International Council on Systems Engineering
A better world through a systems approach

#383
Digital Engineering Adoption at Small Manufacturers
Learning from Digital Thread and MBD Adoption at SMMs from a Prototype Project and Study

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Connecticut Center for Advanced Technology

Today's Agenda

- Problem Statement
- Background, Needs and Solutions
- The DE Role
- Tackling the Barriers
- Develop New Engagement Model for SMMs for DE
- Results and Conclusions
- Next Steps

This presentation proposes an Integrated MBD Adoption (IMBDA) Framework and strategy for SMMs. The IMBDA Framework presents and discusses key elements unique to business aspects of small businesses and how using a combination strategy of technical skills training, business and value proposition training, leadership training, technology adoption strategies, and investment strategies for small businesses can effect change and move SMMs towards higher levels of MBD readiness**. #smallbusiness #digitaltransformation #technologyadoption**

What's the Problem?

Our Suppliers are Great.

What's the Problem? Are we *Defense*-ive?

WASHINGTON — General Dynamics Electric Boat isn't getting what it needs from its supply chain on time, a fact that could put its remit to deliver two Virginia-class attack submarines per year under "considerable pressure," the CEO of parent company General Dynamics said today.

"The supply chain is not getting better at a fast enough rate as we had hoped," said Phebe Novakovic during an earnings call with investors. "Through our internal efficiency, we have now outpaced them. This is the reality of the post-COVID environment for many of our most important suppliers." – *Breaking Defense, October 2024*

- OEMS experiencing issues with their production due to ***delayed and inconsistent deliveries*** from key suppliers.
- **8X Cost.** This is forcing larger manufacturers to perform **out-of-sequence work**, which is significantly more expensive and time-consuming, up to 8x higher costs over increased timelines.
- **Out of Order?** OEMs plan in a specific order, but late deliveries force them to work on modules or components **that should be completed later**, leading to increased costs and delays. Delays in receiving critical components have been identified as major contributors to the problem.

What Are the Underlying Supply Issues?

- We may not know exactly the problem at the supply chain macro level for this supply chain…….

- But we know how to analyze and find solutions to inefficient and ineffective manufacturing systems and supply chains.

What's the Solution?

Our Suppliers Can Advance and Strategically Compete.

Supply Chain Solutions

Mini-Pronged Solutions

- ***Digital Supply Chain Integration. Use digital twins and MBSE to model system dependencies and reduce rework. Real-time tracking of supplier status and quality using digital thread tools.***

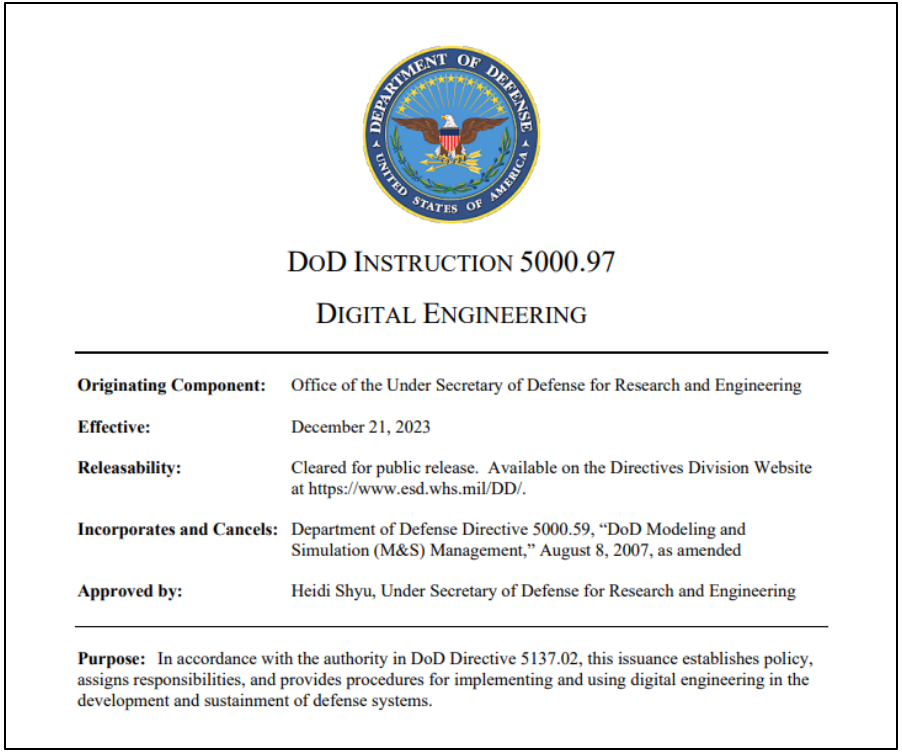
- Supplier Development & Diversification. Invest in Tier-2 and Tier-3 supplier development to create redundancy. Offer long-term contracts or co-investment for critical component production. Certify alternative suppliers in allied nations if permitted.
- Additive Manufacturing (AM)Use AM for producing low-volume, custom parts—especially when originals are obsolete. Use 3D printing for jigs, fixtures, or temporary tooling to accelerate production.
- Obsolescence Management. Implement a proactive obsolescence tracking system. Use lifetime buys and redesign plans for long-lead parts.
- Capacity and Workforce Development. Collaborate with technical schools and regional development programs to expand the skilled labor pool. Invest in automation for repetitive welding, inspection, or machining processes.\
- Advanced Planning and Risk Forecasting. Use AI/ML to simulate risks in material availability, transportation delays, and workforce shifts. Develop multi-scenario build schedules to account for supplier or regulatory changes.
- Cybersecurity and Compliance Readiness. Train all suppliers on CMMC, ITAR, and other compliance requirements. Set up secure information-sharing platforms across the supply chain.

