Ohio

Defense & Aerospace 2030

The Governor's Comprehensive Strategy

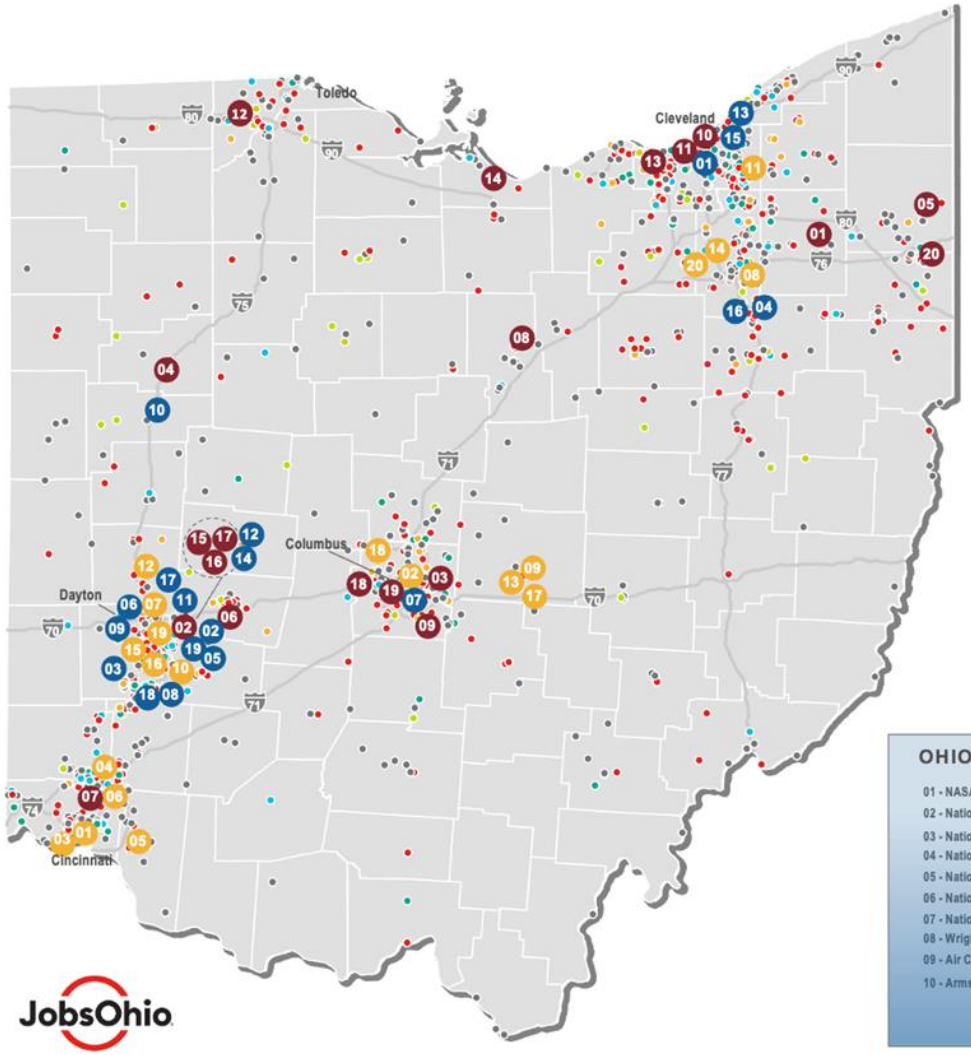
&

Digital Defense and MicroElectronics

Joseph E. Zeis, Jr.
Sr. Policy Advisor to the Governor
for
Aerospace and Defense

Ohio's World-Leading Aerospace Industry

OHIO DEFENSE MANUFACTURING CONTRACTORS AND ASSETS



INDUSTRY SECTOR

- Advanced Manufacturing
- Aerospace & Aviation
- Automotive
- Healthcare
- I.T. & Services
- Other

MAJOR MILITARY FACILITIES

01 - Camp James A. Garfield (JMTC)
02 - Wright-Patterson AFB
03 - Defense Supply Center Columbus
04 - Joint Systems Manufacturing Center
05 - Youngstown Air Reserve Station
06 - Springfield Air National Guard Base
07 - Blue Ash Air National Guard Station
08 - Mansfield Air National Guard Base
09 - Rickenbacker Air National Guard Base
10 - U.S. Coast Guard 9th District HQ
11 - DFAS Cleveland
12 - 180th Fighter Wing, Ohio Air National Guard

FEDERAL AEROSPACE RESEARCH FACILITIES

13 - NASA Glenn Research Center
14 - NASA Plum Brook
15 - Air Force Research Laboratory
16 - Naval Aerospace Medical Research Lab
17 - U.S. Air Force School of Aerospace Medicine
18 - Battelle (Columbus)
19 - Battelle (West Jefferson)
20 - America Makes

TOP DEFENSE CONTRACTOR LOCATIONS

01 - General Electric Company
02 - GE Rolls-Royce Fighter Engine
03 - CFM International, Inc.
04 - Battelle Memorial Institute
05 - Northrop Grumman Corporation
06 - L-3Harris Technologies
07 - The Wornick Company
08 - The Boeing Company
09 - GE Aviation Systems
10 - Veyance Technologies
11 - Lockheed Martin Corporation
12 - Goodrich Corporation
13 - HDT Expeditionary Systems
14 - Integrated Procurement Technologies
15 - Raytheon Company
16 - General Dynamics Land Systems
17 - DRS Advanced ISR
18 - Safran Electrical & Power
19 - Parker Hannifin
20 - Eaton Corp.
21 - Howmet Aerospace
22 - Collins Aerospace

CONTRACT TOTALS*

- 291,630 CONTRACTS
- 185,250 SMB CONTRACTS
- 3,260 TOTAL COMPANIES

*FISCAL YEAR 2015 - MY 2020

OHIO/NATIONAL AVIATION HERITAGE ASSETS

01 - NASA Glenn Visitor Center (Great Lakes Science Center)
02 - National Aviation Hall of Fame
03 - National Aviation Heritage Area
04 - National Inventors Hall of Fame (HQ)
05 - National Museum of the U.S. Air Force
06 - National Park Service - Dayton Aviation Heritage NHP
07 - National Veterans Memorial and Museum
08 - Wright Brothers National Museum (Carillon Historical Park)
09 - Air Camp
10 - Armstrong Air and Space Museum
11 - Boonshoft Museum of Discovery
12 - Champaign Aviation Museum
13 - Crawford Auto-Aviation Museum (Western Reserve Historical Society)
14 - Grimes Flying Lab - Historic Grimes Field
15 - International Women's Air and Space Museum
16 - Maps Air Museum
17 - WACO Air Museum
18 - Wright B Flyer
19 - Wright State Special Collections and Archives

Source: USASPENDING.gov

The Ohio *Aerospace and Defense Pillars*

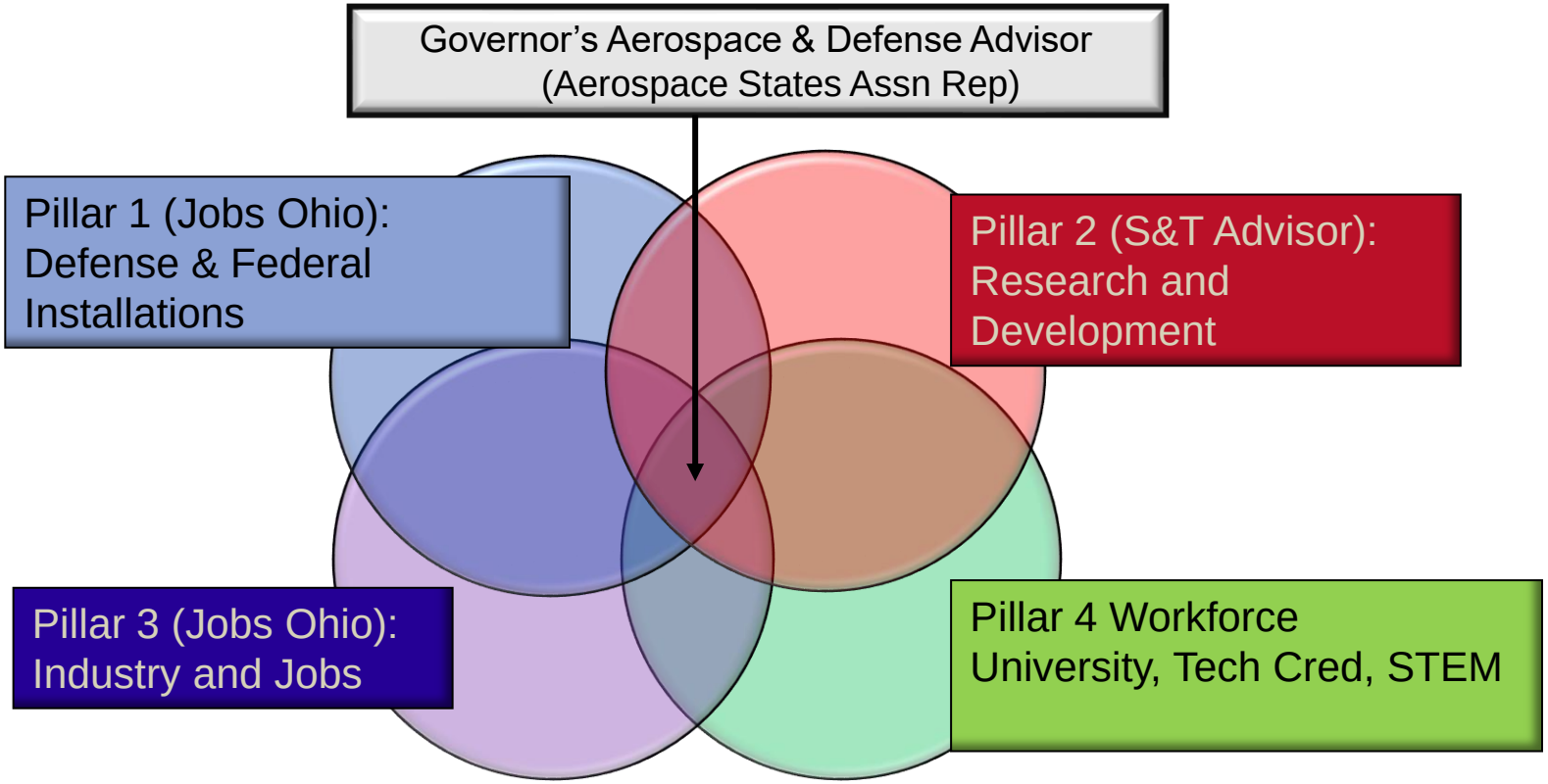
- Preserve, Protect, Defend and Expand the **Federal Aerospace and Defense Installations**

- Increase the Research Portfolio and State-wide Synergies of **Ohio's National-Level Laboratories**:

- Work with **JobsOhio** to:
  - Preserve & Expand **Ohio's Aerospace and Defense Industry**
  - Aggressively Attract Jobs, Mission, and Companies to Ohio

- Maintain and Grow the **Workforce** (Govt. and Comm.)
  - University-Educated
  - Craftsman-trained
  - STEM/STEAM Preparation

Governor's Aerospace and Defense Pillars



Ohio Space Commercialization Strategy

Ohio International Aerospace Strategy (JO - OAI)

The Value Proposition = Proximity

Bottom Line: Ohio is self-attractive to industry

The Value Proposition = Economic Impact

Ohio is a *World-Recognized Leader* in the Aerospace and Defense Industry:

- **Home to Irreplaceable Aerospace and Defense Installations - Transformational**
  Wright-Patterson AFB 33,000+ and $16 Billion impact
  Home to USAF Research and Development & Air and Space Intelligence Ctr
  HQ Largest aircraft holding company in the world
  NASA Glenn World-unique Test and Research Facilities – Space Vacuum
  Defense Supply Center Columbus
  >40% of the entire Defense budget goes through Columbus
  5th Largest National Guard in the Nation – 2nd Largest Air Guard

- **The Aerospace R&D capital of the Nation** – Four "National-level" Laboratories
  Air Force Research Lab / NASA Glenn / Battelle / EPA Lab
  Underpinned by the Ohio Federal Research Network
  The National Leader in Agricultural R&D through OSU

- **Preeminent in manufacturing and supply chain**
  Intel & SNC
  #1 Supplier to Boeing and to Airbus of 50 States
  Primes – GE (largest aircraft engine manufacturer in world; General Dynamics – Last Heavy armor plant in US, Boeing – Singular Guidance and Control MRO

Aerospace and Defense encompasses **110,900 Ohio jobs, 5.9% of Ohio economy and over $39.9B in Economic Impact.**

Bottom Line: Ohio is self-attractive to industry

Recent Wins

The Governor's Vision: Ohio led this nation into the Air and Space Age in 20th Century…A new generation of Ohioans will lead this nation into the Aerospace Age of the 21st Century!

