recapitalized systems.
MBT&E and SE

Mission-Based T&E

(2) Define Mission Context
- Determine Operational Mission
- Determine Factors & Conditions

(3) Develop Mission Tasks
- Conduct Mission Analysis
- Link to Authoritative Tasks

(4) Develop Supporting Tasks
- Determine Conditional Tasks
- Determine Enabling Tasks

(5) Identify Task Capabilities
- Identify Capability Requirements
- Associate Tasks with Required Capabilities

(6) Determine System-of-System Components (physical architecture)

(7) Develop System Attributes
- Identify Attribute Requirements
- Associate Components with Attributes

(8) Associate Task Capabilities with Component Attributes

Understand the Mission

Systems Engineering

Requirements Analysis
- Missions and Environments
- Functional Requirements
- Define Performance Requirements

Functional Analysis
- Decompose to lower level Functions
- Allocate Performance
- Define Functional Interfaces

Synthesis
- Transform Architectures
- Define Alternative System Concepts
- Define Physical Interfaces
- Define Alternative Products & Process

Understand the System
MBT&E & SE Aligned Goals*

• Execute SE and scope T&E efforts earlier in the acquisition cycle based on mission task capabilities.
  – Addresses:
    • “Insufficient systems engineering applied early in the program life cycle…”
    • “Requirements not always well-managed, including the effective translation from capabilities statements into executable requirements…”
  – By: Focusing on mission task capabilities as the starting point.

• Enable robust SE and T&E strategy development for Joint networked SoS and a common environment for collaborative effort between capabilities developer, materiel developer and T&E.
  – Addresses: “Collaborative environments, including SE tools, are inadequate to effectively execute SE at the joint capability, SoS and system levels.”
  – By: Using a framework that links all components of the SoS to the mission capability and uses a common definition of terms.

* From NDIA SE Division Task Group Report July 2006
SE Connections to T&E

• T&E must be an integrated aspect of the SE process from virtually the beginning to the end.
  – Both DT and OT are integral to the SE process.
  – DT addressing the technical maturity and specification compliance.
  – OT addressing customer needs and satisfaction.

• Testers working together with requirements systems engineers assure requirements and specifications are unambiguous and verifiable.

• The role of SE is determining and translating operational needs to engineering specifications. MBT&E checks both.

• T&E supports the system engineering process by turning information into knowledge.
  – The cost associated with obtaining information is not trivial. However, the cost of ignorance is huge.
  – Some believe testing is expensive but fixing the problems found late in the program is far more expensive.

• Successful design reviews answer questions, assure risk is appropriate and convince decision makers to approve moving into the next phase.
  – T&E results provide the most compelling rationale.
Challenges

- Integrating DT/OT
- Information Assurance/Network security
- Software
- System of Systems integrations
- Live, Virtual, Constructive considerations