The Digital Engineering Role

DE Policy and Driving DE Adoption.

Department of Defense Instruction 5000.97

Modernize the Department's engineering practices by integrating digital methodologies across the acquisition lifecycle.



DoD INSTRUCTION 5000.97

DIGITAL ENGINEERING

Originating Component:	Office of the Under Secretary of Defense for Research and Engineering
Effective:	December 21, 2023
Releasability:	Cleared for public release. Available on the Directives Division Website at https://www.esd.whs.mil/DD/.
Incorporates and Cancels:	Department of Defense Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," August 8, 2007, as amended
Approved by:	Heidi Shyu, Under Secretary of Defense for Research and Engineering

Purpose: In accordance with the authority in DoD Directive 5137.02, this issuance establishes policy, assigns responsibilities, and provides procedures for implementing and using digital engineering in the development and sustainment of defense systems.

Mandatory Incorporation of Digital Engineering:

All programs initiated after December 21, 2023, are required to integrate digital engineering practices unless an exception is granted by the decision authority. Programs initiated prior to this date are encouraged to adopt digital engineering when practical and beneficial

Establishment of Digital Threads and Artifacts:

The policy advocates for the development of digital threads to connect authoritative data and models, providing actionable information throughout a system's lifecycle. Additionally, it calls for the creation of digital artifacts, such as design specifications and technical drawings, generated directly from digital models

[1] Department of Defense. (2023, December). Digital Engineering Instruction 5000.97. DoDI 5000.97, "Digital Engineering," December 21, 2023

Why Implement Digital Engineering at a Small Manufacturer?

