The Authoritative Source of Truth
Enterprise Systems-of-Systems Model for Digital Thread Enabled Acquisition

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Introduction

- Methodology: Multi-level Sociotechnical Modeling & Enterprise Systems Analysis
- Context Background: DE Transformation; Authoritative Source of Truth
- Systemigram
- Outcomes & Next Steps
This research was conducted to evaluate the impacts of DE on current DoD acquisition enterprise processes. The following questions guided the research:

- What changes are likely to emerge from the transition to DE processes, methods, and tools?
- What are the enablers and barriers to such innovation in the DoD acquisition enterprise?
- What stakeholders will be affected and how will they likely embrace or oppose change?
- How might stakeholders be incentivized to embrace innovation and how will this be measured?
- What are the leading and long-term indicators of change?
- How might the value of such changes be predicted and measured?
Specific Questions of Interest

- How will DE help the acquisition enterprise respond to the realm of the possible with warfighter needs?
- What are the opportunities that can be gained from deeper information in the authoritative source of truth?
- How will DE make the acquisition process more efficient and reduce rework?
- Can DE make it easier to ingest new processes and incorporate acquisition expertise into acquisition tools?
- How do DE documented architecture principles add value to development and acquisition processes?
- How will DE environments capture and maintain lessons learned within and across programs?
- How can DE improve the performance of the acquisition workforce, at every skill level?
Agenda

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It’s a rather interesting phenomenon. Every time I press this lever, that post-graduate student breathes a sigh of relief.

Graphic: smumn.edu/facpages/~dbucknam/rat_cartoon.jpg
Full Process & Project Scope

1. Context Analysis
   - Background Research
   - Interviews

2. Central Questions of Interest

3. Identify System Structure & Phenomena
   - Systemigram Narratives & Diagrams

4. Visualize Relationships

5. Identify Areas of Exploration
   - Innovation System Analysis
   - Key stakeholders
   - Critical enablers & barriers to change

6. Identify Data Sets to Parameterize
   - What are the measurement areas that will drive change?
   - What measures are collected versus what should be collected

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**Framework:**

1. View the System as a Multi-Layer Enterprise
   - Domain Ecosystem (Society)
   - System Structure (Organizations)
   - Delivery Operations (Processes)
   - Work Practices (People)

**Facilitation:**

2. Agree on Central Questions of Interest

3. Identify System Structure & Phenomena

4. Visualize Relationships

5. Identify Areas of Exploration

6. Identify Data Sets to Parameterize

7. Identify Relevant Computational Models

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**Model Design:**

Agree on Context & Boundaries

Conceptualize Models and abstractions

Develop Narratives & Diagrams

Develop Data Models

Integrate Computational Models

Test/Verify

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1. The problem situation: unstructured

2. The problem situation: expressed

3. Structured text

4. Systemigram(s) Design
   - 4a. Formal system concept
   - 4b. Other systems thinking

5. Dramatization and Dialogue

6. Feasible, desirable changes

7. Action to improve the problem situation

Central Questions of Interest

Stakeholder Interviews

Innovation System Development

Stakeholder Reconciliation, Measures of Change

Real world

Systems thinking

A qualitative stakeholder-driven process to produce quantitative goals
Stakeholder Interviews & Research

• 15 Project Visits Completed, 25 People Interviewed
  — DASD/SE
  — Aerospace Corp
  — JHU APL
  — SAF/AQ
  — Army PM-Aviation
  — Army Future Vertical Lift Program Office
  — Ground-Based Strategic Deterrent Program Office
  — SPAWAR San Diego
  — TARDEC
  — J8 JCIDS office
  — DOT&E
  — NASA-Langley
  — NASA-Marshall
  — JPL

