Digital Engineering in Complex Systems: From Leadership Understanding Through Application

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MBE Summit

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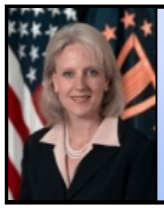
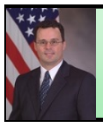
DASD, Systems Engineering



Acting Deputy Assistant Secretary of Defense and Principal Deputy, Systems Engineering
Kristen Baldwin

Homeland Defense Capability Development
Robin Hicks

Major Program Support
James Thompson



Engineering Enterprise
Robert Gold

Supporting USD(AT&L) Decisions with Independent Engineering Expertise

- Engineering Assessment / Mentoring of Major Defense Programs
- Program Support Assessments
- Overarching Integrated Product Team and Defense Acquisition Board Support
- Systems Engineering Plans
- Systemic Root Cause Analysis
- Development Planning/Early SE
- Program Protection

Leading Systems Engineering Practice in DoD and Industry

- Systems Engineering Policy and Guidance
- Technical Workforce Development
- Specialty Engineering (System Safety, Reliability and Maintainability, Quality, Manufacturing, Producibility, Human Systems Integration)
- Security, Anti-Tamper, Counterfeit Prevention
- Standardization
- Engineering Tools and Environments

Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs

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DDR&E - SE - IAWG

DDR&E Strategy:

- Mitigate current and anticipated threat capabilities
- Enable new or extended capabilities affordably in existing military systems
- Create technology surprise through science and engineering

SE Challenges:

- Flexible designs that adapt with innovation, and are resilient to unknown missions and threats
- Ability to quantify cost and affordability attributes of the design and lifecycle trade space
- Responsive, and able to balance agility with rigorous analysis and data

IAWG MBSE Benefits:

- Informed decision making through increased transparency and greater insight
- Enhanced communication
- Understood flexibility/adaptability in the capability
- Increased confidence that the capability will perform as expected
- Increased efficiency

(Interagency Working Group for Complex Systems)

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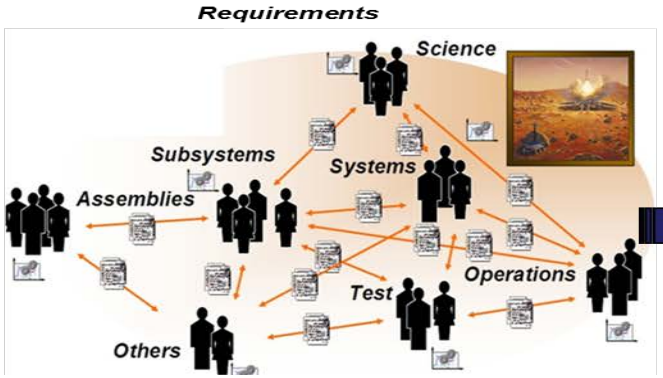
Digital Engineering: MBSE approach for DoD

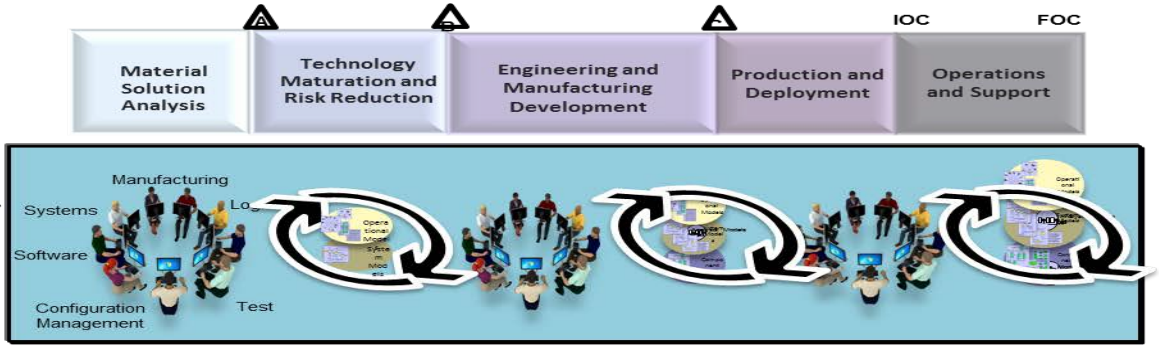
Current State

- Our workforce uses stove-piped data sources and models in isolation to support various activities throughout the life-cycle
- Current practice relies on standalone (discipline-specific) models
- Communication is through static disconnected documents and subject to interpretation

Future State

- Digital Engineering moves the engineering discipline towards an integrated model-based approach
  - Through the use of digital environments, processes, methods, tools, and digital artifacts
  - To support planning, requirements, design, analysis, verification, validation, operation, **and/or** sustainment of a system
- Digital Engineering ecosystem links our data sources and models across the lifecycle
  - Provides the authoritative source of truth