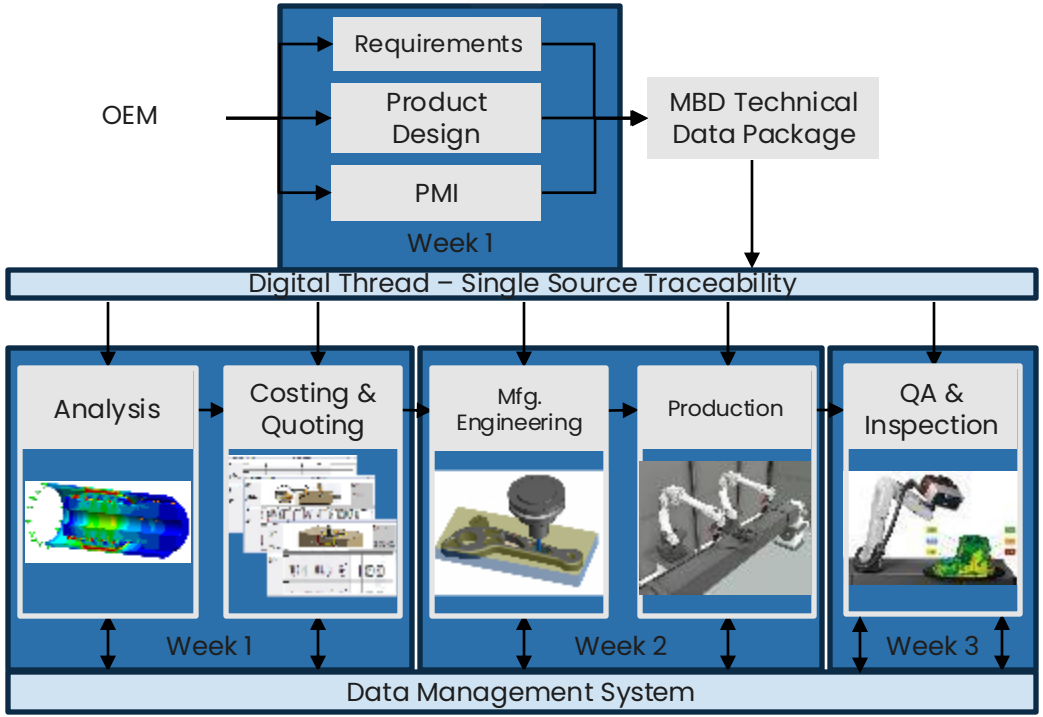
Government Contracts

Digital Foundation

Time Savings/ROI

Strategic Advantage

Manufacturers: Part to Sub Assembly to System, D-M-I Model-Based Definition: Automate Manufacturing Workflows



- Streamlined Communication (SSOT)
- Faster Time-to-Market
- Cost Reduction & Efficiency
- Improved Quality Rates
- Enhanced Collaboration
- Digital Thread Integration
- Resiliency

Tackling the Barriers

DE Policy and Driving DE Adoption.

Tech Adoption Barriers

Category	Key Barriers
Technological	Complexity, poor UX, security risks, infrastructure gaps
Organizational	High cost, weak leadership, unclear ROI, poor planning
Human/Cultural differences	Resistance to change, lack of skills, trust issues, generational
External/Environmental dependence	Legal barriers, supplier readiness, lack of standards, vendor

Digital Engineering Technology Barriers

- **Tool interoperability issues**
  - Engineering teams use many tools (CAD, MBSE, PLM, simulation) that often don't work seamlessly together.
- **Legacy systems**
  - Existing infrastructure may be outdated and incompatible with digital workflows.
- **Data silos and lack of integration**
  - Inconsistent or non-standardized data across teams, departments, or life cycle stages.
- **Cybersecurity concerns**
  - Sharing models and data across digital platforms increases security risks.
- **Model fidelity and validation challenges**
  - Ensuring digital models accurately represent real-world performance can be complex.

How to Engage and Adoption?

Driving Engagement and Participation.

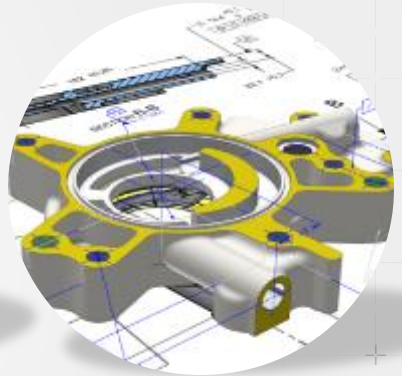
Future FWD: Technology

East Hartford, CT

Advanced Design,
Automation & Metrology

Additive Technologies,
Optimization & Machining

Advanced Composites
Technology Center



Digital Thread Lab:
Automation & Additive Nexus

Advanced Technology Center

Talent & Training Accelerator

Developing transformative solutions for a connected world

Supply Chain Transformation Approach

CCAT + Manufacturers

Top-Down Approach

Change Leadership Mindset & Train Current Technical Staff

+

CCAT + Higher Ed Institutions Bottom-Up Approach for Scale

Training of New Hires – Incoming Students through Train the Trainer Approach with Faculty