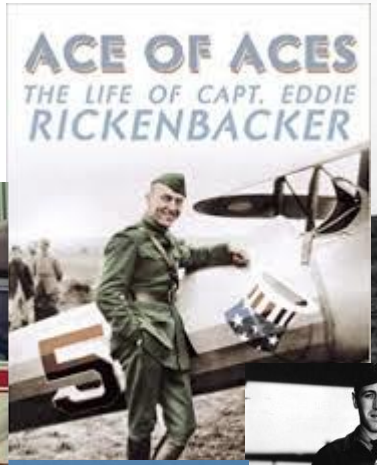
Ohio is a *World-Recognized Leader* in the Aerospace and Defense Industry:

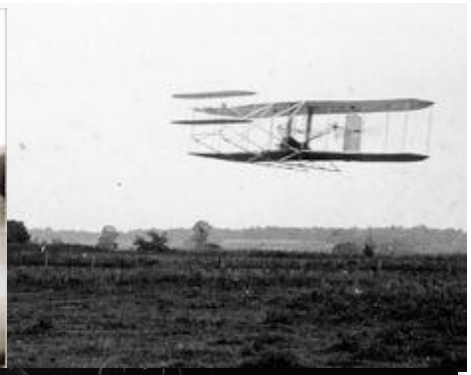
- National Space Intelligence Agency – Wright-Patterson AFB (1)
- CyberSpace Warfare Wing – Mansfield Air National Guard Base (1,4)
- Airbus Voyager Nanoracks Commercial Space Station R&D (2, 3, 4)
- National Center for Advanced Air Mobility (1,2,3)
- Intel Corporation Production (3)
- Google Data Center (3)
- Sierra Nevada Corporation MRO (1, 2, 3)
- C-130J recap at Youngstown ARB (1)
- KC-135 Fleet RTIC Mod Line at Rickenbacker ANGB (1, 3)

Bottom Line: Ohio is self-attractive to government and industrial Aerospace and Defense

The Governor's Call to Action

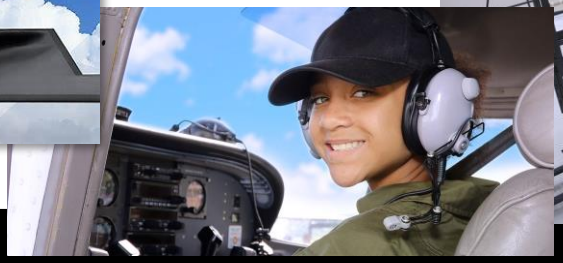
As Ohio, *and Ohioans*, led this nation into the Air Age of the early 20th Century and the Space Age of the later 20th Century…

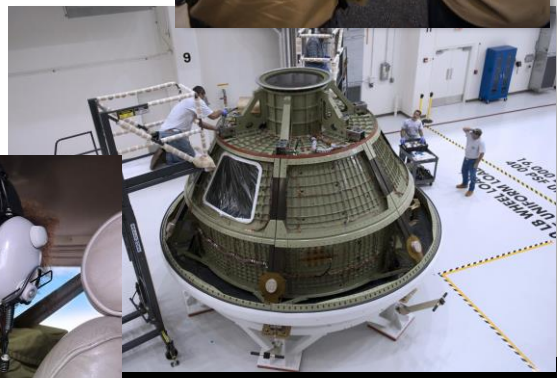




And….

…So will Ohio, and a new generation of Ohioans, lead this nation into the Aerospace Age of the 21st Century!





Thank you

Digital Transformation

Mr. Noah “Odie” Demerly
Process Automation Lead, Digital Transformation Office

May 2023

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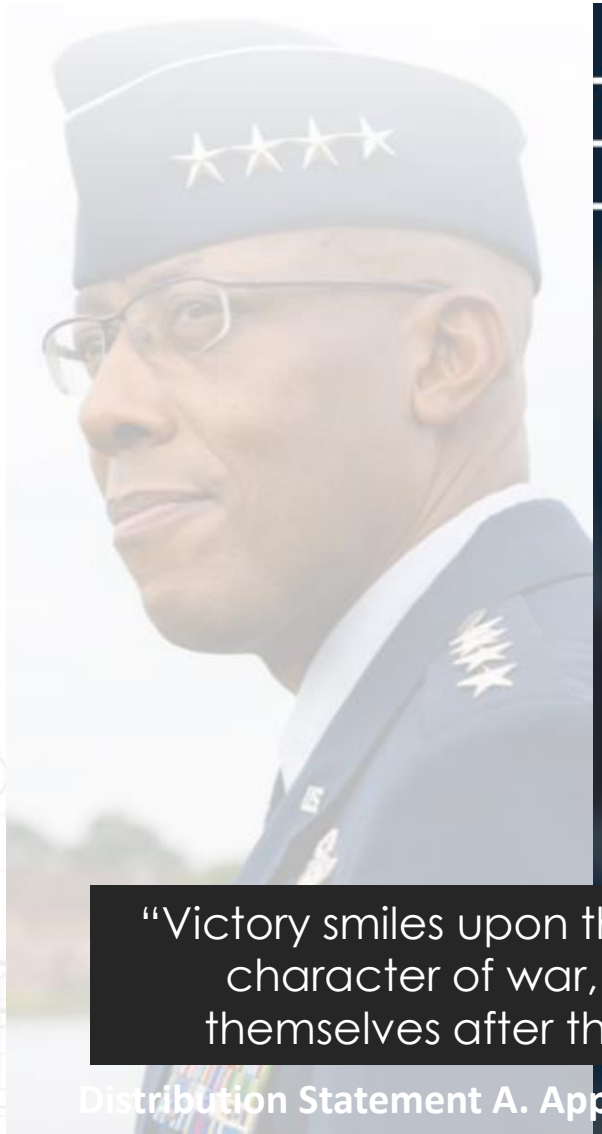
Vision, Strategy & Benefits

DAF Vision



ACCELERATE CHANGE OR LOSE

"The current acquisition process is not built to maintain our advantage in tomorrow's fight"

"We are seeing competitors outpace our current fielding timelines"

"Good enough today will fail tomorrow"

AUGUST 2020

"Victory smiles upon those who anticipate the change in the character of war, not upon those who wait to adapt themselves after the changes occur." — Giulio Douhet

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USSF Vision

Vision for a Digital Service

"We know potential adversaries are developing a spectrum of threats at an alarming pace… To counter their threats, we must change the paradigm"

"We must take up a permanent residence inside the adversary's OODA loop"

"A key aim is to manage the complexity of contemporary weapon system acquisition as well as accelerate and modernize the entire capability development lifecycle—from conception to deployment to operations and sustainment"

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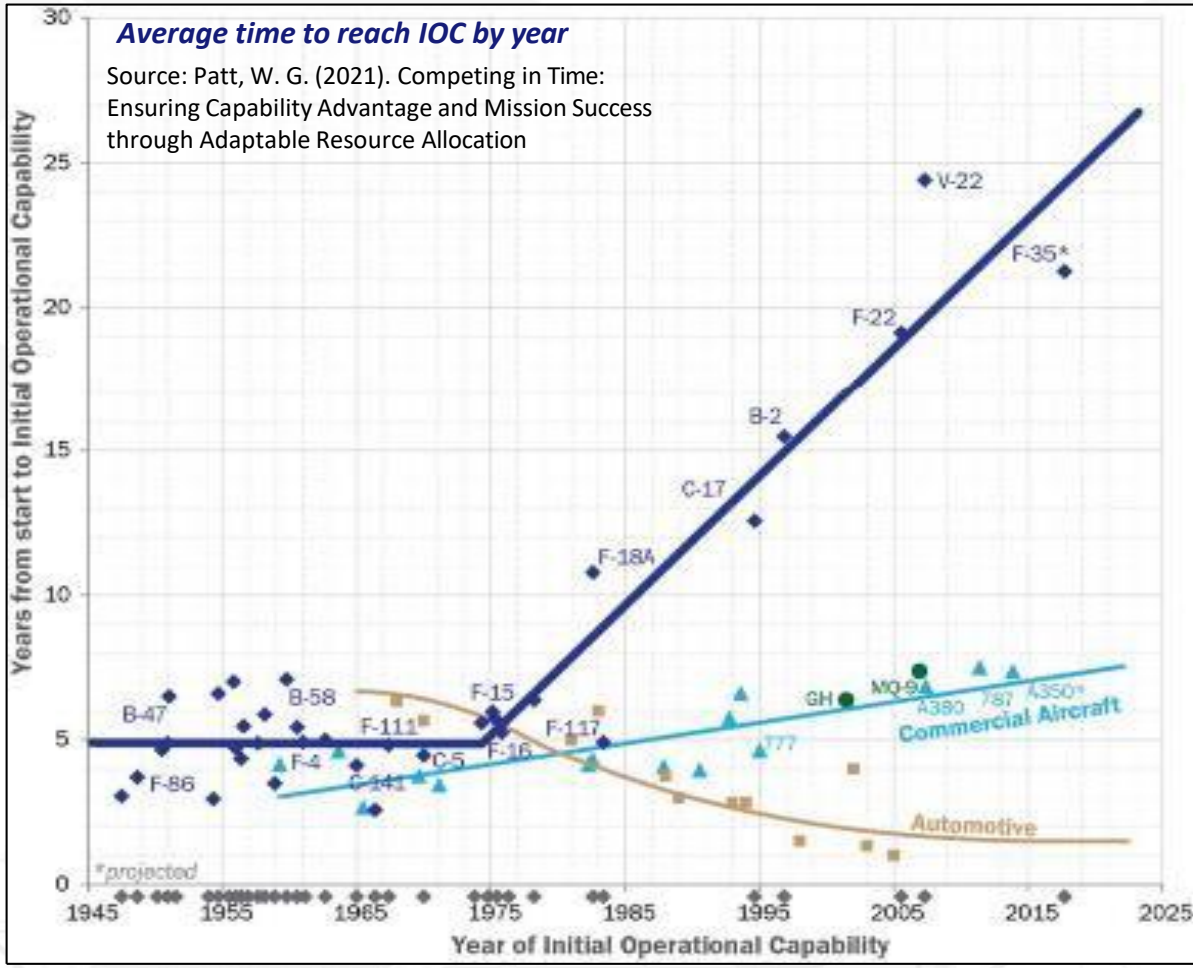
Strategic 'Why': Competing in Time

- "it takes the **US on average sixteen years** to deliver an idea to operational capability, versus **fewer than seven for China**"
- "Defense acquisition process and legacy defense industrial base approach **struggle to accommodate timely adoption of these emerging technologies**"
- "**Competitive advantage** in decision-centric operations (whether budgeting or on the battlefield) **comes from the scale of available options, tempo of decision- making, and superior decision processes**"

Digital Materiel Management (DMM) is HOW we revolutionize AFMC acquisition and sustainment processes



Better Capability, Faster

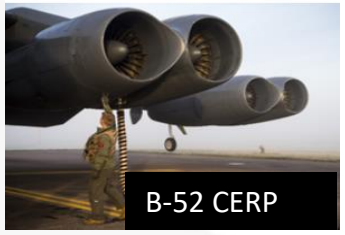
Research | Develop | Design | Test | Supply | Sustain | Maintain | Retire

Prototype | Requirements | Analysis | DT & OT | SLEP | Modernize | DMSMS

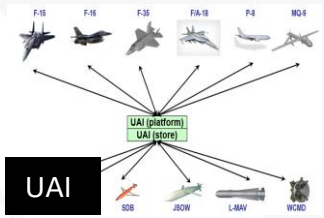
- First flight in 36 mo from concept dev.
- Modularity enables >10 variations
- Digital models enables rapid design/test/validate cycles w/warfighter feedback

- >6B design variants analyzed to optimize performance
- ~6 month reduction in time to SRR
- VR based training for operators/MX

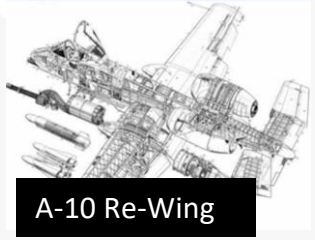
- Months → Days for software development & release
- 1000's of high fidelity design iterations
- Months → Weeks prep time for acq. reviews
- Pivot w/evolving threat



- >60 day reduction in time to PDR w/shared digital tool environment
- Months saved in virtual validation of assembly & MX
- Virtual training opportunities for crews/MX



- >2 yrs, $2M saved in ICD dev't and SIL testing for F-15/SDB II integration
- For NATO munitions: 19 & 15 months saved on wpn integration compared to 5 year nominal avg



- ~1 yr saved in design qualification
- ~60% reduction in sustainment eng response time
- 2000 hrs of A/C downtime reduced to 700 hrs