Current: Stove-piped models and data sources

Future: **Digital Engineering Ecosystem**

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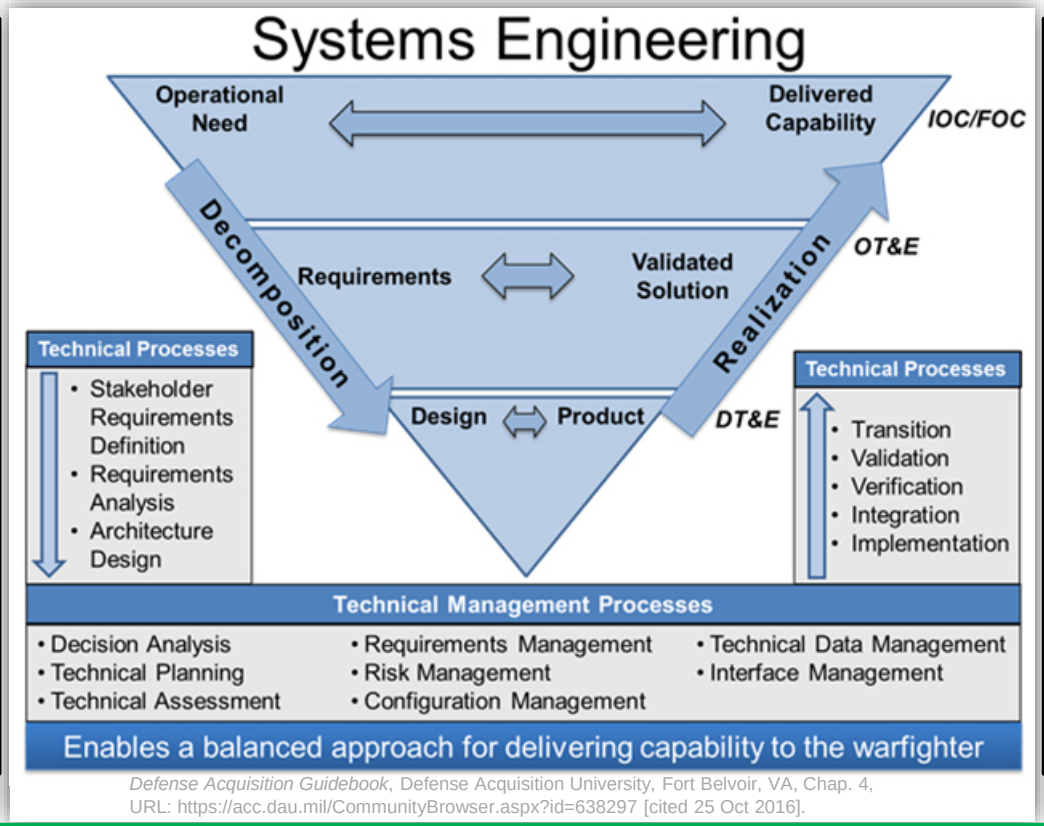
Digital Engineering Scope

DE includes both SE Technical Processes and SE Technical Management Processes.

The Digital System Model provides stakeholders a structure for the types of data that should be considered across the life cycle.



Defense Acquisition Guidebook, Defense Acquisition University, Fort Belvoir, VA, Chap. 4, URL: https://acc.dau.mil/CommunityBrowser.aspx?id=638297 [cited 25 Oct 2016].

Digital Twins link probabilistic engineering models with test, operational, and maintenance data to simulate elements of system performance and reliability on a serial-number-specific basis.

The Digital Thread includes manufacturing, and provides cross-process, cross-domain connectivity/traceability.

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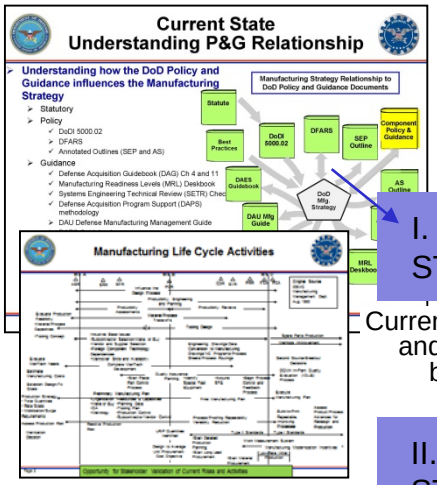
DoD Manufacturing & Quality Activities