• Also:
  — ~50 documents reviewed
  — 6 facilitated meetings with DASD/SE team
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SERC Project RT-182 Digital Thread Enabled Acquisition
# Context Analysis (Selected Phrases)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Enabling Environment</th>
<th>Key Actors &amp; Resources</th>
<th>Interactions/Activities</th>
<th>Outcomes/Outputs</th>
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</thead>
<tbody>
<tr>
<td><strong>Operational Context</strong>&lt;br&gt;• Increasing complexity&lt;br&gt;• DoD DE Strategy</td>
<td>• Manufacturing 4.0 drivers&lt;br&gt;• Global innovation in DE</td>
<td>• Curate models across domains, fidelity, phases and the lifecycle</td>
<td>• Goal 1: Formalize the development, integration and use of models to inform enterprise and program decision making&lt;br&gt;• Map the realm of the possible with warfighter needs</td>
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<tr>
<td><strong>Institutions</strong>&lt;br&gt;• Develop, mature, and use IT infrastructures&lt;br&gt;• Define and govern authoritative source of truth</td>
<td>• INCOSE and other professional organizations</td>
<td>• Digital program documents&lt;br&gt;• Enterprise owns the ontology and data layer for analytical approaches&lt;br&gt;• Libraries of reusable models&lt;br&gt;• Pay once for data, reuse everywhere</td>
<td>• Goal 2: Provide an enduring authoritative source of truth (AST)&lt;br&gt;• Goal 4: Establish a supporting infrastructure and environment</td>
<td></td>
</tr>
<tr>
<td><strong>Processes</strong>&lt;br&gt;• Lexicon, taxonomies, ontologies&lt;br&gt;• Paperless system and technical information</td>
<td>• Communities: Standards, guides&lt;br&gt;• Communicators/matchmakers&lt;br&gt;• Model governance/version control mgmt.&lt;br&gt;• Better informed Decision makers</td>
<td>• Digital twin that injects data back into the models&lt;br&gt;• System data accessible from a single portal&lt;br&gt;• Eliminate human process of finding and using data&lt;br&gt;• Everything needed is on desktop, what’s been done before is there to reuse</td>
<td>• Goal 3: Incorporate technical innovations to improve the engineering practice&lt;br&gt;• Opportunities that can be gained from deeper information in the AST&lt;br&gt;• Make the process more efficient and reduce rework&lt;br&gt;• Capture and maintain lessons learned</td>
<td></td>
</tr>
<tr>
<td><strong>People</strong>&lt;br&gt;• Comfort with technology&lt;br&gt;• Usability of DE methods &amp; tools&lt;br&gt;• Organizational and cultural resistance&lt;br&gt;• Learning systems that adapt to individual abilities</td>
<td>• Leadership &amp; messaging&lt;br&gt;• Older vs younger workforce&lt;br&gt;• Human capital - skills&lt;br&gt;• A-Teams &amp; B/C-Teams - performance</td>
<td>• Enhance collaboration&lt;br&gt;• Humans can focus on creative work and machines can take care of mundane tasks&lt;br&gt;• Understand incremental value of all trades, done dynamically</td>
<td>• Goal 5: Transform Culture and Workforce&lt;br&gt;• Easier to ingest new processes and incorporate acquisition expertise into the tools&lt;br&gt;• Make the B-team and C-team players perform more at the A-Team level</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**
- 3. Structured text
- 4. Systemigram(s)
  - 4a. Formal system concept
  - 4b. Other systems thinking
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Systemigram

- Outcomes & Next Steps
DE Transformation Systemigrams

Workforce and Culture

Much of the discussions around digital thread and digital engineering focuses on the technological and modeling aspects. While those are integral to the changing dynamics and processes, often overlooked is the human role and associated changes, and how it will shift and might change over time, as the broader system seeks to become more agile.

Most stakeholders and experts do agree there is a cultural change at play, along with needs for the workforce to adapt and change with the broader trends at play as well. There are divergences in perspective in regards to what this might look like, the change in the “old guard” to “new guard”, whether or not there are workforce capabilities and the “talent” will look like.

DE is a cultural change in and of itself. There are the new tools which bring in digital natives and will be a merger of new technology and existing experience. As such, the workforce shift will be substantial. There will be big struggles to learn new ways. The goal is having the models to feed the decision processes, which requires training of modelers and a new breed of decision makers. However, it’s a challenge to get a large group of people to change. Culture change is not done without resistance or done overnight. There is an exceptional advantage to maintain the status quo and temptation to “do it like how we did last time”. Culture change is organizationally dependent and unchangeable.

One of the bigger points of diversion amongst stakeholders is whether or not there is a workforce in place to grapple with the changes at play, and if so, whether there are capabilities to address the changes. On the one hand, DE is done today often times without the realization that is being applied. People who do models do it without thinking about it. However, there lacks the process and culture to bring together the emerging digital natives with grizzled veterans and their domain knowledge.