Foundational Supporting Capabilities

Model Based System Engineering (MBSE) | Threat Informed Mission Modeling | Acquisition Data Management | Open Standards | Reference Architectures | Automated Certification Processes | Authoritative Sources of Truth (ASoT) | Enterprise Tools | PLM & linkage to Log-IT | Robust IT Infrastructure | Workforce Training | Enterprise Policy & Governance | Digital Culture

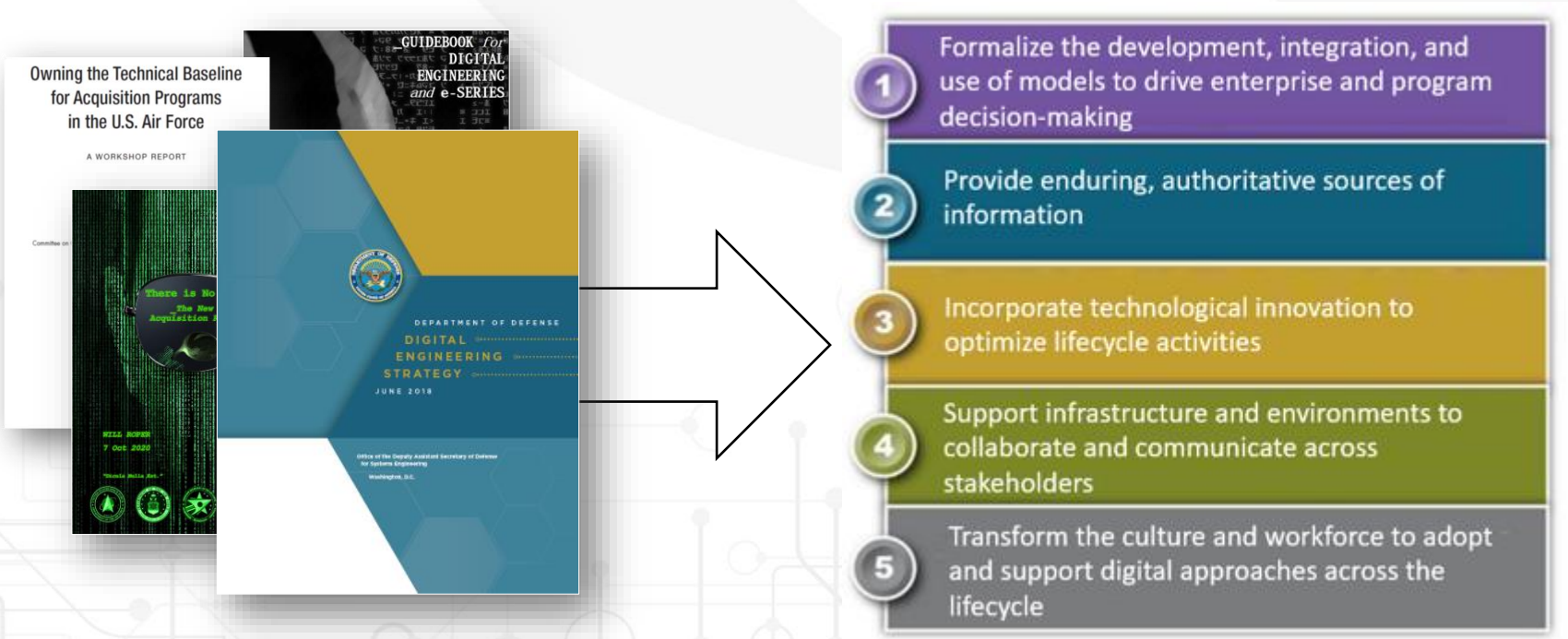
Overcoming silo's and enabling enterprise scale requires enterprise investment

Previous Strategic Guidance

- **Owning the Technical Baseline workshop report (2015)**
- **OSD Digital Engineering Strategy (2018)**
- **AF Digital Campaign (2020-2022)**
  - Influence IT investments to enable a robust, secure infrastructure
  - Provide an Integrated Digital Environment for collaboration, analysis, and visualization across functional domains of AF users
  - Guide the use of Government Reference Architectures and related standards and datasets for enterprise and system-level application
  - Develop Life Cycle Strategies and Processes for Technology Transition, System Acquisition and Product Support
  - Assess and define the required policy and guidance changes to enable full implementation of the Digital Transformation
  - Drive culture change through training and change management
- **SAF/AQ Vision**
  - There is No Spoon: Digital Acquisition (2020)
  - Bending the Spoon: Guidebook for DE and e-Series (2021)
  - Digital Building Codes (2021-)

Derived DTO Goals

DTO Vision: A digitally-empowered Air Force equipped with an *agile workforce*, *state-of-the-art technologies*, and *intuitive processes* that *drive model-based enterprise decision-making*, *enable automation*, *institutionalize open architectures*, and *leverage authoritative models and data* to ensure *seamless stakeholder collaboration across the lifecycle*.



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Organizational Evolution

Historical Summary

- **Summer 2019: Digital Engineering Enterprise Office (DEEO) established in SAF/AQR**
  - Supporting SAF/AQ Digital Trinity vision documents
- **March 2020: Digital Campaign established**
  - Organized into 6 LOEs
  - Initial scope largely AFMC and engineering centric, quickly expanded to DAF-wide acquisition community effort embracing all functional competencies
  - Aligned with NDS, CSAF *Accelerate Change or Lose*, and USSF *Vision for a Digital Future*, OSD's *Digital Engineering Strategy*
- **Industry Day Sep 2020, Digital Pitch Day Mar 2021, IP Workshop Oct 2021, and various other partnerships with NDIA, FFRDCs, Academia, sister services, OSD, AF Studies Board, etc.**
- **June 2021: DAF Digital Transformation Office (DTO) established**
- **CONOPS governance-based updates to Sr Leadership, AFMC/CC, SSC/CC, & SAF/AQ**
- **Digital Guide** internal site (https://usaf.dps.mil/teams/afmcde/SitePages/Home.aspx) – Post all content and training; public facing guide (https://guide.dafdto.com/) enables industry, academia, and cross service collaboration

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Strategic Digital Initiatives (2022)

AQ Digital Acquisition Priorities

1. Implement Open Systems Standards and Reference Architectures
2. Ensure Programs Are "Born Digital" or Digitally Adapt over the Lifecycle
3. Expand Enterprise Solutions and Embrace Cloud-based Collaborative Environments
4. Institutionalize Processes for Agile Software Development and Software-Intensive Systems

AFMC Digital Materiel Management (DMM)

1. Structure and Secure our Data
2. Train our Digital Workforce
3. Provide Access to DMM Tools
4. Develop Digital Strategies
5. Instill a Digital-First Culture
6. Modernize IT Infrastructure

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Strategic Digital Initiatives (2022)

USSF Digital Priorities

1. Digital Engineering
2. Digital Workforce
3. Digital Headquarters
4. Digital Operations

SSC DE/DT Lines of Effort

1. Digital Engineering Environment
2. Digital Engineering Standards and Workflows
3. Government Reference Architectures
4. Business Processes
5. Workforce Training

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AFMC Strategy Map

MISSION

Powering the world's greatest Air and Space Forces… We develop, deliver, support, and sustain war-winning capabilities.

VISION

One AFMC--integrated, innovative, trusted, and empowered…

Indispensable to our nation, disruptive to our adversaries.

Our Cross-Cutting Attributes

Speed • Strength • Endurance • Balance • Flexibility • Coordination

Our Commitments

Enable DAF Priorities • Support the Warfighter & Respect the Taxpayer • Focus on Enterprise Solutions & Digital Materiel Management • Provide All Airmen the Opportunity to Reach Full Potential • Embrace Innovation

Our Lines of Effort

LOE 1 — Deliver Integrated Capabilities

Integrate research, development, test, sustainment, support, and infrastructure to maximize readiness and lethality for each individual capability and across all capabilities.

- **Sustain the Legacy Force (Internal/External):** Integrate all efforts within and across our centers by working together as One Team to ensure the current force structure is ready anytime and anywhere against any adversary.
- **Deliver the Future Force (Internal/External):** Create future capabilities that deter and disrupt our adversaries using the same integrated intra- and inter-center One Team approaches.
- **Seek DAF Enterprise Solutions (Internal/External):** Through intra- and inter-center integration and coordination, deploy DAF enterprise solutions to the max extent and defer to unique solutions only when necessary.
- **Responsive Support (Internal/External):** Deliver AFMC materiel capability and combat support; integrate to ensure operational surge and sprint capabilities meet warfighter and humanitarian requirements

LOE 2 — Strengthen Our Team

Advance the professional and personal development, retention, and resiliency of our entire workforce so every AFMC Airman can achieve their full potential.

- **Build Full Potential Airmen (Internal):** Provide intentional opportunities for military, civilian team members to achieve their professional and personal goals, ensuring diversity, equity, inclusion, and accessibility.
- **Entrust Decisions to Lower Levels (Internal):** Push responsibilities and decision-making to trained-and-ready lower levels
- **Develop Leaders (Internal):** Develop leaders able to create environments where team members can professionally and personally thrive

Digital Materiel Management - DMM

LOE 3 — Revolutionize Our Processes

Implement AFMC Enterprise Solutions and Digital Materiel Management, revolutionizing critical processes in support of mission execution and the warfighter.

- **Build One AFMC Business Enterprise (Internal):** Inculcate internal processes that activate speed, strength, endurance, balance, flexibility, and coordination in AFMC's ability to deliver capabilities on relevant timelines in spite of fluid threat environments.
- **Employ Digital Materiel Management (Internal):** Ensure critical processes employ digital methods across the entire lifecycle--from invention to retirement--for both warfighting capabilities as well as installation and mission support capabilities.

LOE 4 — Amplify Warfighting Culture

Connect every Airman to the mission and focus the materiel enterprise on delivering capabilities and services in support of operational execution and deterrence.

- **Connect to the Mission (Internal):** Ensure every team member and unit understands their role, value, and connection in materiel capability delivery to the operational units we support.
- **Be the Trusted Partner (Internal/External):** Drive toward the speed of trust with one another, the warfighter, industry, and our mission partners

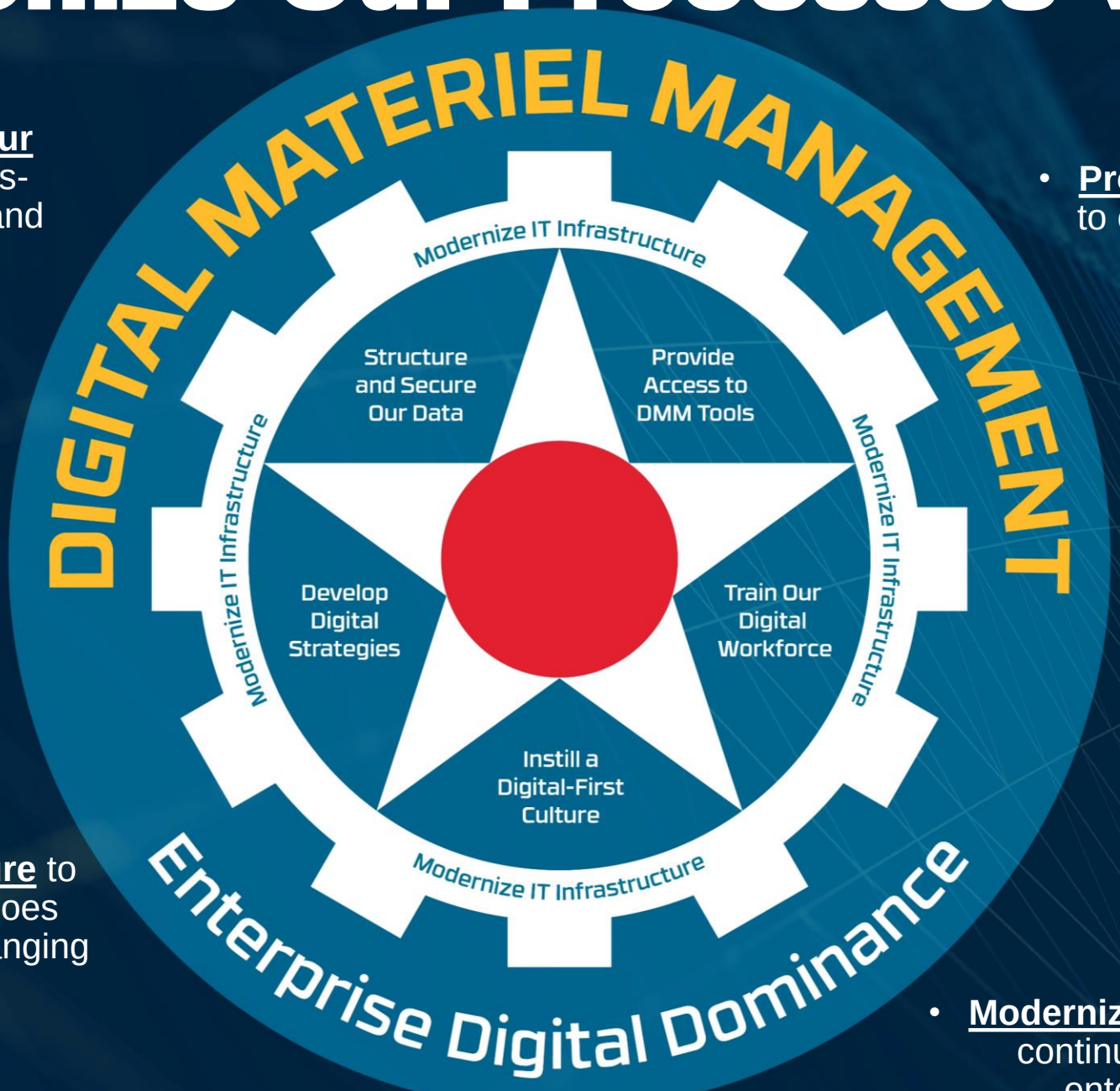
Video OV-1

Revolutionize Our Processes via DMM

- **Structure and Secure Our Data** for low friction, cross-organizational teamwork and decision-making

