



Why Digital Thread?



Global Horizons

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Final Report

United States Air Force
Global Science and Technology Vision



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9. Manufacturing and Materials

9.3 Game Changers

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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

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 tailorability 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.



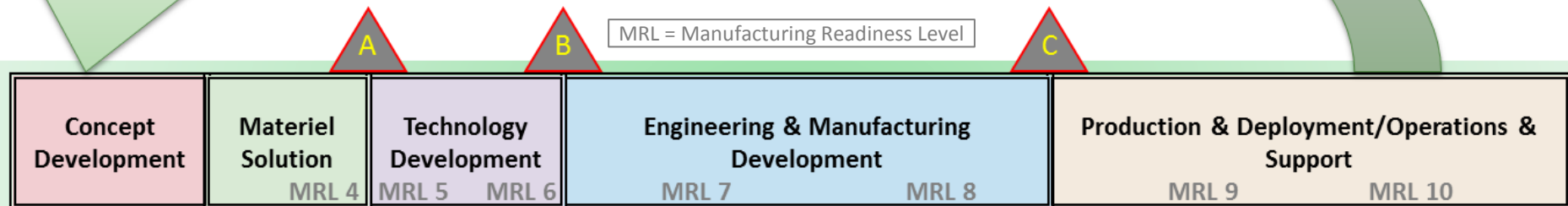


Digital Thread Defined



- “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



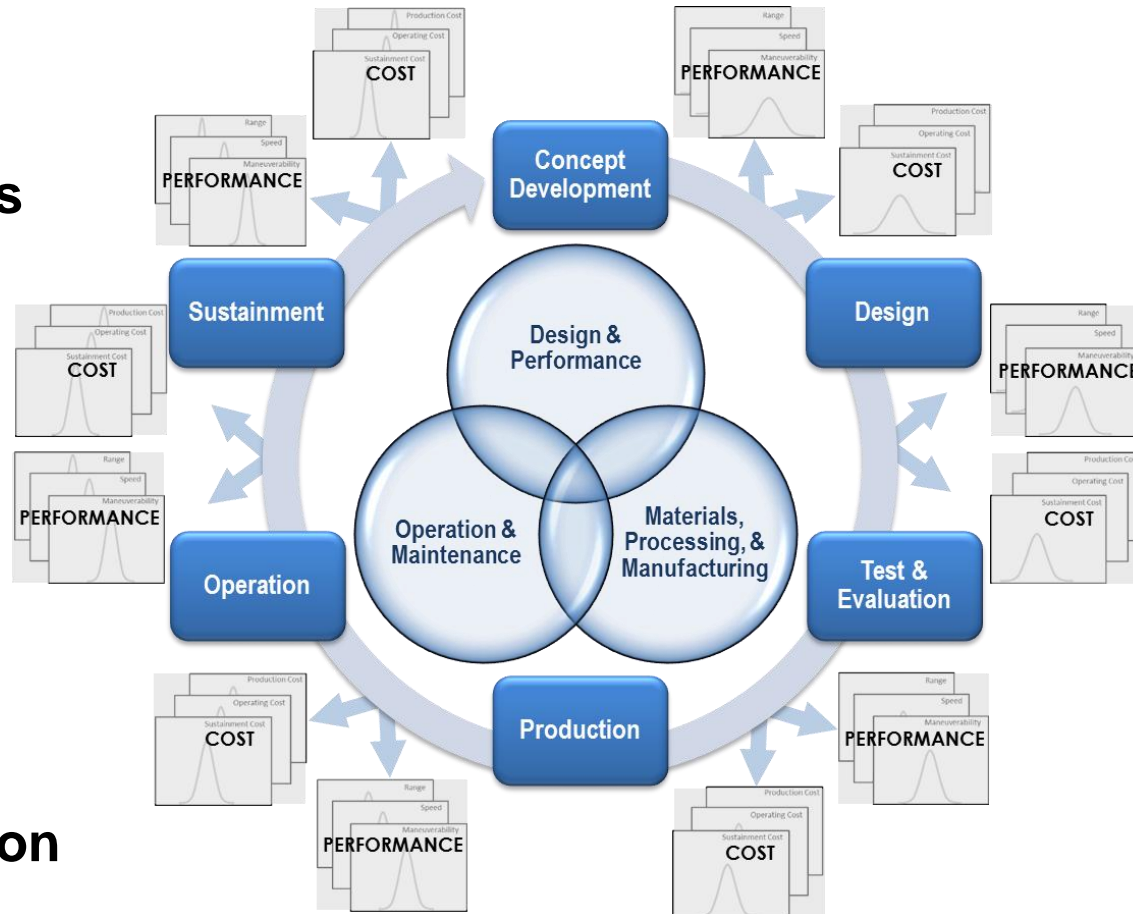


Digital Thread Concept



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

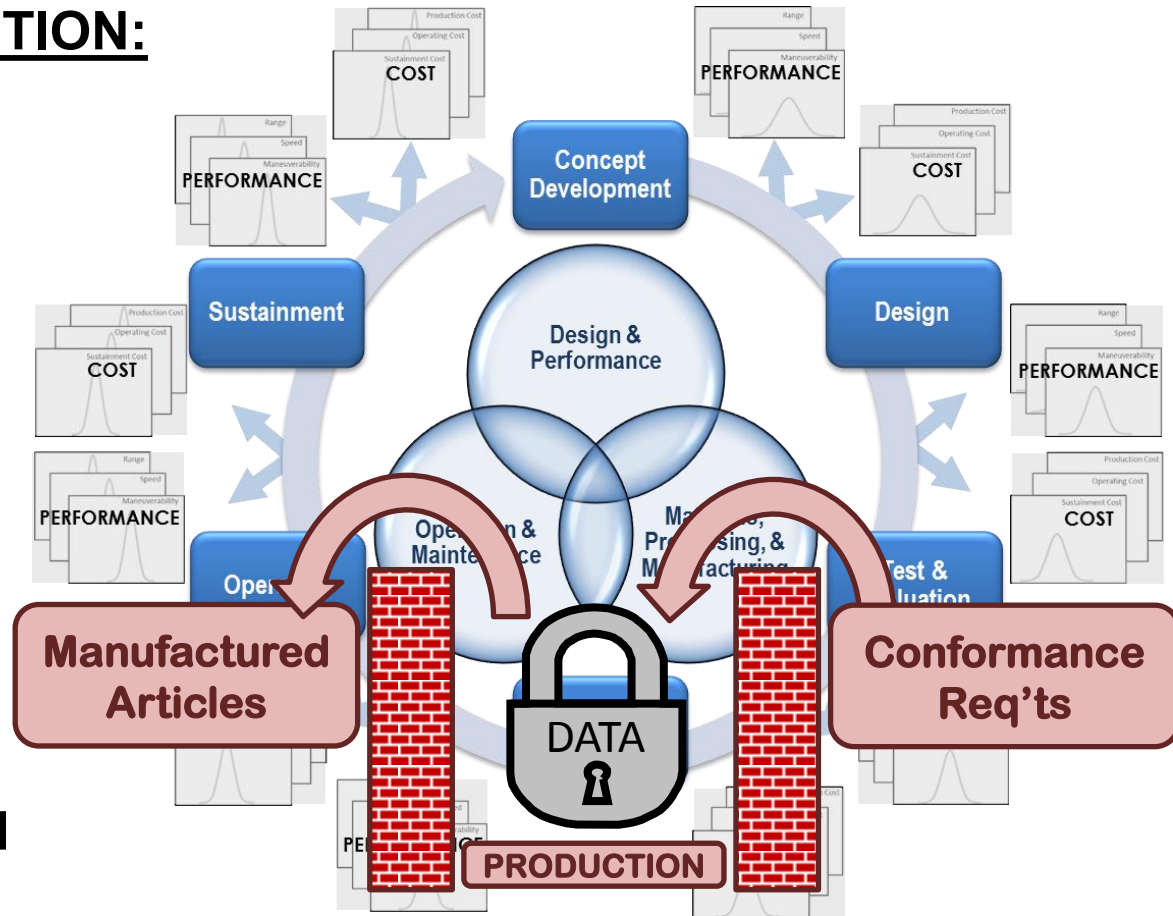


The Need: A Production Perspective



“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!

