Quantifying Return on Investment in Digital Technical Data Packages for Combat Systems: A Lifecycle Perspective

Date
John Fiore, Presenter
Vice President, Strategic Growth
Kitty Hawk Technologies

Coauthors:
Glenna Miller, Program Manager with Kitty hawk Technologies
Chris Petrin, Systems Engineering with Kitty Hawk Technologies

Digital Engineering Adoption: When to Enter and What You Gain

Early Adoption
Pre-PDR

- Highest theoretical Return on Investment (ROI); full digital thread from concept
- Reduced integration risk entering Engineering and Manufacturing Development (EMD)
- Early Modeling and Simulation (M&S) investment yields maximum future leverage per RAND 2024

2-12%

cumulative cost avoidance

Mid-Stream Adoption
SRR-CDR (Most Common)

- Digital retrofit of existing artifacts; most programs live here
- Improved integration, verification, and configuration control
- Engineering Change Proposal (ECP) cycle time cut 20-40%; M&S as Test and Evaluation (T&E)
- Establishes digital baseline for production and sustainment

15-22%

cumulative cost avoidance

Late Adoption
Production / O&S

- Diminishing Manufacturing Sources and Material Shortages (DMSMS) mitigation, software sustainment, depot planning
- Viable when major block upgrades planned or obsolescence pressure is high
- Operations and Support (O&S) = 60-70% of total lifecycle cost: small % savings = large absolute $
- Software modernization and regression test reduction are continuous

35-50%

cumulative cost avoidance

SCENARIO ANALYSIS: DIGITAL ENGINEERING RETURN ON INVESTMENT

SCENARIO 1 — AEGIS BMD: ACCREDITED M&S IN TEST

Cost Avoidance Through M&S

- Accredited modeling & simulation replaced live fire events, reducing test costs by tens of millions across the Aegis BMD program.
- Validated M&S environments met DOT&E rigor standards, enabling full IOT&E credit without additional at-sea test events.

Test Range Efficiency

- Simulation-augmented testing compressed test schedules and reduced range time—critical given scarce Pacific Missile Range Facility (PMRF) availability.

Fidelity & Credibility

- M&S accreditation framework established repeatable verification standards applicable across future ACAT I programs.

SCENARIO 2 — DIGITAL TWIN: HIGH-FIDELITY THREAT MODELING

Operational Relevance, Not Hypothetical Threat

- Digital twin of an emerging threat system allowed the Fleet to assess Aegis weapon system performance against a real adversary capability before any live engagement opportunity exists.