- **Develop Digital Strategies** to leave behind stale practices and pave the way for agile acquisition & sustainment

- **Instill a Digital-First Culture** to revolutionize how AFMC does business in a constantly changing threat environment



- **Provide Access to DMM Tools** to equip our workforce for digital operations with a dynamic toolbox

- **Train Our Digital Workforce** so we are prepared to collaborate with partners in a fully digital ecosystem

- **Modernize IT Infrastructure** to continuously enable rapid enterprise solutions

DMM End State

- **Goal**: Accelerate capability delivery through Digital Acquisition and Digital Materiel Management

- **Vision**: DAF digital ecosystem and fully empowered digital workforce, equipped to deliver integrated, innovative, and trusted capability across Digital Materiel Management (DMM) lifecycle with unprecedented industry and government collaboration

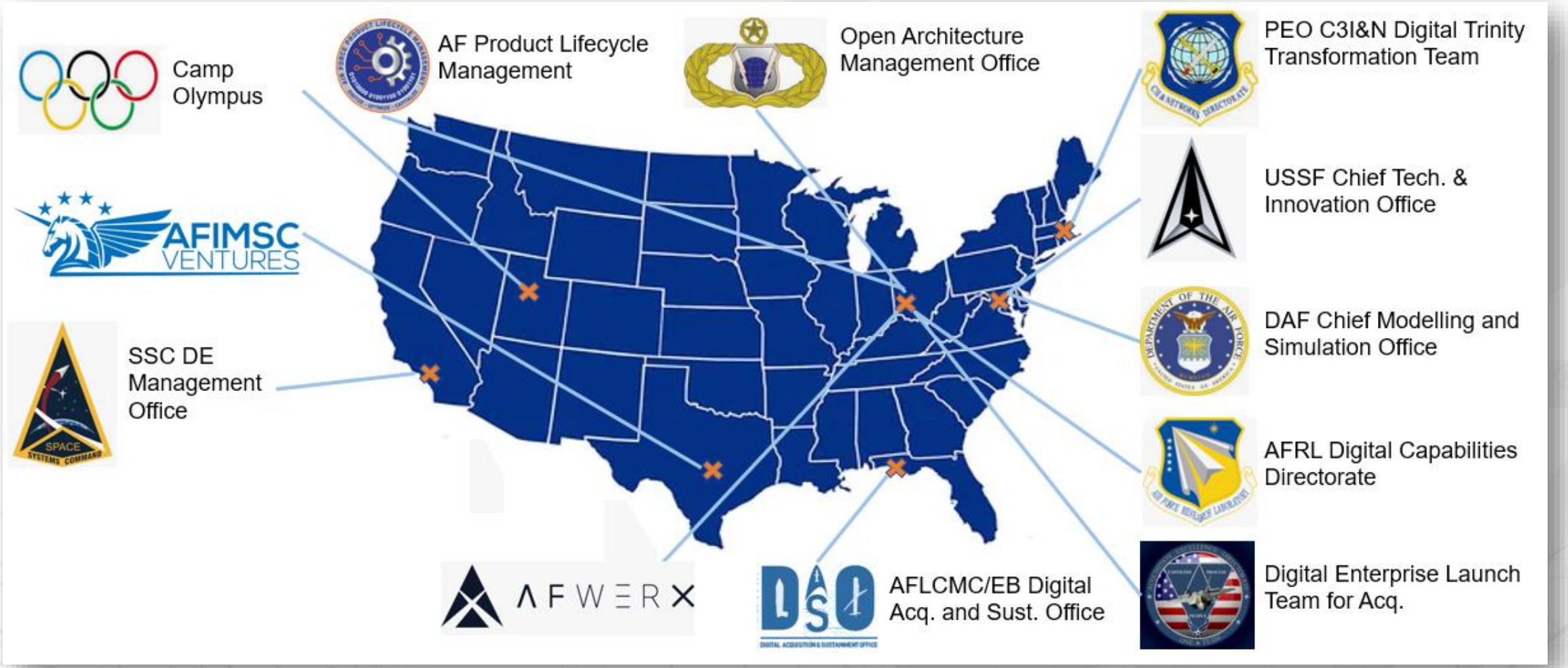
- **Purpose**: Speed, flexibility, and agility in our acquisition enterprise; war winning capability, delivered faster, to win tomorrow's fight.

DMM ≠ digitizing the status quo

DTO

Current Activities

DTO's Digital Coordination



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Digital Transformation Governance

Digital Transformation Council

Co-chairs: SAF/AQ, SAF/SQ, AFMC/CC, SSC/CC

Members: SAF/CN, AF/TE, AF/A2/6, AF/A4, AF/A5, SF/SPoC, SF/CRSO, SF/CTIO, other appropriate HQ DAF 2-ltrs, others as needed

Digital Transformation Board

Co-chairs: SAF/AQR, SAF/SQA, AFMC/EN, SSC/ZA

Members: DAF PEOs, SF/CTIO deputy, AF/TEP, SAF/AQ and SQ 3-ltrs, CMSO, CSO, PEO C3BM, SAF/CNS, AMFC and SSC 2-ltrs, DAF SL/STs, AFMC Center/ENs, others as needed

Digital Transformation Coordination Group

Chair: DAF DTO; **Key Advisor:** SL for SE

Members: SSC DE Office, OAMO, AFLCMC/HNI, AFLCMC/AQ-AZ, AF-PLM, SAF/AQCC, SAF/AQRE, WG leads, Center Digital Transformation leads, DAF PEO representatives, HAF/A4PA, AFMC/A4N, AFMC & SSC functional leads, others as needed

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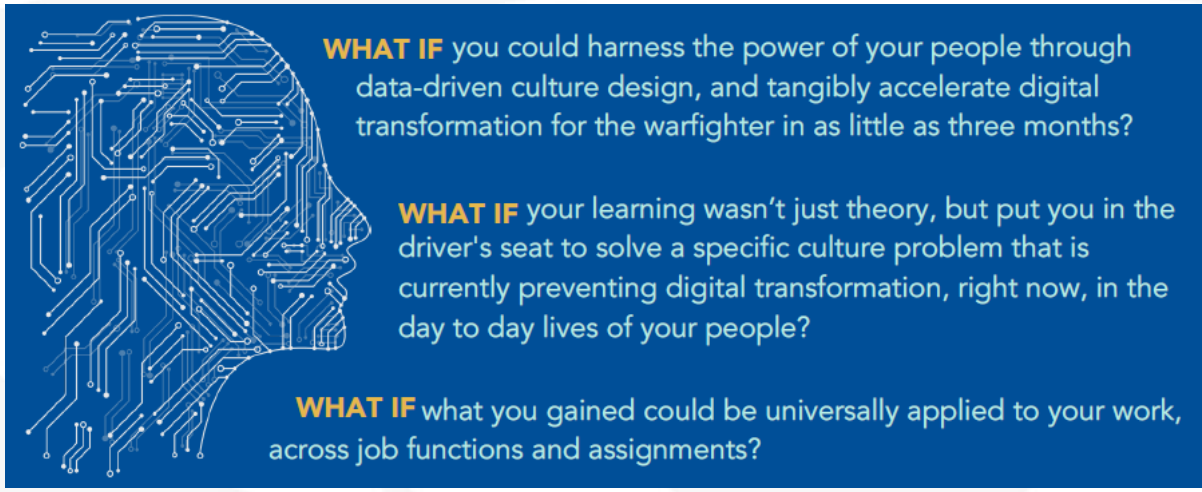
Internal DTO Activities

The C1SERC Launch Pad: lowering the barrier to entry for DAF programs by providing no-cost, rapid access to digital tools in a multi-tenant Environment hosted in Cloud One at IL-5.

LaunchPad (DEPaaS Offering)



Digital First Culture Science Masterclass

[Digital Guide]

Hero Recognition Campaign

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Internal DTO Activities (cont.)

"Tools for All" Business Model Exploration

Category	Metric	Metric Component
Infrastructure	Model Environment	Tool Access and Governance
		Data and Tool Interoperability
	Collaboration	Capability
		Security
Modeling / Analysis	Quality	Authoritative Sources of Truth
		Metrics
		Model-Based Verification and Validation of Systems
		Digital Management Strategy

Digital Maturity Assessment

Certification Pathfinding

AFMC Digital Airworthiness Team

UNITED STATES AIR FORCE

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA)

Program Outreach and Strategy Development

Industry Outreach/Colliders

Data Management Frameworks

ATO/EPL Process Improvement

AFIT Digital Center of Excellence

Open-Source SW inclusion

DTO

BACKUP

LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative A – Structure and Secure Our Data (AFMC/EN, AFMC/A5/8/9, & AFMC/A3/6 collaboration)**
    - **Goal:** Easily shareable data across the acquisition lifecycle, acquisition enterprise, and industry partners. Cleanly organized, fit-for-purpose, models and data. Secured from external attack.
    - **Ongoing Efforts:**
      - Formalized *AFMC Structure and Secured Data Board* – draft charter created
      - Planning initial *summit* with key stakeholders to ID most critical next steps
      - *Acquisition and Sustainment Data Package* – drafting modern contracting language and data item description language (AFLCMC led)
      - *Data Fabric demonstration* - consolidated AI/ML algorithms, visualization tools, security, and infrastructure applied to supply chain and depot use cases (AFSC led)

LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative B – Train Our Digital Workforce (DTO)**
    - **Goal:** Functionally tailored/streamlined digital training offerings, tuned to and evolving with individual needs.
    - **Ongoing Efforts:**
      - *Digital Integration Center of Excellence (DICE)* – AFIT effort to scale existing training programs, streamline research, improve lessons learned documentation, and establish cadre of modeling SMEs for direct program support
      - *Functional Based Training profiles* – update list of functional training recommendations
      - Establish *'day-in-the life'* program and functional examples of applied DMM
      - Explore additional *badging/credentialing* opportunities for DMM applications

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LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative C – Provide Access to DMM Tools (DTO)**
    - **Goal:** Access to the right tools, at the right time, at the right classification level
    - **Ongoing Efforts:**
      - *Digital Platform as a Service (DPaaS) Launchpad* scaling and onboarding at IL-5, establish similar environment at IL-6 level in FY23
      - Improve SW approval and deployment process – SW testing democratization, realized SW reciprocity, and streamlined SW deployment
      - Functional community tool needs/gaps identification

LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative D – Develop Digital Strategies (DTO)**
    - **Goal:** Common vision of applying digital-first strategies to their work; teams easily establish tactical plan and milestones to implement, program, portfolio, and Center strategies aligned with broader enterprise.
    - **Ongoing Efforts:**
      - Publish/Deploy Digital Maturity Assessment Process v3.0
      - Facilitate workshops for program-specific approaches -- 'Digital Interventions'
      - Publish Digital Building Code v3.0 w/industry inputs; Signed by AQ and SQ
      - Enable Digital Airworthiness via establishing, formalizing, and executing 6 WGs
      - Execute CRADA with DAF (DTO, AFRL, & LCMC) and NGC - Melbourne

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LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative E – Instill a Digital First Culture (DTO)**
    - **Goal:** Enthusiastic pursuit of digitally-driven processes; proactively sharing ideas, lessons learned, best practices, improved processes, and digital artifacts
    - **Ongoing Efforts:**
      - Conducting Digital First Culture Science Master Class
      - Scale Hero Recognition Campaign w/additional individual stories
      - Facilitate innovative mechanisms to engage, collaborate, and share