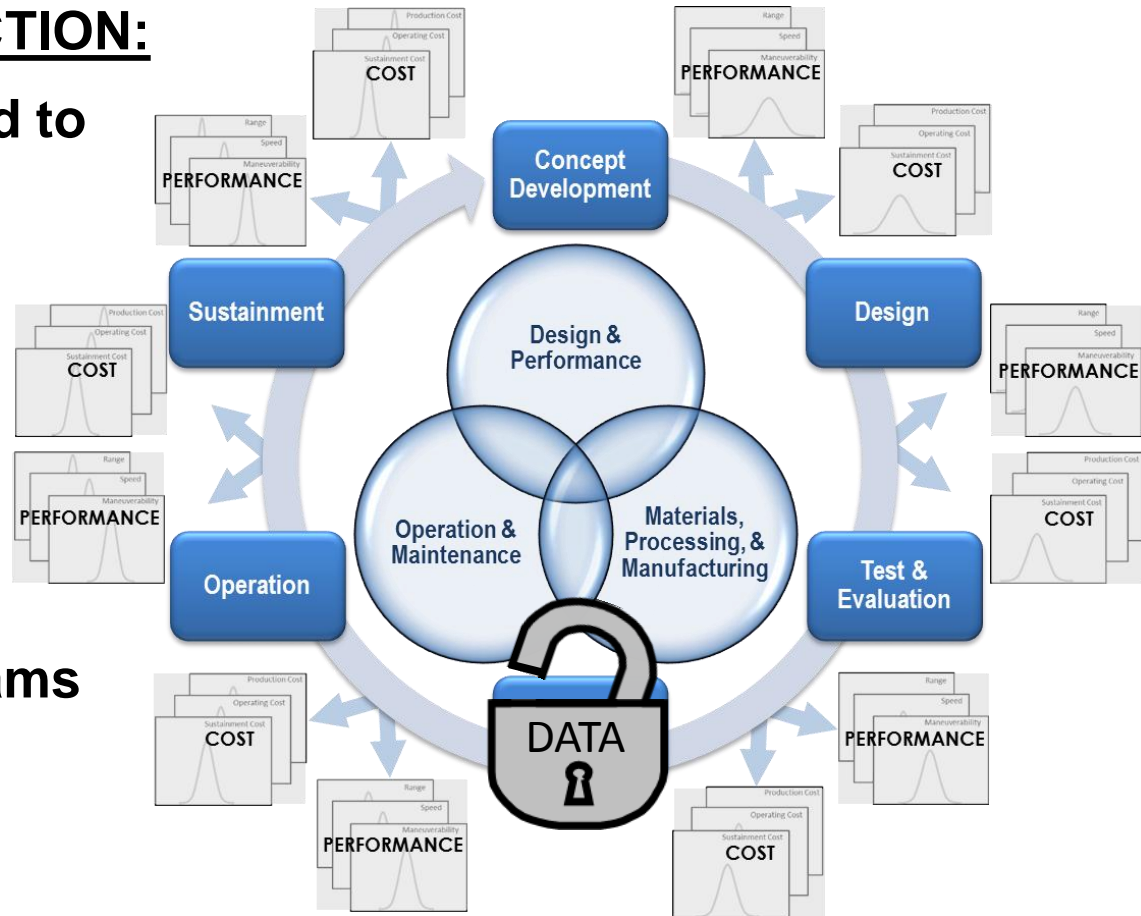


The Vision: A Production Perspective



“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)**