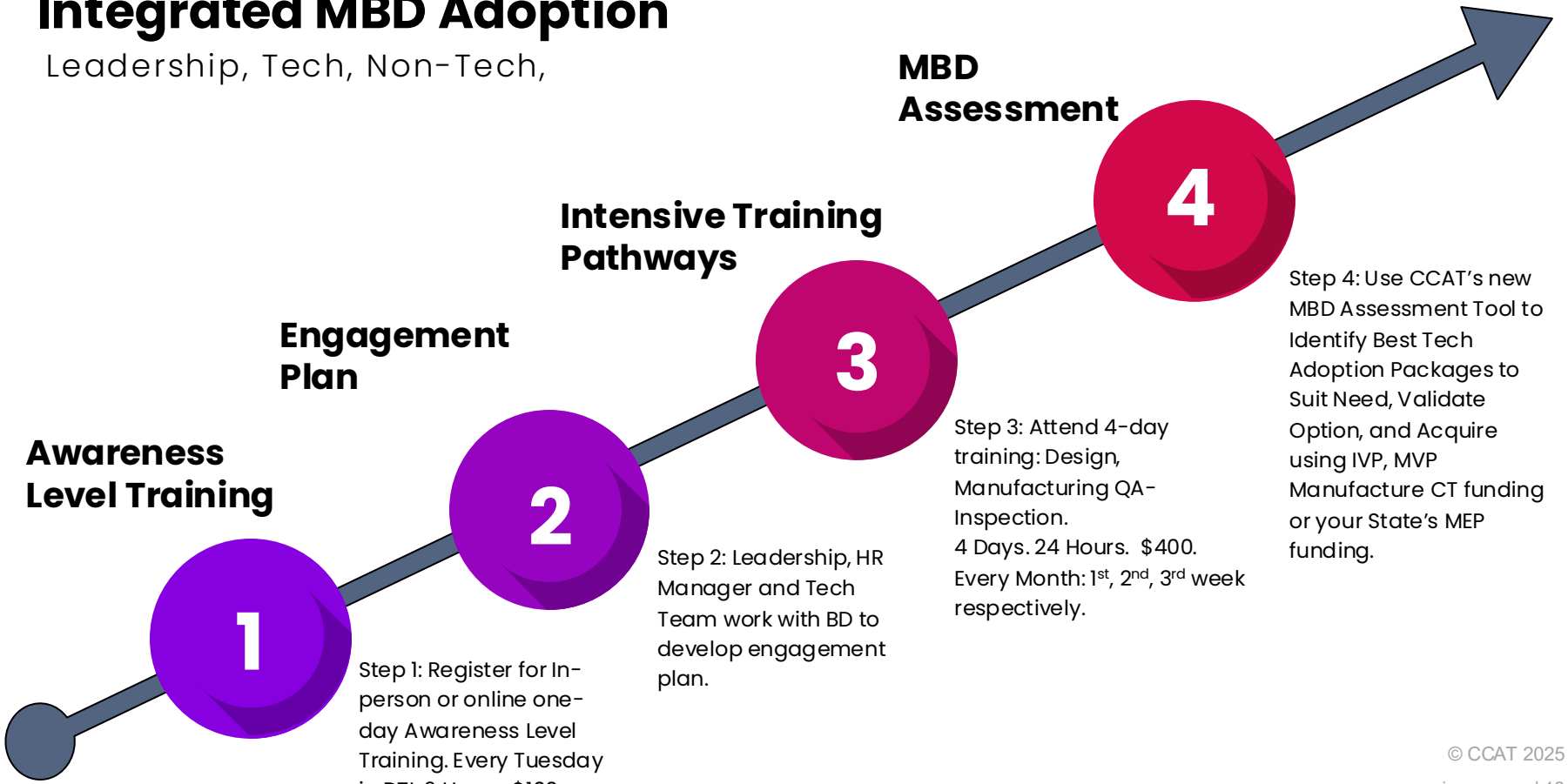
→

Digital Transformation

Support for Manufacturers

Integrated MBD Adoption

Leadership, Tech, Non-Tech,



Step 1: Register for In-person or online one-day Awareness Level Training. Every Tuesday in DTL 6 Hours. $100