LOE 3 – DMM

- **Objective 2 (SII-2) Digital Materiel Management (Mr. Robert Fookes)**
  - **Initiative F – Modernize IT Infrastructure (AFMC/A6)**
    - **Goal:** Upgraded IT infrastructure characterized by speed, agility, and flexibility – foundational to DMM success
    - **Ongoing Efforts:**
      - Identify enterprise demands, requirements, gaps & barriers
      - Articulate multi-level security challenges, industry and gov stakeholders, and a tactical plan with milestones
      - Coordinate with SAF/CN & industry primes on IT environment ATO process changes

Digital Campaign Lines of Effort

- **LOE #0: Integrated Environment –IT Infrastructure {Mr. Rich Kutter, S/L}**
  - Provide overarching guidance to influence corporate IT improvement investments to enable a robust, secure infrastructure for the enterprise-wide Digital Campaign
- **LOE #1: Integrated Environment –Models and Tools {Mr. Tom Lockhart, SES}**
  - Provide an integrated digital environment (IDE) of models and tools for collaboration, analysis, and visualization across the functional domains of AF users
- **LOE #2: Standards, Data and Architectures {Mr. Mitch Miller, S/L}**
  - Provide overarching guidance on the use of Government Reference Architectures (GRA) and related standards and datasets for use in an integrated digital environment for application at the enterprise and system levels
- **LOE #3: Lifecycle Strategies and Processes {Mr. Lansen Conley, SES}**
  - Develop Life Cycle Strategies and Processes for Technology Transition, System Acquisition and Product Support using an IDE, supporting lifecycle activities from concept development to disposal
- **LOE #4: Policy and Guidance {Mr. Tom Doyon, SES}**
  - Assess and define the required policy and guidance updates/changes to enable full implementation of the Digital Transformation
- **LOE #5: Workforce and Culture{Ms. Jackie Janning-Lask, SES}**
  - Drive culture change across the AFMC enterprise through training and change management, enabling a workforce well versed in Digital Engineering

Siloed, Realized Benefits

Demonstrated Impacts/ROI:

- **T-7**: 36 Months From Concept to Production; 80% Reduction in Assembly Hours; 50% Reduction in Software Development
- **B-1**: Geometric Digital Twin enables gov't owned advanced manufacturing uses; better MX understanding; first of its kind S&E recruiting pipeline
- **Advanced Range Threat System**: Operational Analysis plug in to AFSIM; docs derived from models; Digital design enables longer vendor competition
- **B-52**: Reduced time to PDR for CERP by >60 days; months saved in VR assembly validation; data driven analysis ID'ed portfolio funding priorities
- **Sentinel**: Gov't/prime model & data sharing; keeping program on time w/MMIII sunset; PM decision tools; unprecedented system understanding w/virtual models
- **Open Architectures**: >2yrs, $2M saved on munition integration; 90% reduction in avionics system integration timeline; 50% reduction in EGI integration timeline

Primary inhibitors:

- ***No enterprise resources*** to scale; enterprise investments limited to DAWDA, SBIR,…
- Foundational IT, bureaucracy, and cultural issues hinder wide-spread results
- Lack mechanism to scale wins due to org/funding silos

DTO

Quantifying Digital Transformation Benefits

Additional Data Needed		• Capability delivery cycle-time • Lifecycle costs, ROI	
Developing & Proxy Measures	• Cross-Functional Digital Maturity	• RAND, 2023 • Industry ROI	• Opportunity Cost of Inaction
Currently Measurable	• MBSE Literature • Digital Maturity • Strategy Metrics	• RAND, 2022 • Mfg Case Studies	• Current Pacing Threat(s)
	Quantifying Implementation	**Quantifying Lifecycle Benefits**	**Relative Risk**

DTO

Pre-Work Required for Workshop

Required:

- Digital Overview Slide Deck
  - The DTO requests that you present your current digital overview in order to help guide the conversation during the workshop
  - You do not have to develop a new presentation; you can use whatever slide deck template you have

Optional:

- Complete the Digital Maturity Assessment
  - We recommend you do the assessment if you want to know what to do next, but it is not necessary if you already know what to do next
  - https://guide.dafdto.com/2023/01/04/digital-maturity-assessment/
- Attending DELTA Workshops

Digital Maturity Assessment

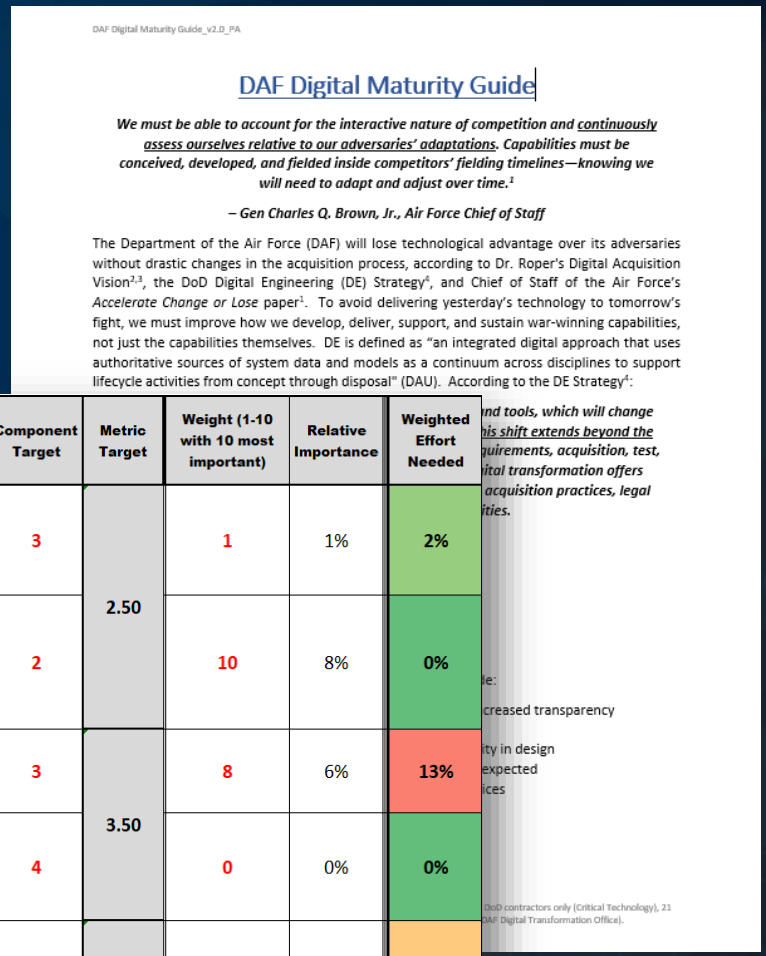
- **Background:**
  - Background Research: Industrial base, Navy, professional societies (e.g., *INCOSE = International Council on Systems Engineering*), TRLs/MRLs, OSD Digital Engineering Strategy, academia, etc.
  - Leverage existing methods and formats (e.g., INCOSE Model-based Capability Matrix) to quantify levels of digital maturity for DAF programs and organizations
- **Approach:**
  - Provide a framework for common understanding – facilitating cross-org collaboration/resource leveraging, but not be prescriptive or unintentionally encourage fixation on numerical results
  - Push users to adapt framework to their program and/or organizational goals/objectives, allowing for variation based on stage the of lifecycle, available resources, etc.
  - Provide leadership a mechanism to prioritize digital initiatives and efforts

Help drive answers to the following questions...
What is Digital? Are we already doing Digital? Where should we start?

DTO

Pre-Assessment Process

- Define “enterprise” scope & the balance of participants
- Assign relative weights to set of components
- Level-set; align maturity components with org. objectives
- Determine Target level for each component



DAF Digital Maturity Guide_v2.0_PA

DAF Digital Maturity Guide

We must be able to account for the interactive nature of competition and continuously assess ourselves relative to our adversaries' adaptations. Capabilities must be conceived, developed, and fielded inside competitors' fielding timelines—knowing we will need to adapt and adjust over time.[1]

– Gen Charles Q. Brown, Jr., Air Force Chief of Staff

The Department of the Air Force (DAF) will lose technological advantage over its adversaries without drastic changes in the acquisition process, according to Dr. Roper's Digital Acquisition Vision[2,3], the DoD Digital Engineering (DE) Strategy[4], and Chief of Staff of the Air Force's *Accelerate Change or Lose* paper[1]. To avoid delivering yesterday's technology to tomorrow's fight, we must improve how we develop, deliver, support, and sustain war-winning capabilities, not just the capabilities themselves. DE is defined as "an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines to support lifecycle activities from concept through disposal" (DAU). According to the DE Strategy[4]:

Category	Metric	Component	If no answer, set Weight (Column O) to zero	Level 0 Description	Level 1 Description	Level 2 Description	Level 3 Description	Level 4 Description	Component Baseline	Metric Baseline	Component Target	Metric Target	Weight (1-10 with 10 most important)	Relative Importance	Weighted Effort Needed
Infrastructure	Modeling Environment	Access and Governance	"N/A" or "Not capable of responding."	Limited access and governance plans or policies in place.	Users have limited access to tools necessary for digital processes across the lifecycle. Tool access and governance plans and policies are in the process of being defined.	Users have limited access to tools necessary for digital processes across the lifecycle. Tool access and governance policies and procedures are generic.	Users have appropriately controlled access to tools necessary for digital processes across the lifecycle. Tool access and governance policies and procedures are defined by the program/organization, understood, and partially applied across the enterprise.	Users have appropriately controlled access to tools necessary for digital processes across the lifecycle. Tool access and governance policies and procedures are defined by the program/organization, understood, and uniformly applied across the enterprise via	1	1.50	3	2.50	1	1%	2%
		Interoperability	"N/A" or "Not capable of responding."	Data/tool independences are not considered and data is partially resident in the tool or tool directed default directories. Databases/tools are independent.	Data/tool independences are considered and enhancements for data independence from tools are planned. Inter-database/tool data item associations defined.	Data/tool implementation independences are managed to allow data to be independent from tools. Limited inter-database/tool data item associations defined, captured, managed.	Data/tool implementation independences are managed to allow data to be independent from tools and allow import/export to foster data portability. Highly utilized tools are interoperable; supporting tools interact through file transfer. Inter-database/tool data item associations among all data items defined, captured,	tools are interoperable and used for distributed decision-making via an integrated digital environment. Data is interchanged among and independent from tools. Inter-database/tool data item associations among all data items defined, captured, managed, and traceable where changes in one data source	2		2		10	8%	0%
	Collaboration	Capability	"N/A" or "Not capable of responding."	Collaboration only by business tool applications (e.g. email, telecommunications).	Collaborations occur asynchronously and inconsistently amongst the majority of distributed teams of the enterprise.	On-line, real-time collaboration amongst the majority of distributed teams of the enterprise.	On-line, real-time collaboration amongst the majority of distributed teams; limited interactions via an integrated digital environment.	On-line, real-time collaboration amongst distributed teams actively interacting via an integrated digital environment.	1	1.50	3	3.50	8	6%	13%
		Security	"N/A" or "Not capable of responding."	Limited number of models or data have restrictions.	Models and data across the enterprise are secured by user authentication only. Access is ad hoc.	Models and data across the enterprise are secured by user authentication only. Users only have access to data they need.	Models and data across the enterprise are secured, apply applicable Intellectual Property (IP) policies, and support all classification levels defined by the program.	Models and data across the enterprise are secured, monitored, and controlled; apply applicable Intellectual Property (IP) policies; and support all classification levels defined by the program.	2		4		0	0%	0%
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Assessment Metrics & Components

WORKFORCE / CULTURE

- **Workforce**: how well trained and competent the workforce is for digital operations
  - *Digital User Skills*
  - *Common Digital Understanding*
- **Adoption**: a measure of culture change within the workforce
  - *Digital Artifact Use*
  - *Reference Architecture Implementation*
  - *Milestone, Program, and Technical Reviews; Audits*

MODELING / ANALYSIS

- **Quality:** the ability to make informed decisions from model outputs and data, and understand the associated risk and uncertainty
  - *Authoritative Sources of Truth (ASOT)*
  - *Metrics*
  - *Model-Based Verification and Validation (V&V)*

Maturity values range 0-4
0 = Not Digital
4 = Fully leveraging digital capability

PROCESS / POLICY

- **Model Management:** robustness of internal digital processes and operations, and the ability to seamlessly leverage contracted expertise
  - *Digital Management Strategy*
  - *Model-Based Systems Engineering (MBSE)*
  - *Configuration Management*
  - *Process Verification and Validation (V&V)*
- **Data Management:** internal processes/operations and contractor interchanges ensure the ASOT is defined, utilized, and maintained
  - *Innovative Technical Processes*
  - *Technical Management Processes*
  - *Analysis, User Interface (UI) and Visualization*

INFRASTRUCTURE

- **Model Environment :** the ability to conduct digital operations based on available hardware and software configurations
  - *Access and Governance*
  - *Interoperability*
- **Collaboration:** an integrated digital environment that is standardized, secure, and enabling
  - *Capability*
  - *Security*

DTO

Metric: Adoption

Component: Digital Artifact Use

No Answer	Level 0	Level 1	Level 2	Level 3	Level 4
"N/A" or "Not capable of responding."	Hardcopy or business application (e.g., MS Word) generated documents are not based on digital artifacts.	Isolated processes across the enterprise use digital artifacts and data.	The majority of enterprise processes and decision-making relies on digital artifacts and data.	Enterprise decision making is based on digital artifacts and data. Consistent institutional approach and continual improvement is partially driven by policy, practices, and methods via an integrated digital environment.	Enterprise decision making is based on digital artifacts and data. Consistent institutional approach and continual improvement is driven by policy, practices, and/or automation via an integrated digital environment.