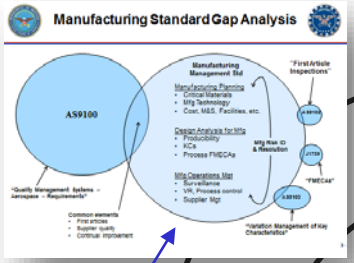
Mfg. Component Leadership

I. CURRENT STATE/AS-IS

Current policy, guidance, and workforce cap[2] based on BoK

II. FUTURE STATE/TO-BE

Required critical processes based on best practices and policy/guidance



III. GAP ANALYSIS

Comparison of As-Is and To-Be state

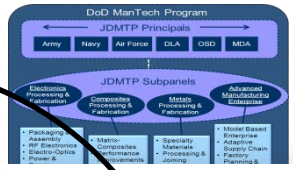
IV. STRATEGY DEVELOPMENT

Identify strategies to close gaps

FAR TERM
5-15 yrs out

MID TERM
2-5 yrs out

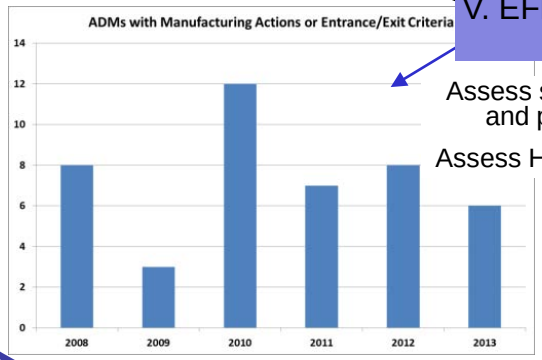
NEAR TERM
1-2 yrs out

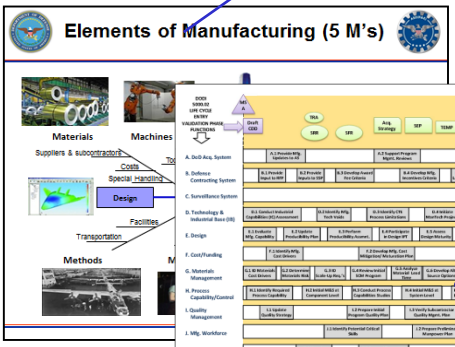


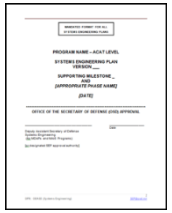
V. EFFECTIVENESS

Assess strategy effectiveness and program execution

Assess Health of the Enterprise







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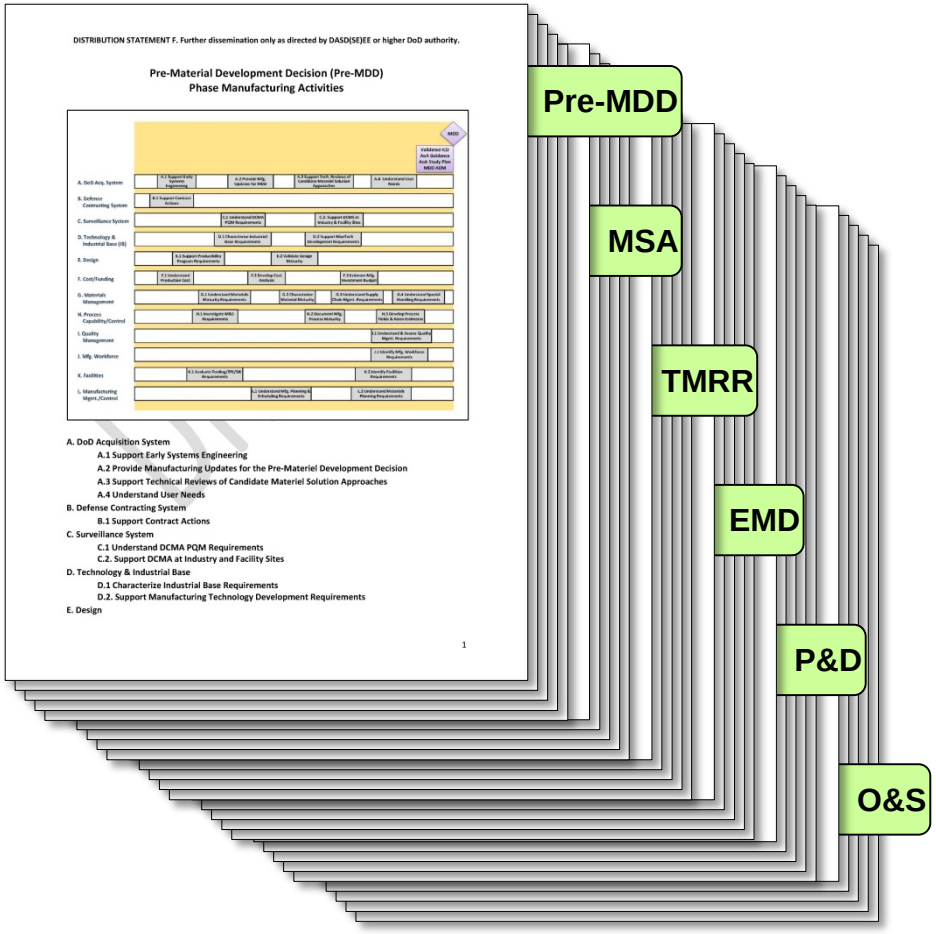
Mfg. Activities by Program Phase



