Why Digital Thread?

Global Horizons
Final Report
United States Air Force
Global Science and Technology Vision

AF/ST TR 13-01
21 June 2013

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9. Manufacturing and Materials

9.3 Game Changers
Exploiting the three game-changing opportunities below will help the AF meet the need for more rapid development and deployment. The recommendations represent the first steps on the path to future game-changers.

Digital Thread and Digital Twin

The concept of a digital thread/digital twin comprised of advanced modeling and simulation tools that link materials-design-processing-manufacturing (Digital Thread) will be the game-changer that provides the agility and tailorable needed for rapid development and deployment, while also reducing risk. State Awareness and System Prognosis advantages will be achieved through the Digital Twin, a virtual representation of the system as an integrated system of data, models, and analysis tools applied over the entire life cycle on a tail-number unique and operator-by-name basis. M&S tools will optimize manufacturability, inspectability, and sustainability from the outset. Data captured from legacy and future systems will provide the basis for refined models that enable component and system-level prognostics. Archived digital descriptions of new systems would greatly facilitate any subsequent re-engineering required in the future. Human performance monitoring will enable adaptation of systems to the “mission capable” state of the operator.
Digital Thread Defined

- “Digital Thread is the creation and use of a digital surrogate of a materiel system to allow dynamic, real-time assessment of the system's current and future capabilities to inform decisions in … acquisition....

- The digital surrogate is a physics-based technical description of the weapon system resulting from the generation, management, and application of data, models, and information from authoritative sources across the system's life cycle.”

(Extracted from SAF/AQR Definition)

Cradle-to-Cradle Transition of Knowledge

Digital Thread

Data – Models - Information

MRL = Manufacturing Readiness Level
Main Goals:

• **Use ALL AVAILABLE INFORMATION** in analyses

• **Use PHYSICS** to inform analyses

• **Use PROBABILISTIC METHODS** to quantify program risks

• **CLOSE THE LOOP** from the beginning to the end and back to the beginning of the acquisition lifecycle

**Make **INFORMED DECISIONS throughout acquisition**
The Need: A Production Perspective

“AS IS” State for PRODUCTION:

- Conformance req’ts thrown over the wall to PRODUCTION
- Conforming product thrown over the wall to OPERATION & SUSTAINMENT
- Conformance reported as “PASS” / “FAIL” only
- OEM/USAF only engaged when problems arise

Lots of data generated in the manufacturing supply chain is not deployed in decision making!
The Vision: A Production Perspective

“TO BE” State for PRODUCTION:

- Conformance req’ts linked to manufacturing process capability as well as design/performance
- Details of “as-built” product delivered to OPERATION & SUSTAINMENT
- Full production data streams captured & analyzed
- OEM/USAF engaged continuously

Engineering decision making informed by the Digital Thread
How the Digital Thread can Benefit the USAF

- Foundation for *streamlined resolution of weapon system performance issues*
- *Reduction in late discovery* of system performance deficiencies
- Identification & *management of technology maturation risks*
- *Quantification of risk at critical decision points*
- Informed trade space exploration (design and manufacturing)
  - In-depth assessment of the feasibility and *lifecycle cost of system configuration* options
  - Data-rich assessment of *requirement, cost, and performance trades*

**Manufacturing Benefits:**
- Yield and Rate improvements through agility on the shop floor (adaptive machining, virtual assembly, etc.)
- Infrastructure to generate, capture, organize, and utilize relevant data & information (e.g. *Pass/Fail to As-Built* for condition-based maintenance)