Digital Engineering

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Systems Engineering focuses on engineering excellence – the creative application of scientific principles:

- To design, develop, construct and operate complex systems
- To forecast their behavior under specific operating conditions
- To deliver their intended function while addressing economic efficiency, environmental stewardship and safety of life and property

**DASD(SE) Mission:** Develop and grow the Systems Engineering capability of the Department of Defense – through engineering policy, continuous engagement with component Systems Engineering organizations, and through substantive technical engagement throughout the acquisition life cycle with major and selected acquisition programs.

**U.S. Department of Defense is the World’s Largest Engineering Organization**

- Over 108,000 Uniformed and Civilian Engineers
- Over 39,000 in the Engineering (ENG) Acquisition Workforce

A Robust Systems Engineering Capability Across the Department Requires Attention to Policy, People, and Practice
"To keep pace with our times, the Department will transition to a culture of performance and affordability that operates at the speed of relevance. Success does not go to the country that develops a new technology first, but rather, to the one that better integrates it and more swiftly adapts its way of fighting. Our current bureaucratic processes are insufficiently responsive to the Department's needs for new equipment. We will prioritize speed of delivery, continuous adaptation, and frequent modular upgrades."

— Gen Mattis, SECDEF
We will expand the competitive space while pursuing three distinct lines of effort:

- First, rebuilding military readiness as we build a more lethal Joint Force;
- Second, strengthening alliances as we attract new partners; and
- Third, reforming the Department’s business practices for greater performance and affordability.

— Gen Mattis, SECDEF
Digital Engineering Overview

• **Background**
  – Dynamic operational and threat environments
  – Growth in system complexity and risks
  – Linear acquisition process that lacks agility and resiliency
  – Cost overruns and delayed delivery of capabilities to the warfighter
  – Current practices can’t keep pace with innovation and technology advancements

• **Need**
  – Outpace rapidly changing threats and technological advancements
  – Deliver advanced capabilities more quickly and affordably with improved sustainability to the warfighter
  – Foster a culture of innovation

Digital Engineering: An integrated digital approach that uses authoritative sources of systems’ data and models as a continuum across disciplines to support lifecycle activities from concept through disposal.

Digital Engineering transforms the way the DoD innovates and operates
Recognizing Digital Engineering

- A model is a representation of reality.
- If you constrain the model building blocks to Data, Algorithms, and/or Processes; AND
- If you accept that Digital Engineering uses computers to perform as much of the lifecycle activities as practical

**THEN:**

- Digital Engineering uses computers to develop, warehouse, evolve, curate, and execute our models (SEE ABOVE) in support of system lifecycle activities, to include activities supporting ESOH concerns and decisions
  - Provides for cohesion, concordance, and continuum of information usable by all stakeholders in the system, regardless of the system form

Minimizing the risk caused by unnecessary human intervention
Model: A Day in the Life

Customer Requirements
- Draft CDD

System Requirements

- Operating Scenarios
- System Behaviors
- Physical Arch
- Dynamic Simulations

Allocated Requirements

- Draft CDD
- System Behaviors
- Physical Arch
- Dynamic Simulations

Design Analyses
- Stress
- Thermal
- Vibration
- Perf
- Reliability
- Etc.

System Architectures
- Alt Prelim Design Concepts
  - CAD
  - Software

Trade-off Studies
- 1
- 2
- 3
- N

Selected Designs
- CAD
- Specs
- Drawings
- Software

Prototype Fabrication
- Mfg Instructions

Testing
- Test Plans
- Test Results

Final Designs
- CAD
- Specs
- Drawings
- Software

Logistics
- Tech Manuals
- Provisioning Data
- Trng Matrls

Mfg Info
- Process Plans
- Work Instr
- N/C Instr

Baseline
- (System Spec)
- (Allocated Specs)

Baseline
- (Preliminary Product Baseline)

Baseline
- (Product Baseline - TDP)