II. FUTURE STATE/TO-BE

- Tasks Defined and Described
- Metrics
- Tools
- References

First Draft Complete

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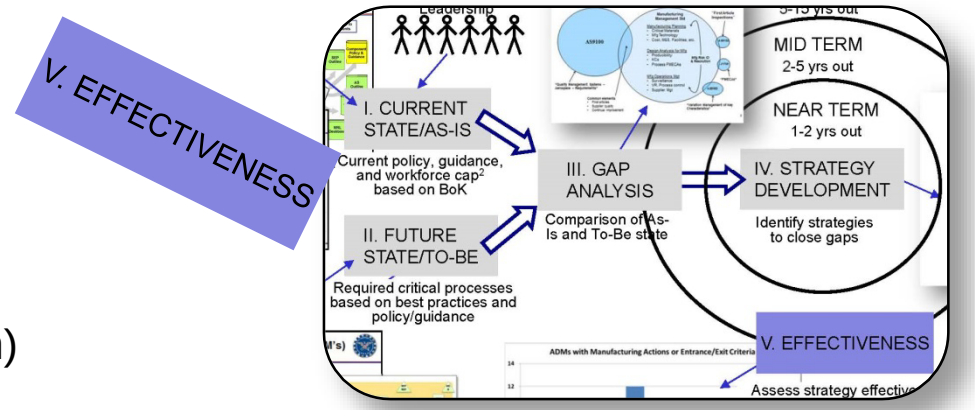
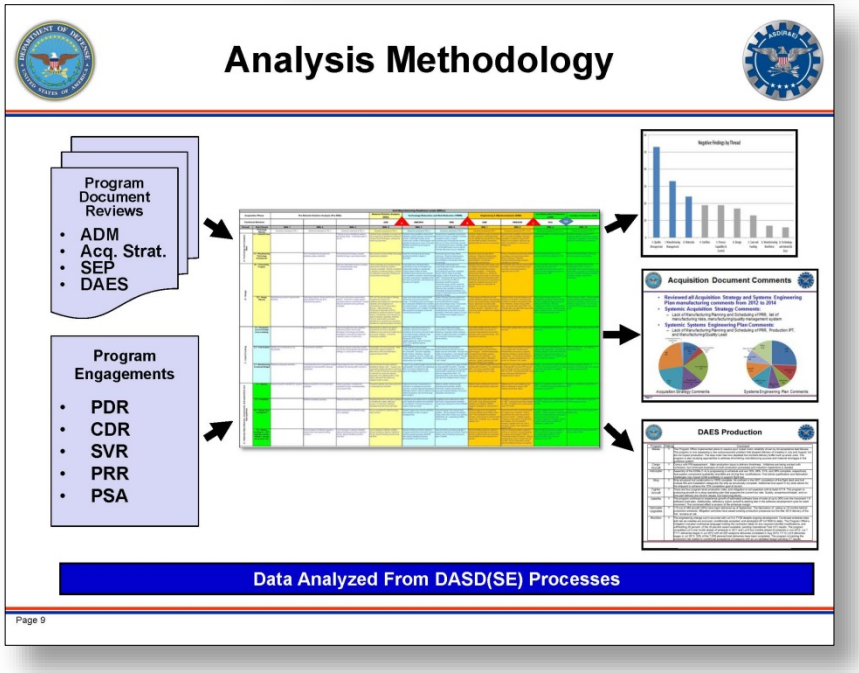
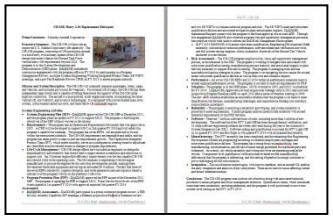
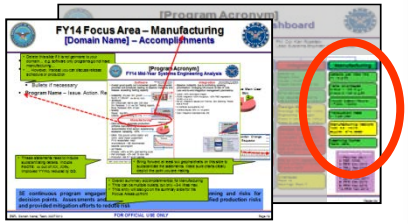
Effectiveness