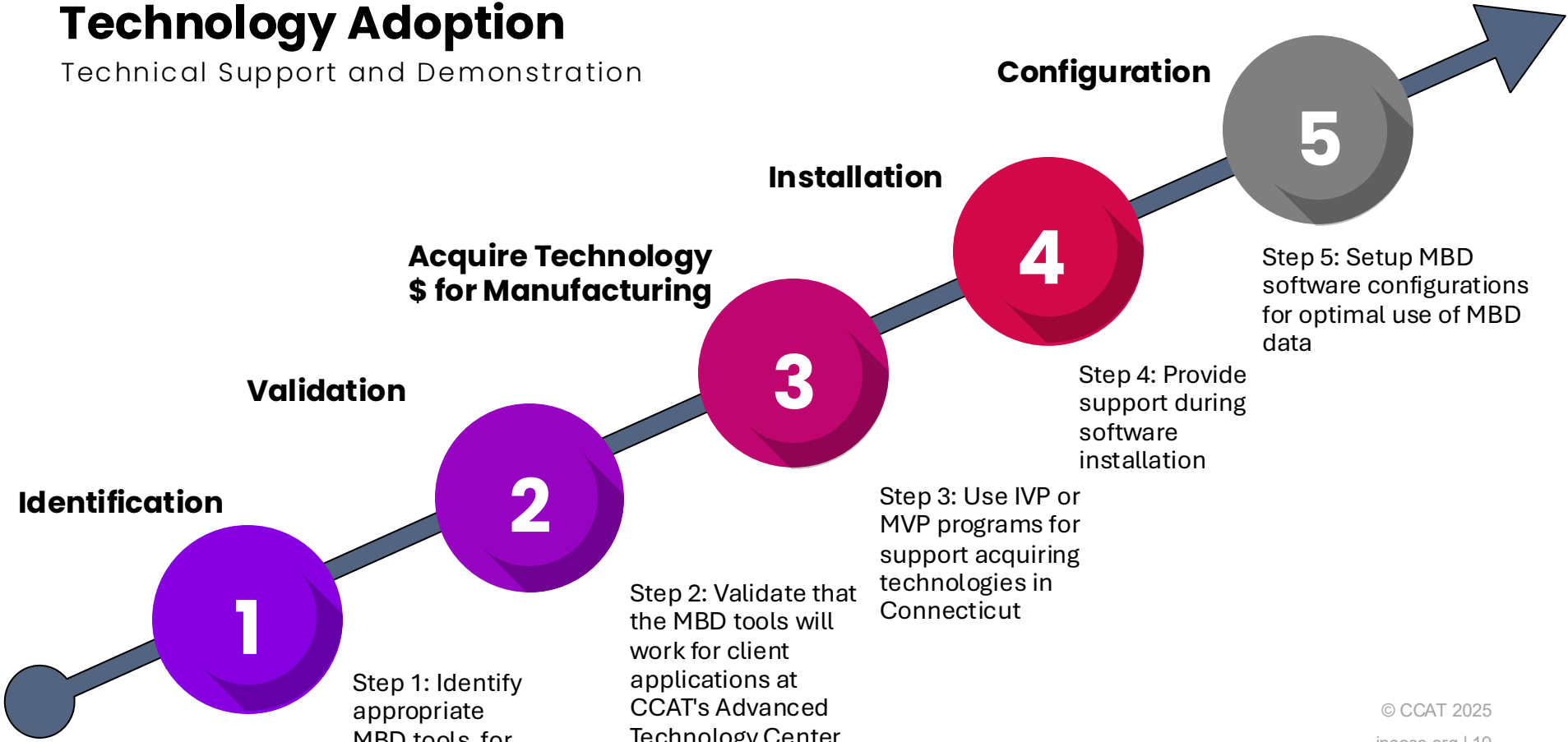
Step 2: Leadership, HR Manager and Tech Team work with BD to develop engagement plan.

Step 3: Attend 4-day training: Design, Manufacturing QA-Inspection.
4 Days. 24 Hours. $400.
Every Month: 1st, 2nd, 3rd week respectively.