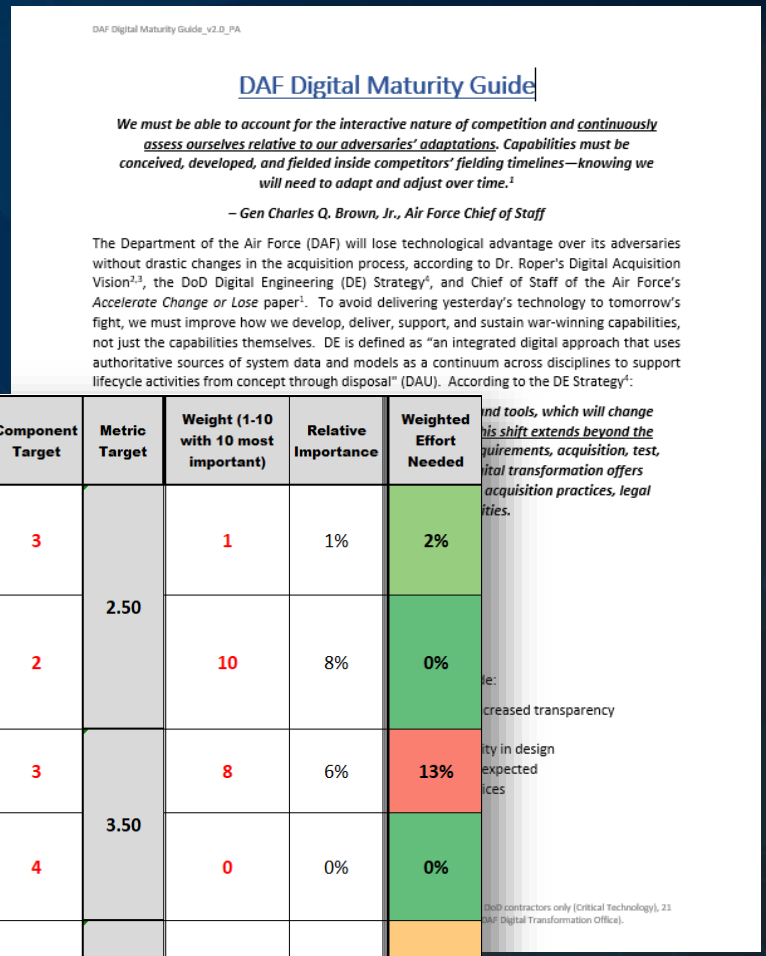
***Digital Artifact**: An artifact produced within, or generated from, the digital engineering ecosystem. These artifacts provide data for alternative views to visualize, communicate, and deliver data, information, and knowledge to stakeholders. (DAU Glossary) *e.g., 2D PDFs and PowerPoint charts are not digital artifacts*

Adoption is the composite of three components: (1) Digital Artifact Use; (2) Reference Architecture Incorporation; (3) Milestone, Program, and Technical Reviews; Audits. The Adoption metric is the average of its three components.

DTO

Post-Assessment Process

- Average results into 19 components & 7 metrics
- Analyze maturation gaps; Compare similar programs/orgs
- Determine root-causes; review prioritized (weighted) results
- Maturation planning; launch workshops & working groups



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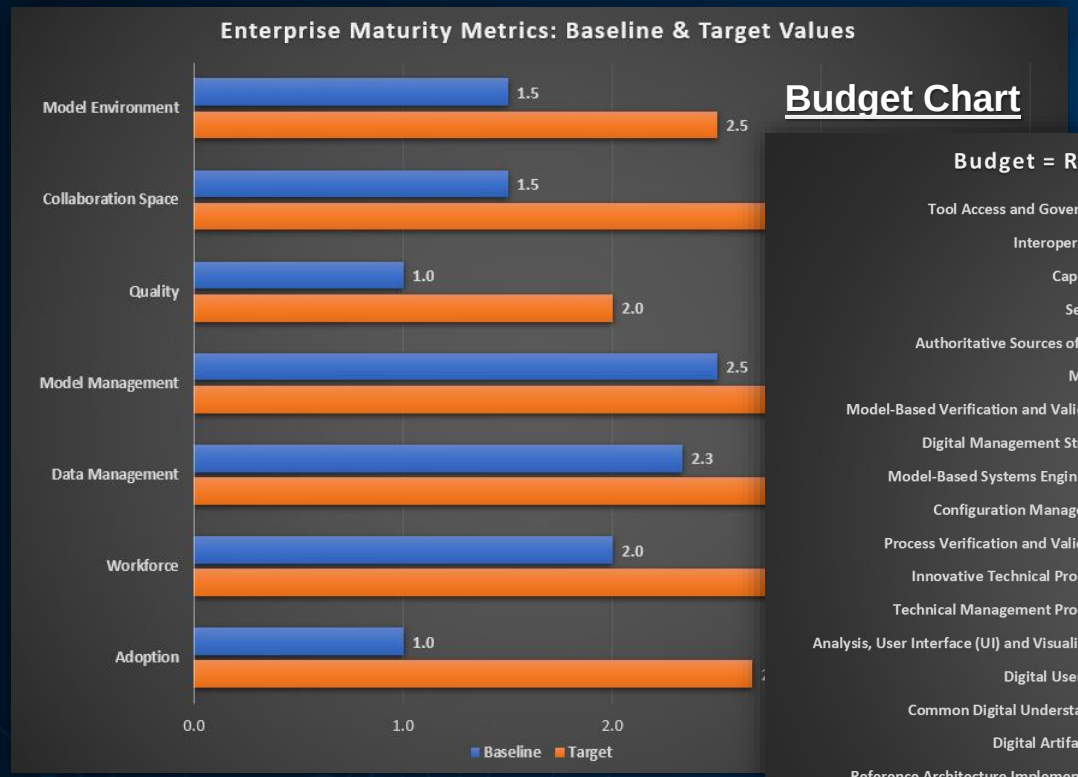
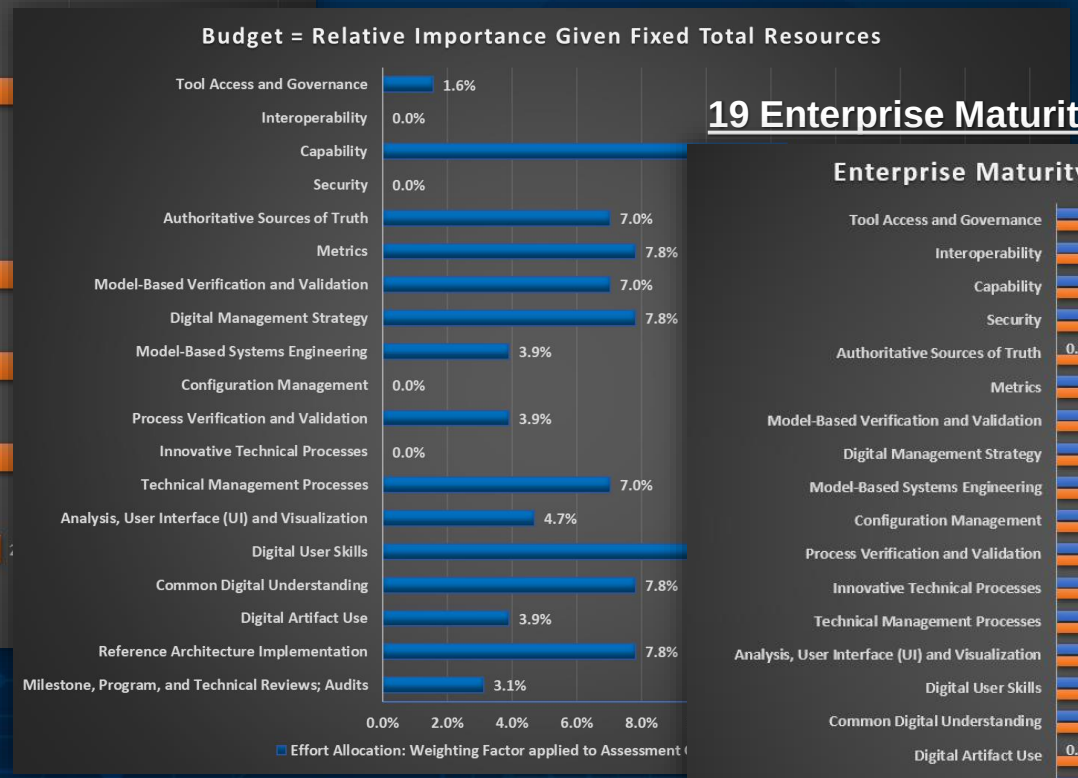
Baselines vs Targets

7 Enterprise Maturity Metrics



Budget Chart



19 Enterprise Maturity Components

DTO

Implementation Roadmap by Target Maturity

	FY21	FY22	FY23	FY24	FY25	FY26
Infrastructure						
Model Environment		Implement generic governance policies		Appropriately controlled access; Defined governance partially applied across enterprise		
		Define inter-database/tool associations	Data independent from tools; Limited item associations managed		Data portability & all data/item traceablility	
Collaboration Space		IDE/MilHub IOC	IDE FOC - partial enterprise usage	Most IPTs integrated into IDE/MilHub	IPTs interacting across enterprise via IDE/MilHub	
		Define permission roles in enterprise	Enforce permissions across enterprise	Apply applicable IP policies	Secure, monitor & control models & data across enterprise	
Process/Policy						
Model Management		Develop digital management strategy		Inconsistent support from DE tools	Infrequent support from DE tools	Mature IDE/consistent spt from DE tools
		Develop full system models across the lifecycle		Consistent institutional approach to integrated system model		
		Define & implement configuration management processes in MilHub		Apply config mgmt in MilHub to some models/data	Apply config mgmt in MilHub to all models/data in enterprise	
		Map & identify standard V&V procedures and programs for limited models & data		Partially implement V&V procedures for identified models & data		
Data Management		Continually update processes to rely on data from ASOT		Update processes via digital thread -- employ limited twins	Decision making using thread/twins	
		Ingest enterprise data into MilHub	Conform data to common architecture -- plan automation techniques		Implement automation & data reuse	
		Employ some visualization tools	Consistently deploy UI & visualization tools that contribute to some enterprise decision making		UI able to interrogate ASOT	
Workforce/Culture						
Workforce Capability		Identify organizational training needs -- identify & promote courses		Develop strategic training plan; hire experts to review modeling methods/data mgmt; plan robust training		
		Identify, use, and promote common lexicons/sources across enterprise		Consistently use common lexicons/sources for lifecycle	Identify, use, and promote authoritative lexicons/sources	
Adoption		Isolated processes across enterprise use digital artifacts and data			Majority of enterprise processes & DM use dig artifacts/data	
		Utilize default architectures and begin customization for enterprise use		Define reference architectures -- plan/identify validation methods		
		Implement limited organizational coordination of digital artifact use as deliverables; Use models to record acceptance of items through model content/data review in modeling environment				
Modeling/Analysis						
Model & Data Quality		Plan/develop ASOT (MilHub)	Implement ASOT	Plan digital thread & limited twins to contribute to ASOT		
		Identify tools that assess model quality; map & define metrics for V&V of models		Implement and monitor metrics		
		Identify standard V&V procedures and programs that require V&V		Establish model dev't processes; select programs for V&V	Partially implement V&V	

Legend

Level 0 | Level 1 | Level 2 | Level 3 | Level 4

Assessment Deployment & Use

- **Summary**
  - Developed by USAF & USSF under SAF/AQR and Digital Campaign leadership/membership, and based on industry standards (e.g., INCOSE Capability Matrix, TRLs, etc.)
  - Assessment based on qualitative maturity levels (0-4) of 19 Components (and 7 Metrics) to describe current state, desired state, capability gaps, and are weighted for investment prioritization
- **Deployment**
  - Beta tested on 11 programs, Utilized by most PEOs on multiple programs
  - Center-wide assessment of NWC & AFRL - more applicable to technical functions
  - Currently the AFMC/A4/10 and AFMC/PK communities are exploring expansion for non-program office use

What is Digital? – *Level 4* descriptions characterize "Digital" operations
Are we already doing Digital? – *Baselining* provides insight to on-going activities
Where should we start? – Frame goals/objectives in the context of the framework, then set targets, priorities, and timelines