- **Iterative process to evaluate manufacturing activities**
- **Initial analysis included:**
  - Manufacturing issues in Acquisition Decision Memorandums
  - Defense Acquisition Executive Summary assessments (Production)
  - Manufacturing trends in major program engagements
  - Acquisition document comments for Systems Engineering Plans and Acquisition Strategies
- **Information will be used to assess effectiveness**
  - Policy & Guidance Coverage/Voids
  - Program Performance
  - Workforce Metrics









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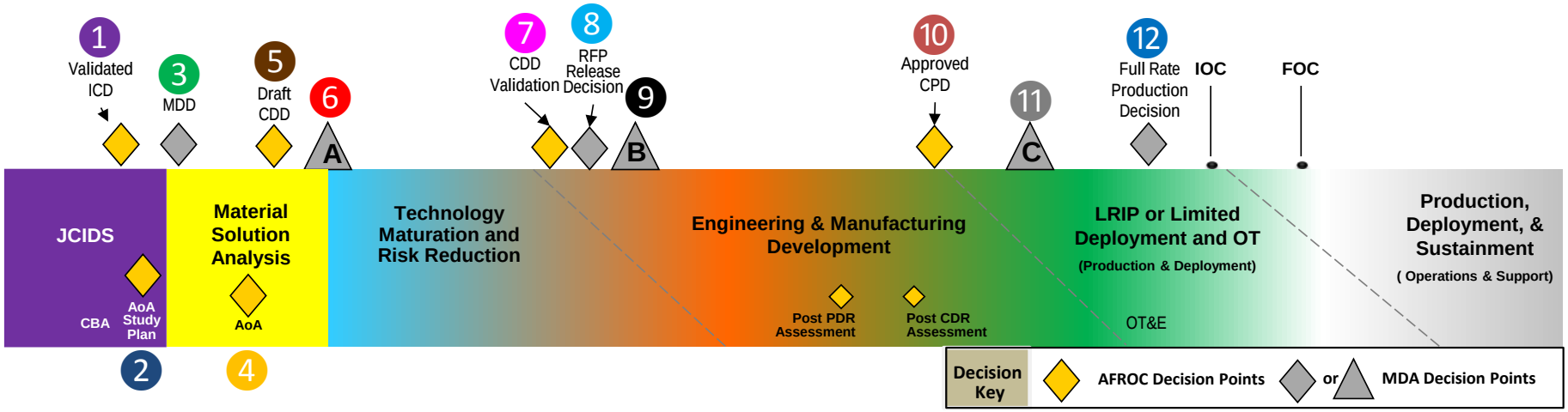
Draft Decision Framework Decision Points



Each Decision Point of the Framework Identifies:

- **Decision** – The decision to be made
- **Decision Point** – Where the decision points are in the acquisition life cycle
- **Decision Maker(s)** – Who will be making the decision (i.e. approval to proceed)
- **Questions to be Asked** – What questions should be asked by decision makers
- **Information Required to Answer the Questions** – Supported answers to the questions

Source: DoDI 5000.02
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Summary

- **Digital Engineering requires change to cultural, historical and business processes to realize a Digital Model-Based Engineering Vision**
- **We need to highlight crisp examples to facilitate broad change, emphasizing how programs have benefitted from Digital Engineering**
- **Some challenging areas requiring further exploration for full Digital Engineering Transition**
  - Where do we have MODEL gaps? At what level of fidelity, and trust?
  - Have we properly divided tasks between humans and computers?
  - How do we implement practices without becoming overly dependent on the tools?
  - How do we adapt legal and procurement regulations to fully enable digital engineering?
  - How do systems engineering processes transition information to manufacturing losslessly?
  - How do we effect, across the acquisition lifecycle, configuration management, security, technical reviews, etc.
  - What is the full scope of opportunity from digital engineering? What are the impacts realized when bridging across design, prototyping, test and evaluation, manufacturing and sustainment activities?

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Systems Engineering: Critical to Defense Acquisition










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

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

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For each Decision Point

- **Models and simulation results are selected, by asking:**
  - What analysis is required by the question?
  - What data needs to be provided?
  - Who does analysis/generates data?
  - How to share/collaborate?
  - How to assess quality/fidelity of analyses, data, models? (UQ/V&V)
  - How to use results to plan next steps?