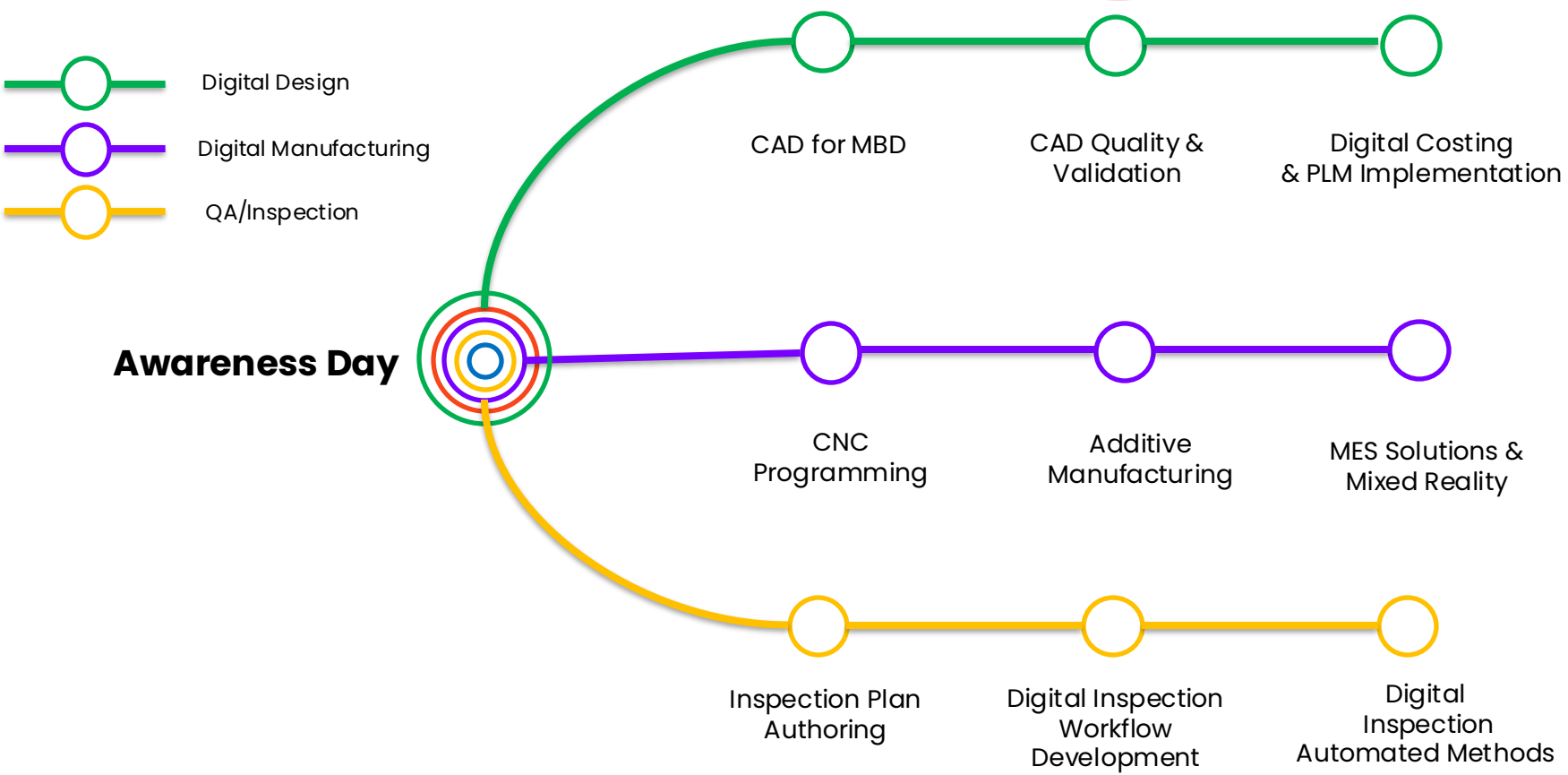
Step 4: Use CCAT's new MBD Assessment Tool to Identify Best Tech Adoption Packages to Suit Need, Validate Option, and Acquire using IVP, MVP Manufacture CT funding or your State's MEP funding.

Technology Adoption

Technical Support and Demonstration



Training Pathway Subway Map



Target Audiences

Awareness

From the shop floor to the C-Suite, where orgs learn about digital thread applications and workflows

Digital Design

- Application and Design Engineers
- R&D Engineers
- Drafters
- Mechanical Designers

+ more!