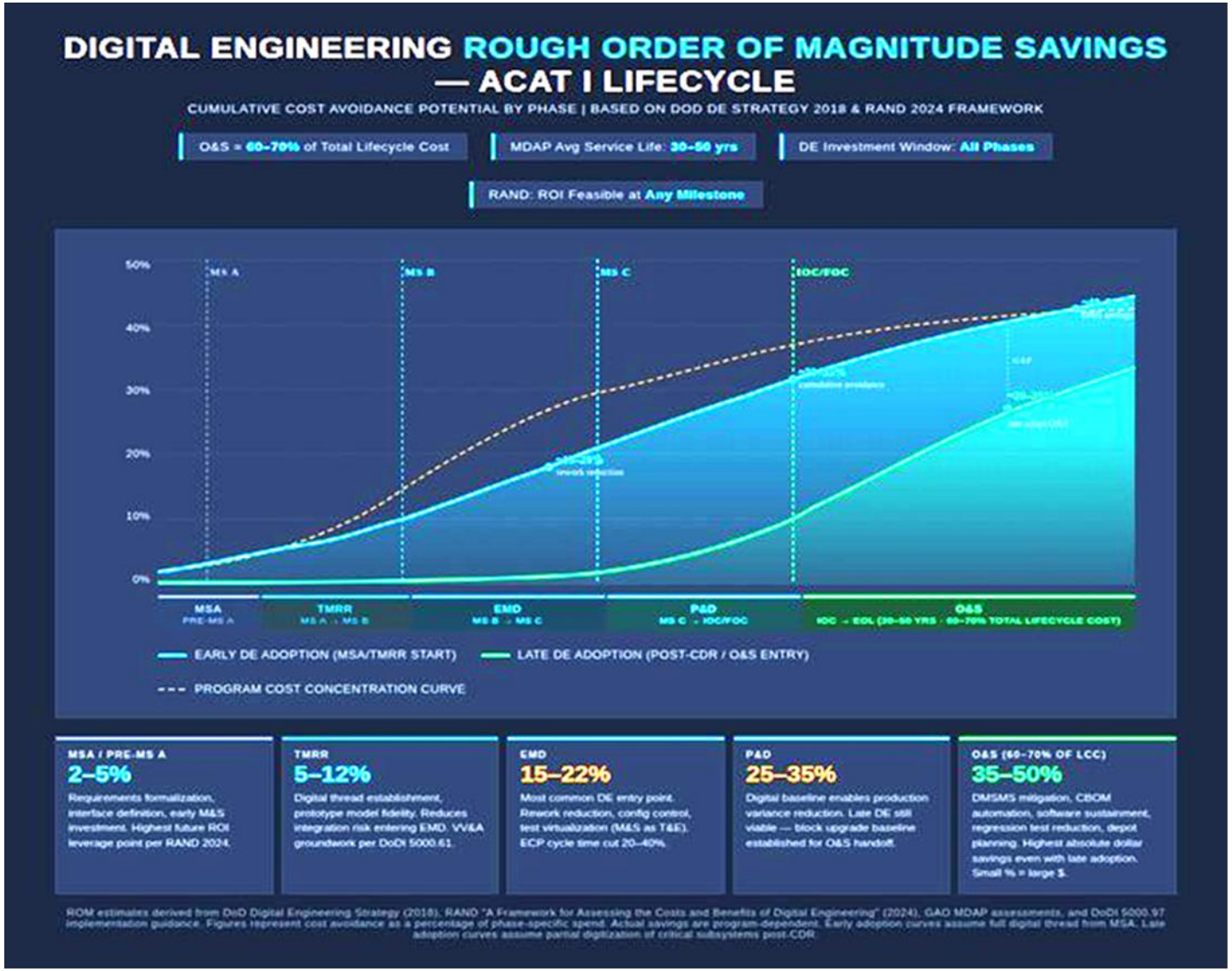
Speed to Insight

- High-fidelity threat model compressed the traditional test-analyze-fix cycle—enabling warfighter decision support in operationally relevant timelines rather than acquisition timelines.

System-of-Systems Performance Assessment

- Demonstrated how digital engineering enables weapon system performance characterization across threat envelopes that cannot be safely or legally replicated in live testing.

DE ROI by Acquisition Phase: The Case for Acting at Any Milestone



2-5% **(MSA / Pre-MSA)** Requirements formalization, interface definition, early M&S investment. Highest ROI leverage point per RAND 2024.

5-12% **(Technology Maturation and Risk Reduction)** Digital thread establishment, prototype model fidelity. Reduces integration risk entering EMD. VV&A groundwork per DoD 5000.61

MSB

15-22% **(Engineering and Manufacturing Development)** Most common DE entry point. Rework reduction, config control, test virtualization (M&S as T&E). ECP cycle time cut 20-40%

MSC

25-35% **(Production and Deployment)** Digital baseline enables production variance reduction. Late DE still viable – unlock upgrade baseline established for O&S handoff

Initial Operational Capability / Full Operational Capability (IOC/FOC)

35-50% **(Operations and Support)** DMSMS mitigation, CBOM automation, software sustainment, regression test reduction, depot planning. Highest absolute dollar savings even with late adoption. Small % = large $.

- 35-50% = the cost avoidance/sharing you can achieve through Digital Engineering adoption
- 60-70% = how much of the total program lifecycle cost is *spent* during O&S regardless. It's saying O&S is where most of the money goes, which is *why* DE savings there are so valuable even if adoption is late.
- These are **cumulative cost avoidance ranges**, not continuous bands

Recommendations and Conclusion

Successful Digital Engineering (DE) Adoption Strategy: Governance, Rigor, Validation

Treat DE as a Program-Level Investment
Not an unfunded mandate. Align resources to the phases where the greatest returns are achievable.

Establish Standardized ROI Measurement Frameworks
Across lifecycle and T&E domains, enabling programs to qualify benefits in a defensible, repeatable manner.

Develop Authoritative Exemplars
Such as AEGIS BMD – disciplined DE application produces evidence-based value even without full DEE maturity

Prioritize Model Credibility and Data Pedigree
Configuration control and data pedigree are foundational. Digital artifacts must remain authoritative across decades of service life.

Support Incremental Adoption Pathways
Begin with high-value, low-risk digital practices. Enterprise-level maturity in a single leap is neither realistic nor necessary. Let capability grow – the ROI shows up early and compounds

There is no wrong time to start Digital Engineering -- only a more or less optimal one. The financial case exists at every milestone.