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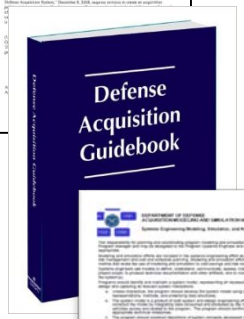
Leveraging Multiple Activities to Advance Digital Engineering Within DoD

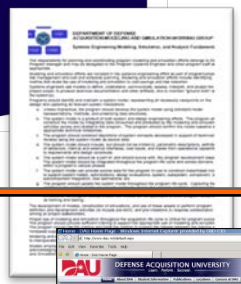
Infusion in Policy & Guidance

http://www.acq.osd.mil/se/pg/guidance.html

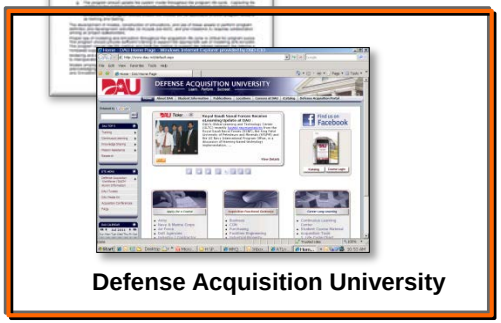
DoDI 5000.02, Enclosure 3, Section 9: Modeling and Simulation



Defense Acquisition Guidebook Chapter 4

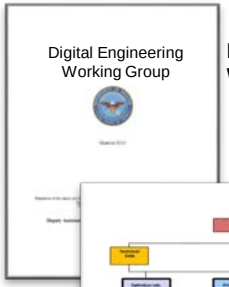


DoD Digital Engineering Fundamentals

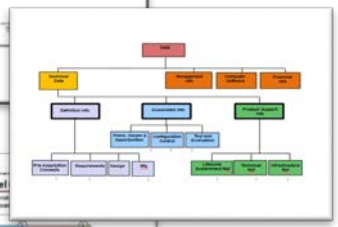


Defense Acquisition University

DoD Initiatives



DoD Digital Engineering Working Group (DEWG)



DSM Taxonomy: Defining categories of data across acquisition

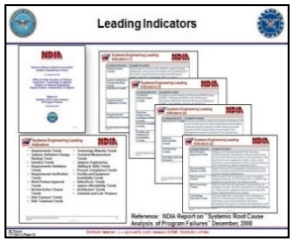
SERC: Model Centric Collaborative Environment

Engineered Resilient Systems: Adapting to changing requirements

HPCMP CREATE: Physics Based Modeling

Other Partnerships

USAF Own the Technical Baseline



NDIA: Essential Elements of the System Model

DMDII
DIGITAL MANUFACTURING AND DESIGN INNOVATION INSTITUTE

Additive Manufacturing

Inter-Agency Working Group on the Engineering of Complex Systems

Inter-Agency Working Group

NASA: Sounding Rocket Program

Advancing the state of practice for Digital Engineering within DoD

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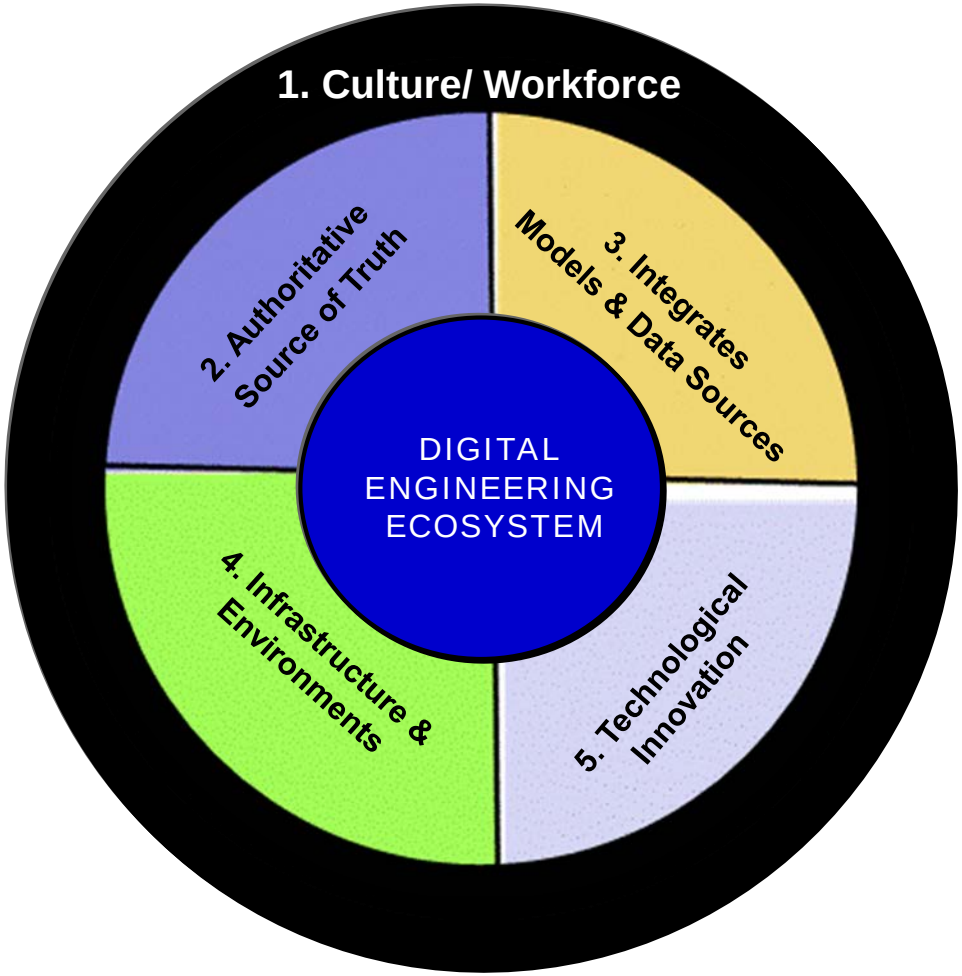
Digital Engineering Strategy

