Early Systems Engineering –
A Level of Analytical Fidelity to
Support MDD and MS A Decisions

“Risk, Trade Space, and
Analytics in Acquisition”
MORS Workshop
21 September 2011
DP underpins pre-acquisition CBP
Early SE enables the technical elements of DP

Inputs:
- Capability gaps and shortfalls identified during CBA
- Technology opportunities
- Leadership direction

Outputs:
Data to technically inform / support SAE recommendations at MDD, AoA, and Milestone A

INPUTS
- Capability gaps and shortfalls identified during CBA
- Technology opportunities
- Leadership direction

OUTPUTS
Data to technically inform / support SAE recommendations at MDD, AoA, and Milestone A

TRADE SPACE CHARACTERIZATION
- Capability Decomposition / Analysis
- Trade Space Exploration
- Trade Space Refinement and Concept Exploration

IMPLEMENTATION ANALYSIS
- Overall Assessment
- Programmatic Analysis
- Verification Assessment

Disciplined, analysis-based decision support
Early SE “V”

TRADE SPACE CHARACTERIZATION

1. TRADE SPACE EXPLORATION
2. TRADE SPACE REFINEMENT and CONCEPT EXPLORATION
3. ARCHITECTURE CHARACTERIZATION
4. PROGRAMMATIC ANALYSIS
5. OVERALL ASSESSMENT

IMPLEMENTATION ANALYSIS

CANDIDATE SOLUTION SETS CHARACTERIZATION

1. SYSTEM INTEGRATION
2. SYSTEM CHARACTERIZATION

EARLY SE “EXAMINATION POINTS”
1. Candidate Solution Sets Selection
2. Initial Concepts Review
3. Concept Characterization Review
4. Final Concepts Review
5. Release Approval

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Trade Space Characterization

TRADE SPACE CHARACTERIZATION

CAPABILITY DECOMPOSITION / ANALYSIS
Interpret user needs; analyze operational capability shortfalls; identify sponsor’s top-level “value elements” to focus effort

TRADE SPACE EXPLORATION
Develop capability trade space; identify key “ABC” (Assumptions, Boundaries, Constraints)

TRADE SPACE REFINEMENT & CONCEPT EXPLORATION
Decompose capability trade space into prospective solution sets; establish SoS and capability-level objectives (e.g., MOEs)

- Trade Space Characterization checks of potential programmatics and critical portfolio considerations (essentially the “1000s-to-100s” filter) include, e.g.,
  > Affordability
  > Technology maturation timelines
  > Industrial base adequacy
  > Architecture/SoS Requirements

- “ABC” have to be relevant to Value Elements as they represent the basis of MOEs
- Further investigations against capability objectives provide the “100s-to-10s” filter

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Candidate Solution Sets Characterization

ARCHITECTURE CHARACTERIZATION
Decompose solution sets into constituent elements; establish system-level objectives (e.g., MOPs)

SYSTEM CHARACTERIZATION
Develop details of elements; identify key constraints and cost drivers (e.g., enabling / critical technologies); identify “DE” (Dependencies, Enablers)

SYSTEM INTEGRATION
Reassemble candidate solution sets from elements; analyze/assess performance vs. system objectives

CANDIDATE SOLUTION SETS CHARACTERIZATION

- Detail work inside Candidate Solution Sets Characterization should focus on concepts with a reasonable chance of timely maturation (the “10s of reasonable approaches”)
- The “DE” should include things that have historically led to significant program issues when not given sufficient or timely consideration, e.g.,:
  - Key interfaces (e.g., data and comm systems)
  - Configuration management at SoS level
  - Intelligence inputs
  - Basing / support infrastructure

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Implementation Analysis

OVERALL ASSESSMENT
Analyze / assess capability vs. defined user needs; validate trade space adequacy (include examination of other approaches, e.g., S&T investment)

PROGRAMMATIC ANALYSIS
Assess operational, technical, and technology risks; assess overall affordability (include examination of incremental acquisition strategies)

VERIFICATION ASSESSMENT
Analyze / assess concept performance including "ABCDE" and SoS considerations; analyze / assess functional performance vs. capability objectives

"Trade space adequacy" is critical to DCAPE approval … a good plan sets AoA up for success

"Assessments vs capability objectives" reflect the growing knowledge base of the select few candidate approaches

Moving up the block does NOT mean revisiting the 100s and 1000s
Fitting It All Together

TRADE SPACE EXPLORATION
Sponsor’s most critical value element(s); what’s driving the discussion
Sponsor lead (“blue-sky” brainstorming)

1000s of ideas

Assumptions, Boundaries, Constraints

CONCEPT EXPLORATION & TRADE SPACE REFINEMENT
Art / Realm of the Possible
Broader cross-section of Materiel stakeholders

100s of prospects

Assumptions, Boundaries, Constraints

CONCEPT DEVELOPMENT, REFINEMENT, & ANALYSIS
What’s realistic (in terms of capabilities, technology application, etc.)

10s of reasonable approaches

Commitment for next phase

A handful of viable options

Balancing affordability and achievability

Covers the trade space

Comprehensive stakeholder engagement
CCTD Content Supports MDD Information Needs

1. Mission / Capability Need Statement / CONOPS (MOEs)
   - Stakeholders

2. Concept Overview (OV-1)

3. Trade Space Characterization
   - Scope
   - Assumptions and Constraints
   - Interfaces
   - Operating Environment (Draft Enabling CONOPS)
   - Key Parameters / Attributes / MOPs
   - Compliance Issues

4. Evaluation (Studies, Analyses, Experiments)
   - Common Assumptions and Methodologies
   - Parametric Studies
   - Analyses
   - Experiments
   - Modeling & Simulation (and associated data)
   - Evaluation Results
   - Conclusions

5. Concept Characterization/Design
   - Design Description & Variants
   - Concept of Employment
   - Architecture Considerations (Interfaces / Interoperability / SoS Approach / Integration)
   - Critical Design Constraints
   - Critical Technology Elements
   - Supportability / Sustainment / Logistics Features
   - Cost Drivers
   - Required Enabling Capabilities

6. Program Characterization / Implementation Analysis
   - Critical Technologies (including S&T needs / feed-forward)
   - Technology Maturation Approach
   - T&E / V&V Approach
   - Prototyping Approach
   - Manufacturing / Producibility Approach
   - Sustainment / Supportability Approach
   - Other Relevant Considerations
   - Schedule Assumptions / Methodologies
   - Cost Analysis Assumptions and Methodologies
   - Cost Estimates

7. Risk Assessment and Decision-Certain Consequences
   - Operational Risk
   - Technology Risk
   - Program Risk

8. DOT_LPF Implications and other Interdependencies

9. Conclusions (Capability Description / Traceability to Need Statement)
   - A – Potential to meet the need
   - B – Covers the trade space (this, more accurately, is the subjective sum of all concepts presented at the MDD)
   - C – What can be done in the interim
   - D – Plan to support and fund the next phase of analytic, engineering, and programmatic activities - sponsor

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