On the other hand, there is the belief that much of the workforce is an aged workforce that looks back at the way things were done rather than looking to the future. The younger group coming in also has shortfalls. The younger workforce is more skilled in a single discipline rather than a broad perspective. There needs to be an effort to better train the younger workforce to oversee multiple different domains to provide a more robust understanding of digital environment. However, bureaucracy and paperwork make it hard to train due to time constraints. Additionally, there is not enough money or time to train older workforce to train them how to use new tools as well.

This squeeze on resources also impacts the focus on SE, as discipline workforces are less and less SE focused and system implications. Labor is expensive and systems are expensive to implement. There are no expectations to think about larger system aspects from the onset. Hiring managers are worried about finding MBSE workers, but there should be more of an effort place finding systems engineers.
Increasing System Complexity drives System Characteristics (Size, Connectedness, Safety, Security, Reliability). It leads to inability to sustain System Complexity.

Weapon Systems are a feature of today's systems. They are dependent on Constituent Systems, which are dependent on Program Office Staff, Program Managers, Procurement, and Developers. Program Office Staff is responsible for deciding who produces Tech Data Procurement, System Updates, and needs enabling of Design Escapes/Defects.

Systems-of-Systems Analysis involves System Complexity and is too great to be understood by individual. It needs a Define phase where Systems Acquisition Concept, Development, Production, and Sustainment are defined. Systems Acquisition Concept defines the System Requirements.

Other Programs and Standards provide initial Source of Systems-of-Systems Analysis. They are a good starting place for Systems Acquisition. System Complexity needs access to Domain Specific Federated Data Set, which is built & used by Future Systems Engineers for interop. To sustain Warfighter needs a Warfighter strategy that is enabled by Innovation and Managing the Realm of the Possible.

Government Program/Enterprises has existing DoD Policy to set the strategy and governs the System Complexity. Government Program/Enterprises must manage the DoD Policy and must ensure System Complexity.

IT Savvy Workforce is more distributed and more flexible. It is a feature of today's systems. IT Savvy Workforce provides Data & Model Availability, which drives AI-enabled Big Data Tools. Data & Model Evolution spurs improving Agility.

Central Data Storage supports Central Data Repository and enables Test Data. Test Data is extracted from Ontology & Data Standards and is validated by Future Systems Engineers. Test Data feeds a Central Data Storage, which is a Single Portal and Computing System that is Cloud Server. Everything is on the Desktop when needed.

Configuration Management leads to inability to sustain System Complexity. It drives DoD Policy, which governs Government Program/Enterprises. Government Program/Enterprises provides the Authoritative Source of Truth, which is a Common Data Baseline and supports Version Control. Authoritative Source of Truth makes up the Domain Specific Federated Data Set, which is a feature of today's systems.

Authoritative Source of Truth drives the warfighter's needs, which are built & used by Future Systems Engineers. Future Systems Engineers manage the System Complexity and trust in the Warfighter. Warfighter findings & using data enables everything, which is on the Desktop when needed.

Authoritative Source of Truth must manage the System Complexity and ensure the Warfighter's needs. Authoritative Source of Truth is a feature of today's systems that provides Data & Model Availability, which is a feature of today's systems. Data & Model Availability is a feature of today's systems that provides Data & Model Evolution.
Authoritative Source of Truth 1

System Complexity
- Is too great to be understood by individual
  - Weapon Systems
  - Constituent Systems
  - Other Programs
  - Systems-of-Systems Analysis
  - Initial Source of
  - Needs access to
  - Makes up the

Configuration Management
- Has existing
- Is a good starting place for
- To develop
- Provides
- Needs managing
- Resides in

DoD Policy
- To set
- To provide
- Which governs
- Provides
- Helps managing
- Must manage the

Government Program/Enterprises
- To hire
- Strategy
- Domain
- Actors
- Structure
- Processes/Resouces

Legend
- Increasing
- Critical to
- Driving strategy from the
- Leads to inability to sustain
- Increasing
- Responsible for
- Need
- Competition
- Innovation
- Managing the
- Warfighter