1. Develop and maintain a ***culture*** and ***workforce*** that adopts, supports and applies Digital Engineering across the lifecycle
2. Formalize development and use of models for providing an enduring ***authoritative source of truth***
3. Foster the integration of models and data sources across functional disciplines to inform enterprise and program decision making
4. Establish supporting ***infrastructure & environments*** to perform engineering activities, collaborate, &communicate across stakeholders
5. Leverage advanced tools, computing power, and advanced capabilities to improve system capabilities, automate workflow processes (as applicable) and generate digital artifacts and deliverables using models



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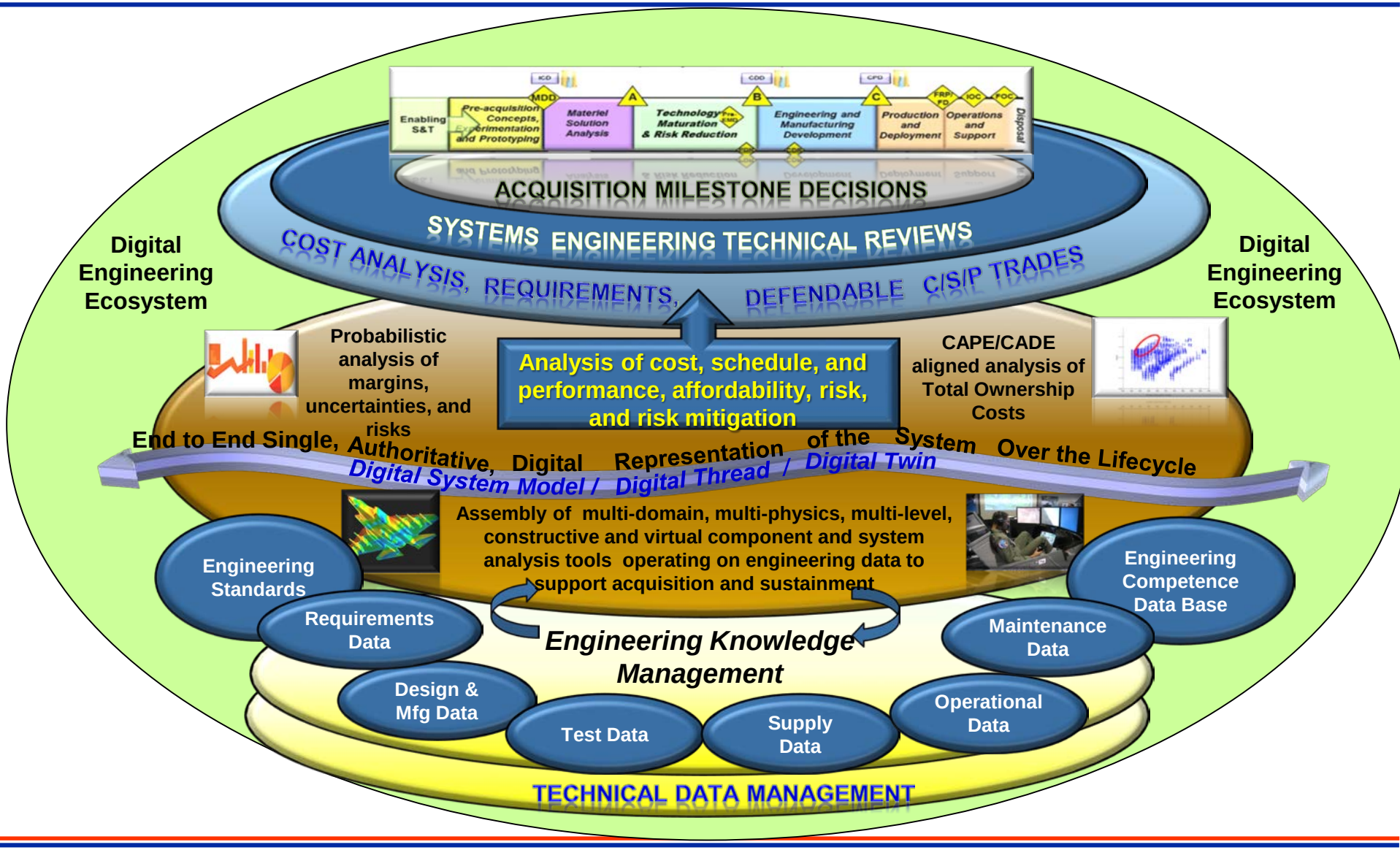
A Holistic View of Digital Engineering Support to DoD Acquisition