Digital Mfg.

- Manufacturing Engineers
- Shop Supervisors
- CNC Programmers & Operators

+ more!

Digital QA/Inspection

- Quality Engineers
- Quality Managers
- Inspectors
- CMM Programmers

+ more!

DIGITAL THREAD LAB

Goal

Utilize data-driven digital technologies to improve the efficiency and agility of the supply chain in meeting the Department of Defense's requirements

Components of DTL

- Model-based definition (MBD)
- Digital design & costing, digital manufacturing, & digital quality inspection (DCMI)
- Manufacturing execution system (MES)
- CNC's and CMM's
- Robotics & automation
- Non-contact inspection
- Extended reality: AR/VR/MR
- Additive manufacturing

DIGITAL THREAD LAB

Talent & Training Accelerator

powered by

CONNECTICUT CENTER FOR ADVANCED TECHNOLOGY

Closing the skills gap for **digital transformation** en masse across the defense industrial supply base. **Hands-on training** curriculum designed by subject matter experts for your current and future digital manufacturing workforce.

Amy Thompson, PhD
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Training workflows in design, manufacturing & inspection with a full suite of equipment and software:

CAD & Process Models	Process Authoring and Work Instruction	CAM	Path Generator and Validation	Equipment
SOLIDWORKS SIEMENS NX CAPVIDIA	TEAMCENTER TULIP SOLIDWORKS PDM	Mastercam SIEMENS NX SOLIDWORKS CAM	Origin CheckMate ITI CADIQ PolyWorks	5-axis Mini Mill Markforged X7 3D Printer HEXAGON Global CMM Model S 5.7.5 Scan+ Absolute Arm 7-axis m3di Variscan Pro 48 MP Microsoft HoloLens ABB CRB 1500

Setting National Standards

NSC MBE Maturity Index

Level Name	Drawing-Centric	Drawing Model-Centric	Validated Model-Centric	Formalized Model-Based Definition	Trusted Model-Based Definition	Integrated Model-Based Enterprise	Extended Model-Based Enterprise
Level Identifier	L0	L1	L2	L3	L4	L5	L6
Level Theme	2D Drawings Only; Disconnected	2D Drawings & STEP Derived from 3D Models; Drawings Managed, Disconnected from Models	2D Drawings & Equivalent Derivatives from Validated 3D Models; Drawings Managed, Disconnected from Models	3D Models with Semantic PMI Added; Producing 3D Interactive Viewables; Managed as Part-Centric	Digital Model-Based Definition (MBD) , Certified & Authorized; Managed & Sourced as Part-Centric	Enterprise Integrated from Trusted Digital Product Definition Dataset; Process Data Managed with Part-Centric	Enterprise Extended with Optimized Capabilities and Extended Partners
Key Differentiators							
Authoritative Product Definition	2D Drawing	2D Drawing	2D Drawing w/ Support 3D Model	Drawing (3DIV preferred) from MBD w/ Support 3D Model	MBD w/ Support 3DIV Drawing	3D MBD Dataset	3D MBD Dataset
Artifact Management	File-Sharing	Document-Centric PDM	Document-Centric PDM	Part-Centric PDM	Part-Centric Lifecycle PDM	Enterprise Part-Centric PDM	Extended Part-Centric PDM
Categories for Assessment							
Design Activities	2D Drawings used for all activities	2D Drawings derived from models	2D Drawings and other derivatives from validated 3D model	Semantic PMI included within 3D model	Certified, Authorized MBD	MBD dataset made useable for all lifecycle activities within enterprise	MBD Dataset made useable for all lifecycle activities
Product Data Management	File-sharing directory	Document-centric PDM; Disconnected models	Document-centric PDM; Connected models	Part-centric PDM; Connected product related disciplines	Authoritative part-centric PDM; Source for product definition; Connected [illegible]	Enterprise part-centric PDM; Digitally "One" PDM for [illegible]	Extended digital part-centric PLM exchange with trusted suppliers

Training & Credentials

Connecticut Center for Advanced Technology - Badges - Credly

[1] Sandia National Laboratories. (2020, February). A Next-Generation Model-Based Enterprise Maturity Index. https://www.sandia.gov/app/uploads/sites/171/2022/03/2020_MBE_Summit_NSE_MBE_Maturity_Index_Paper.pdf

I'm sorry I didn't come earlier. You were trying to help me, and I didn't know what I was missing. I'm sorry it took me so long to come here.