DTO

Workshop Meetings

- Workshops will be held virtually using Teams
- Workshops will be multi-day based on scheduling of topic POCs
  - Most workshops will be 3-hour sessions over the course of two weeks
  - Total time commitment will vary based off the number of topics selected
- The workshop will be facilitated by Collaboration AI

Summary / Out-brief

- A summary briefing will be done on the last day to the senior leadership that cannot attend the workshop
- The goal of the out-brief is to:
  - Summarize the workshop
  - Identify Action Items/ Next Steps
- Who to invite:
  - Appropriate Senior Leaders
    - You will want to invite all next level leadership who can't to attend workshop
  - All workshop participants
- Summary out brief may be recorded

Post-Workshop

- Create/Update your Digital Strategy
- Mandatory 2 month follow up with the DTO team
  - Review your Digital Strategy
  - Develop plan for resourcing (as necessary)
  - Update on Action Items
- Progress Updates with DTO (as required)

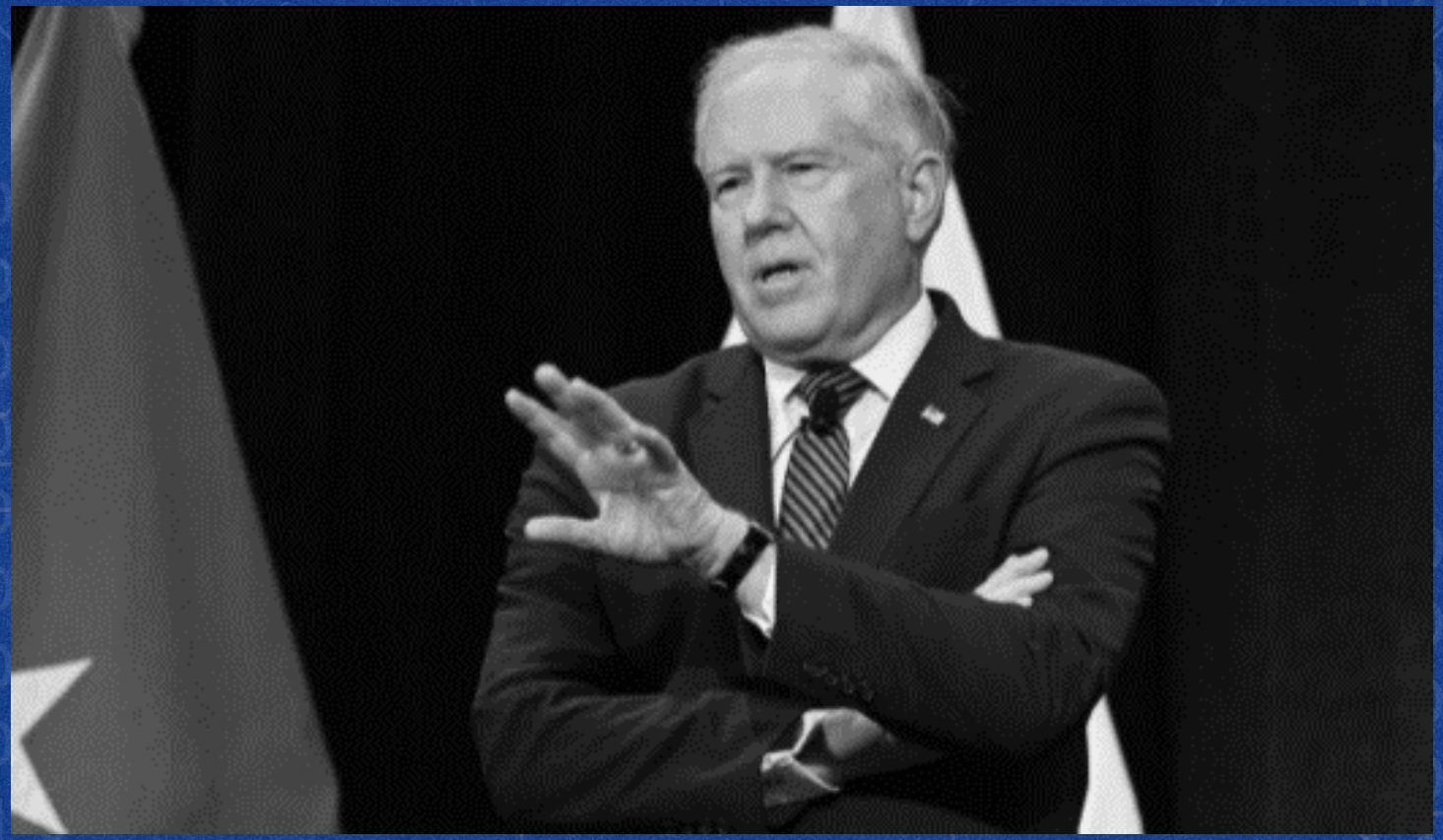
AFRL

DIGITAL
CAPABILITIES DIRECTORATE

AFRL Is MADE to Accelerate!

The Impact of AFRL's Digital Transformation

Presenter: Mr. David Shahady, DR-IV (GS-15), DAF
Acting Director / Chief Operating Officer, Digital Capabilities Directorate



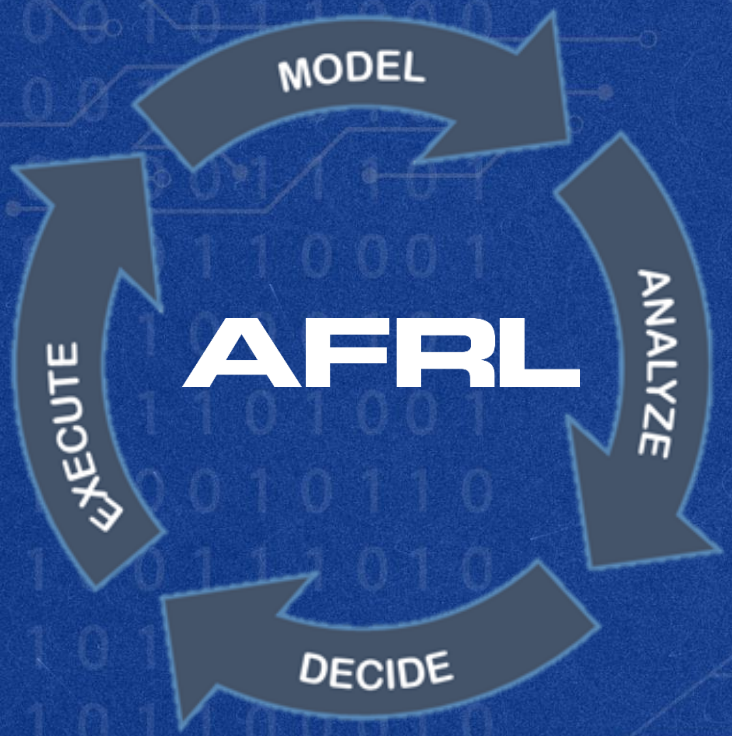
"We are in a race for technological superiority!"

- Air Force Secretary Frank Kendall

AFRL

DIGITAL
CAPABILITIES DIRECTORATE

AFRL is MADE to Accelerate



GOAL 1

FASTER RESEARCH

Accelerated Research, Experimentation, and Innovation

GOAL 2

BETTER DECISIONS

Analytically Rigorous Technical, Business, and Operations Decisions

GOAL 3

STREAMLINED TRANSITIONS

Seamless Entrance into Acquisition and Implementation

GOAL 4

LOW-FRICTION BUSINESS & OPERATIONS

Flexible and Responsive Business and Operations

AFRL Digital Transformation Strategy

AFRL Digital Transformation Vision

AFRL MADE to Accelerate:
Model, Analyze, Decide, Execute

AFRL Digital Transformation Mission

Measurably accelerate the generation and transition of adoption-ready technology with demonstrable military benefit

AFRL Digital Transformation Goals

FASTER RESEARCH:	***BETTER DECISIONS:***	***STREAMLINED TRANSITIONS:***	***LOW-FRICTION BUSINESS & OPS:***
Accelerated Research, Experimentation, and Innovation	Analytically Rigorous Technical, Business, and Operations Decisions	Seamless Entrance into Acquisition	Flexible and Responsive Business & Ops

AFRL Digital Transformation Lines of Effort

- ***Data***
- ***Modeling / Analysis***
- ***Collaborative Tools***
- ***Infrastructure***
- ***Cybersecurity***
- ***Human Capital***
- ***Architecture***

AFRL Digital Transformation Objectives

1- Increase researcher time spent in a 'flow' state (i.e., time spent 'in the zone')	4- Furnish an authoritative source of detailed and up-to-date information on verified capability and enabling technology targets	7- Obtain and maintain purposeful and continuous stakeholder engagement in technology development and prioritization	10- Eliminate internal barriers to efficient business & operations
2- Provide on-demand access to resources needed to do research	5- Implement a means of allocating resources to priorities at the speed of relevance	8- Synchronize technology maturation process with transition & implementation timelines	11- Challenge external barriers that limit AFRL's efficiency & effectiveness
3- Reduce researcher downtime waiting for non-research tasks to complete	6- Instill an intuitive, near-real-time feedback loop from strategy to execution	9- Deliver "ready to consume" S&T results and artifacts to stakeholders	12- Deliver effective and reliable AFRL Core Services to all regardless of AFRL office symbol

AFRL Digital Foundational Capabilities

- AFRL Data Marketplace
- Worldwide Collaboration Environments
- Cross-Domain Solutions & Multi-Level Security
- Digital Services for Hybrid Multi Cloud IT
- Capability-based Investment Planning

AFRL Organizational Structure

AFRL

DIGITAL CAPABILITIES DIRECTORATE

AFRL Commander

Executive Director

Chief Technology Officer

Vice Commander

Deputy TEO for Space S&T

Mobilization Asst to the Commander

Command Chief

Headquarters AFRL

Plans and Programs Directorate

Engineering Directorate

Research and Computational Directorate

Other Staff Offices / Functionals

Office of the Chief Information Officer

Aerospace Systems Directorate

AF Office of Scientific Research

AFWERX

Directed Energy Directorate

Information Directorate

Materials and Manufacturing Directorate

Strategic Dev Planning and Experimentation Directorate

Munitions Directorate

Sensors Directorate

Space Directorate

Systems Technology Office

Transformational Capabilities Office

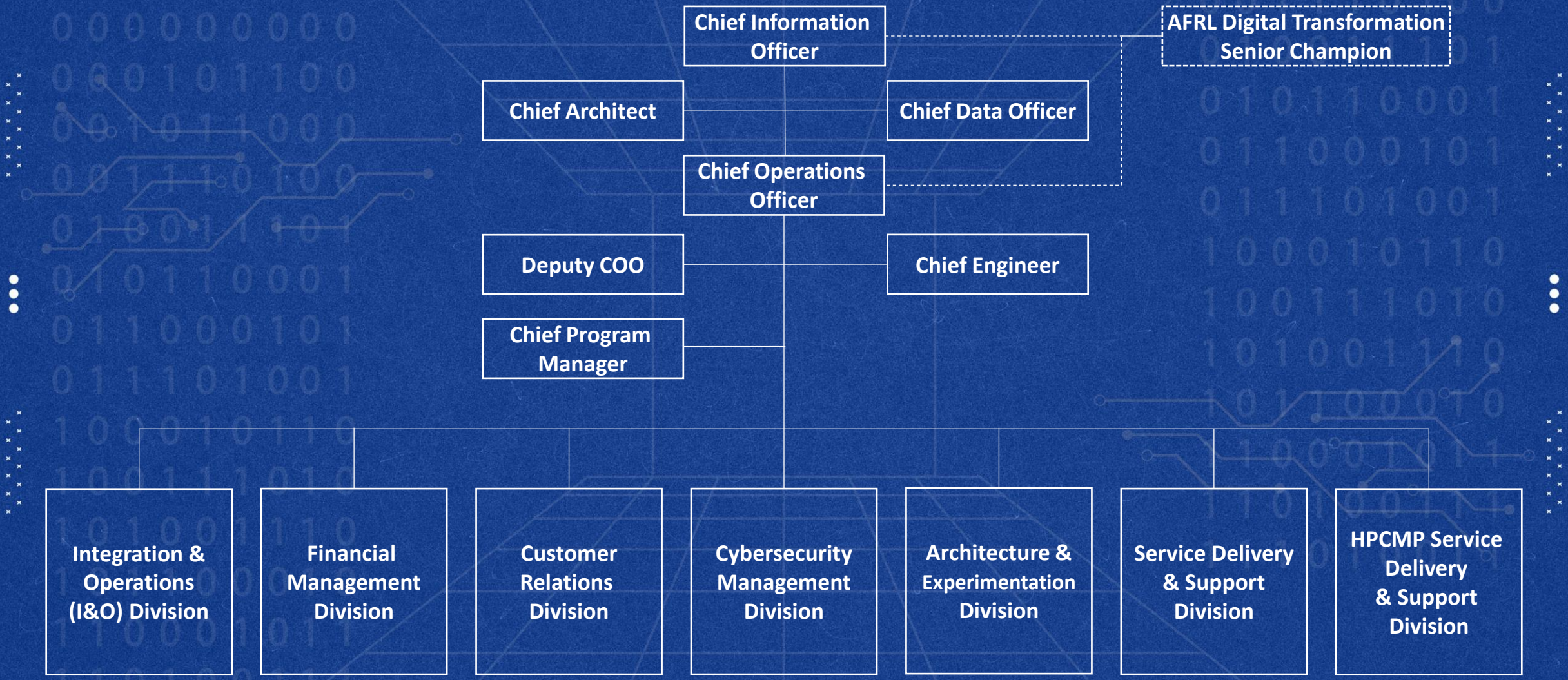
Digital Capabilities Directorate

711th Human Performance Wing

Airman Systems

School of Aerospace Medicine

AFRL Digital Capabilities Directorate



AFRL

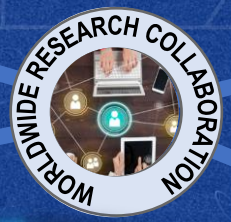
AFRL Digital Transformation Connected Journey

DIGITAL CAPABILITIES DIRECTORATE

Enterprise is aggressively disruptive in the use of new digital technologies and models. Ecosystem awareness and feedback is constant input to innovation.