Technology Development

Engineering and Manufacturing Development

Production/Deployment
Digital Engineering Strategy: Five Goals

1. Formalize the **development, integration and use of models** to inform enterprise and program decision making

2. Provide an enduring **authoritative source of truth**

3. Incorporate **technological innovation** to improve the engineering practice

4. Establish supporting **infrastructure and environments** to perform activities, collaborate, and communicate across stakeholders

5. Transform a **culture and workforce** that adopts and supports Digital Engineering across the lifecycle

Drives the engineering practice towards improved agility, quality, and efficiency, resulting in improvements in acquisition
Formalize the Use of Models
Provide an Enduring, Authoritative Source of Truth

Key: Data

Specialty Engineering Models
- Product Support Models
- System Models
- Verification and Validation Models
- Management Models
- Design Models
- Manufacturing Models
Incorporate Technological Innovation
Establish Supporting Infrastructure
Transform Culture and Workforce

Transforms a culture and workforce that adopts and supports Digital Engineering across the lifecycle.

Leadership
Training and Education
Communication and Engagement
Strategy and Implementation
Continuous Improvements
## Strategy-in-Action Example

### Warfighting Benefits

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<thead>
<tr>
<th>Benefits</th>
<th>How</th>
<th>Examples</th>
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<tbody>
<tr>
<td>More Effective &amp; Lethal Weapon Systems</td>
<td>Ability to manufacture complex shapes and otherwise impossible designs/components</td>
<td>Consolidated assemblies&lt;br&gt;Lattice structures&lt;br&gt;Multi-functional materials&lt;br&gt;Embedded sensors</td>
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<td>Tailored Solutions for the Mission and Warfighter</td>
<td>Ability for mission tailorability and mass customization at almost no additional cost</td>
<td>Armor&lt;br&gt;Munitions&lt;br&gt;Nutritionally Tailored Foods&lt;br&gt;Weapons&lt;br&gt;Unmanned systems</td>
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<td>Agility of Production Line - New era of supply chain independence</td>
<td>Ability to produce only what is needed, where it is needed, when it is needed</td>
<td>Improved field fabrication&lt;br&gt;“Good enough” &amp; “Conditionally Approved” parts&lt;br&gt;Environment-independent printers</td>
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<td>Reduced Sustainment Costs and Increased Responsiveness</td>
<td>Ability to make obsolescence obsolete</td>
<td>Rapid reverse-engineering&lt;br&gt;Anti-corrosive Anti-degradation materials</td>
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<td>Accelerated Capability Development</td>
<td>Ability for INNOVATION; novel designs, rapid development, faster transitions</td>
<td>Urgent needs&lt;br&gt;Rapid response</td>
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AM is any process by which digital 3D design data is used to build up a component in layers by depositing material.
**Expectations & Big Rocks**

### Digital Engineering Expectations

- Informed decision making/greater insight through increased transparency
- Enhanced communication
- Increased understanding for greater flexibility/adaptability in design
- Increased confidence that the capability will perform as expected
- Increased efficiency in engineering and acquisition practices


### Digital Engineering Big Rocks

- Investment
- Culture and workforce
- Policy, guidance, contracting
- Governance
- Security
- Intellectual property protection
- Tool/model portability
- Infrastructure and environments
- Model quality and assurance

(synthesized from Digital Engineering Working Group; National Defense Industrial Association Model-Based Engineering Report, Aerospace Industries Association Model-based Engineering reports)

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**Coordinating with the Services/Agencies to implement Digital Engineering strategy elements and develop mitigation for remaining challenges**
Summary

• Business processes and behaviors (culture) need to be changed to realize the benefits of Digital Engineering implementation

• Multiple activities in government, industry, academia, and professional organizations are being leveraged to advance digital engineering concepts within DoD enterprise

• Expected benefits of implementing digital engineering practice outweigh the monetary, time, and training needed up front

• Basic elements of Digital Engineering are in place; we need to weave them together and instantiate with policy, guidance, and training
Systems Engineering: Critical to Defense Acquisition

Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

DASD, Systems Engineering
http://www.acq.osd.mil/se