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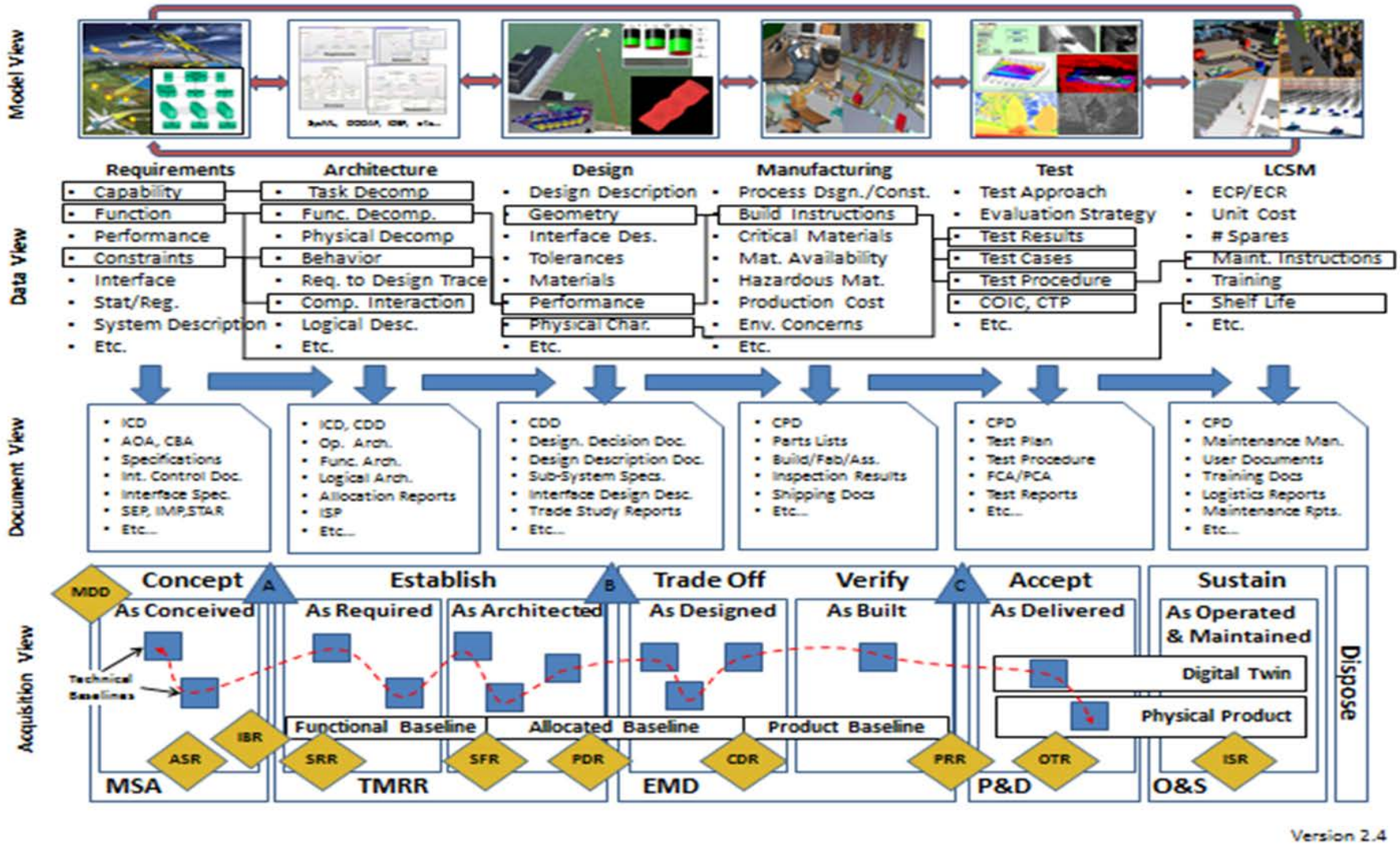
Transition to Digital Engineering



Version 2.4

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