This changes **Everything.**

Given CCAT's **extensive experience** & **expertise** in digital transformation, **I see tremendous value** in leveraging your insights and best practices as we begin to lay out this roadmap.

Partnering for MBD and Digital Thread Awareness and Readiness

Supply Chain Coordination Model for DE

Coordinate, Sustainable DE Adoption

- Cooperation and feedback: OEM with supply base
  - Methods: Synchronization of methods and practice and compatibility vs. replication
  - Training: skills and competencies: feedback, improvement, continual advancement
  - Adoption practice Timing
  - Coordination for timing of roll out of DE models

Did you know?

F135 ECU was fully funded in FY24, but in order to keep the program on schedule, consistent funding is needed in FY25 as well. Your advocacy is appreciated!

Need support? Contact F135strategy@prattwhitney.com

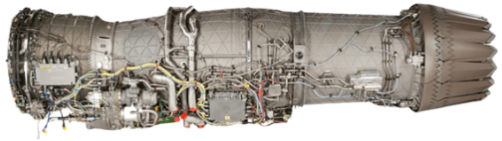
Dear Supply Partner,

Thank you for helping to enable the critical network supporting the F135 and F135 Engine Core Upgrade (ECU). As part of Pratt & Whitney's dedication to building strong partnerships with our suppliers, I'm happy to introduce the first edition of the F135 Supplier Newsletter - a new way for our team to keep you informed on program progress. Our goal is to build strong relationships with our suppliers to ensure continued readiness of the current F135 fleet, while also executing an efficient production ramp of ECU in the coming years.

You are crucial to the success of the F135 program and the advancement of the warfighter. Thank you for your continued support.

Chris Johnson

Vice President, F135 Program, Pratt & Whitney



Pratt & Whitney reached new Preliminary Design Review Milestone for ECU

Pratt & Whitney has completed the preliminary design review for the F135 Engine Core Upgrade, which will enable Block 4 capabilities and beyond for all F-35 Lightning II variants. This successful review validates the ECU design progression, enhancing the F135's capabilities by utilizing cutting-edge technologies developed for advanced programs. The ECU will restore full life and provide the power and thermal management needed for next-generation weapons and sensors. Pratt & Whitney will continue collaborating with the F-35 Joint Program Office to deliver this critical capability on schedule.

Digital Corner

Pratt & Whitney is advancing its manufacturing by investing in digital initiatives for 5th and 6th generation engines to:

- Increase quality and shorten delivery with Agile manufacturing systems
- Improve supply chains using data-driven insights
- Enhance productivity, streamline operations, and drive cost savings
- Reduce cybersecurity incidents affecting legacy systems

Did you know? The Connecticut Center for Advanced Technology (CCAT) unveiled the Digital Thread Lab (DTL) this year to advance digital manufacturing and model-based definition (MBD) skills. Pratt & Whitney and its suppliers are partnering with CCAT to boost digital transformation and MBD readiness in defense manufacturing. To register for courses or learn more about DTL training modules and digital credentials, visit here.

News to Share

Fifth & Sixth Gen Propulsion

"Pratt & Whitney makes the F135 engine that powers the Joint Strike Fighter, and I'm happy to report that we're making great progress on our Engine Core Upgrade, which will introduce next-generation technologies to the platform. This upgrade is going to not only enhance the engine's durability and performance, it will also fully enable the F-35 for Block 4 capabilities and beyond." Read more here.

"Latest F135 engine news! We're proud to announce that Patria and Pratt & Whitney have signed a Memorandum of Agreement (MoA) to produce F135 engines within Finland's F-35 industrial participation programme." Check it out here.

UPCOMING EVENTS:

Sept.16-18, AFA - Washington, D.C.
Nov. 19, 2024, Virtual Supplier Townhall hosted by Chris Johnson

https://www.youtube.com/watch?v=hqE-XT3tXt4