Central Data Repository
- Authoritative Source of Truth
- Common Data Baselines (like FMECA)
- Model Libraries
- Central Data Repository

Authoritative Source of Truth
- Central Data Repository
- Domain Specific Federated Data Set
- Ontology & Data Standards

Domain Specific Federated Data Set
- Extracted from
- Version Control
- Data & Model Evolution

Ontology & Data Standards

Authority
- Version Control
- Data & Model Evolution

Central Data Storage
- Single Portal
- Computing System
- Cloud Server

Central Data Storage
- Instantly on the
- AI-enabled Big Data Tools
- Help manage
- Must manage the
- Scale and Complexity
- Must ensure

IT Savvy Workforce
- System Engineering
- More distributed
- More flexible

IT Savvy Workforce

Future Systems Engineers
- Manage
- Trust

Future Systems Engineers

Government Owned
- Contractor Owned
- Digital Models

Digital Models

Program Office Staff
- Program Managers
- Procurement
- Developers

Program Office Staff

Weapon System Acquisition
- Concept
- Development
- Production
- Sustainment

Weapon System Acquisition

Tech Data Procurement
- Who produce
- Need
- of enabling

Tech Data Procurement

Government Owned
- of enabling
- Knowledge Translation

Government Owned

DoD Policy
- To set
- To provide
- Which governs

DoD Policy

System Complexity
- Drives
- Size
- Connectedness
- Safety
- Security
- Reliability

System Complexity

Increasing

Inability to sustain

Increasing

Authoritative Source of Truth
- Central Data Repository
- Model Libraries
- Common Data Baselines

Authoritative Source of Truth

Government Program/Enterprises
- To hire
- Strategy
- Domain
- Actors
- Structure
- Processes/Resouces

Government Program/Enterprises

Legend
- Increasing
- Critical to
- Driving strategy from the
- Leads to inability to sustain
- Increasing
- Responsible for
- Need
- Competition
- Innovation
- Managing the
- Warfighter

Legend
Authoritative Source of Truth 4

Increasing System Complexity

- Leads to inability to sustain
  - Drives System Characteristics: Size, Connectedness, Safety, Security, Reliability
  - Has existing Standards

Configuration Management

- Is too great to be understood by individual
  - Needs access to Initial Source of
    - Is a good starting place for
      - Needs a System of Systems Analysis
        - Which are dependent on
          - Other Programs

DoD Policy

- To set DoD Strategy
  - Driving strategy from the Program Office Staff
    - Program Managers
    - Procurement
    - Developers

Program Office Staff

- Define
  - Working for
    - Weapon System Acquisition
      - Concept
      - Development
      - Production
      - Sustainment
    - Digital Models
      - Contractor Owned
      - Government Owned

Domain Specific Federated Data Set

- Makes up the Authoritative Source of Truth
  - Common Data Baselines (like FMECA)
    - Model Libraries
    - Central Data Repository

Domain Specific

- Provides
  - Which governs
    - Government Program/Enterprises
      - Program Office Staff
        - Program Managers
      - IT Savvy Workforce
        - System Engineering
          - More distributed
          - More flexible

Government Program/Enterprises

- To provide
  - To set
    - DoD Policy

IT Savvy Workforce

- Help manage
  - AI-enabled Big Data Tools
    - Scale and Complexity
    - Must ensure
      - Endurance

Data & Model Availability

- Instantly on the Desktop when Needed
  - Everything is on the Desktop when Needed
    - For the Warfighter
      - Use
        - Manage
          - Governs
            - Version Control
              - Data & Model Evolution
                - Improving
                  - Agility

On the Edge

- Computing System
  - Single Portal
    - Cloud Server

Central Data Storage

- Extracted from
  - Version Control
    - Data & Model Evolution
      - Improving
        - Agility

Strategy

- Aligns with
  - Domain
    - More distributed
      - More flexible

Design, Escalates, Defects

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Outcomes & Next Steps
Outcomes and Next Steps

• Created holistic model of DoD Acquisition Enterprise change as DE is gradually adopted

• Good agreement across stakeholders on the nature of the strategy

• Descriptive modeling process reveals scope of change

• Testing insights in multiple forums using Systemigrams

• Next steps:
  — What do program offices need to emphasize?
  — What are the short and long-term metrics for success?
Questions?

Thank you!