Enabling a Data-Informed Organization: Easily find, share, and use data across the AFRL

Digitally collaborate effectively and securely worldwide at the required security level



Provide modern digital services facilitated by a robust enterprise IT architecture

Conduct capability-based investment planning & portfolio assessment anchored in intelligence-informed enterprise modeling, simulation, and analysis

Conduct work at multiple levels of security and across security and network domain boundaries

AFRL Data Marketplace

Enabling a Data-Informed Organization: Easily find, share, and use data across the AFRL

Multitudes of Independent Systems

Implementing Data Exchange Methods & Standards

AFRL Data Marketplace

Implementing Central Source for Data

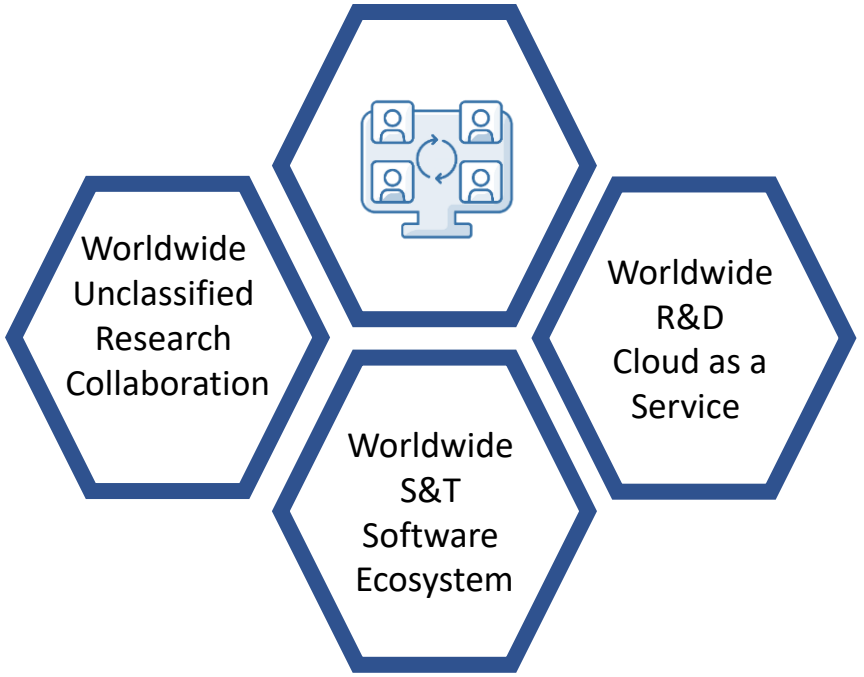
Implementing Data Organization for Use

Scientist, Engineer, Manager, Specialist

Implementing Ways to See Data

Worldwide Research Collaboration

Digitally collaborate effectively and securely worldwide at the required security level



Multitude of Research Partners

Spectrum of Security Access

MENU

Implementing Collaboration Tools as a Service

Worldwide Research Collaboration

Capitalizing on Cloud Networks for R&D

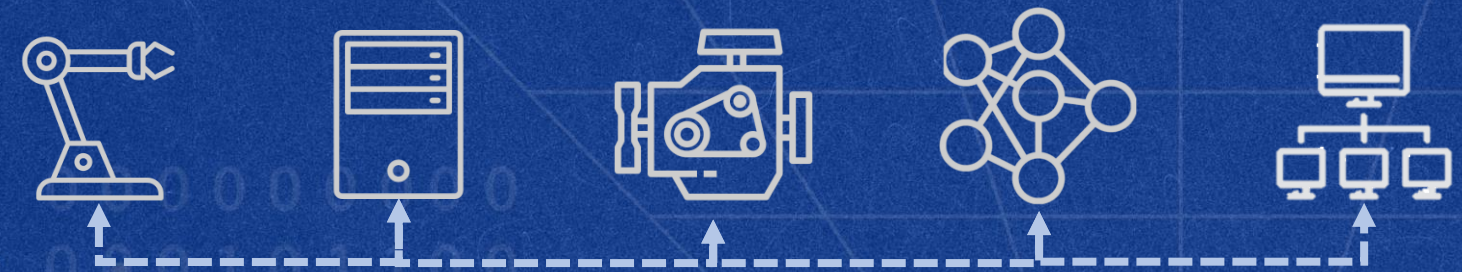
Scientist, Engineer, Manager, Specialist

Implementing Ecosystem of Collaboration Tools

Cross Domain Solutions and Multi-Level Security

Conduct work at multiple levels of security and across security and network domain boundaries

Isolated Networks and Laboratory Equipment



Implementing Transport Solutions

Cross Domain Solutions and Multi-Level Security

Scientist, Engineer, Manager, Specialist

Implementing Solution Across Classifications

Public

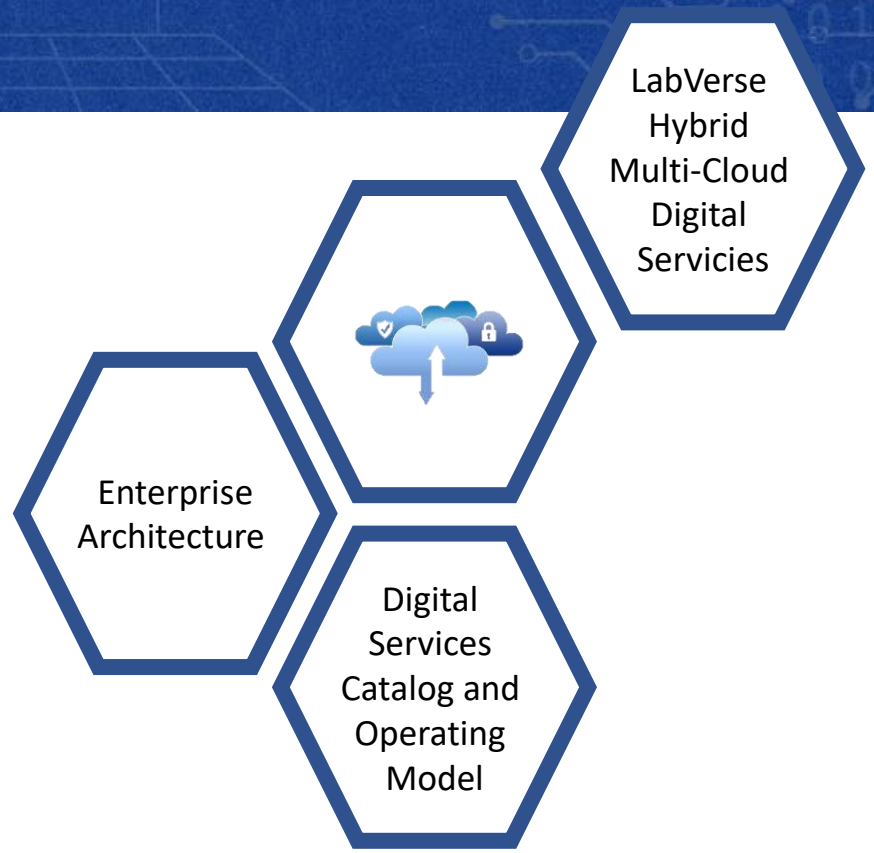
Unclassified

Classified

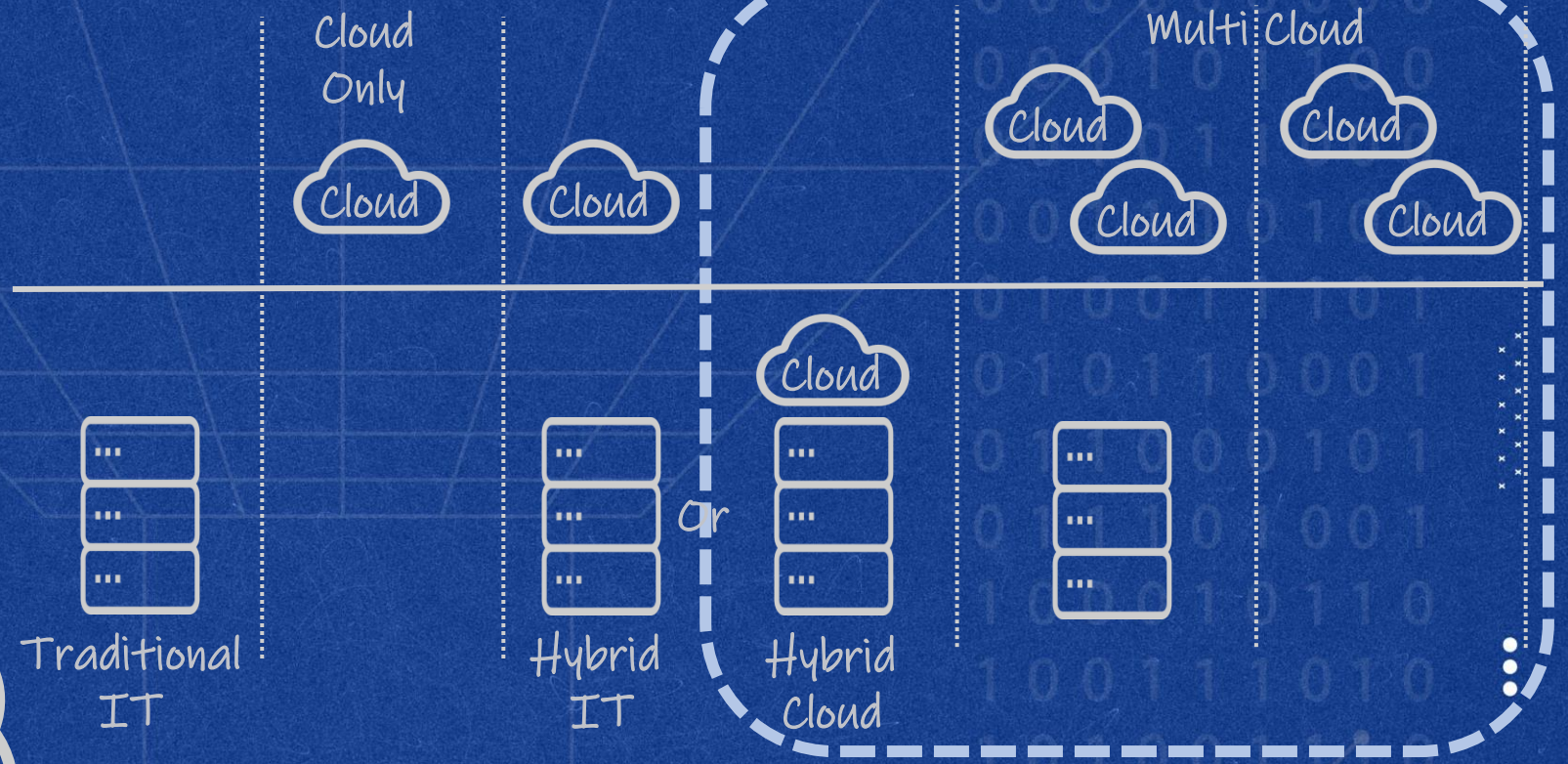
Implementing Multilevel Security Endpoints

Digital Services for Hybrid Multi-Cloud IT

Provide modern digital services facilitated by a robust enterprise IT architecture



Implementing Services Catalog



Digital Services for Hybrid and Multi Cloud IT

Scientist, Engineer, Manager, Specialist

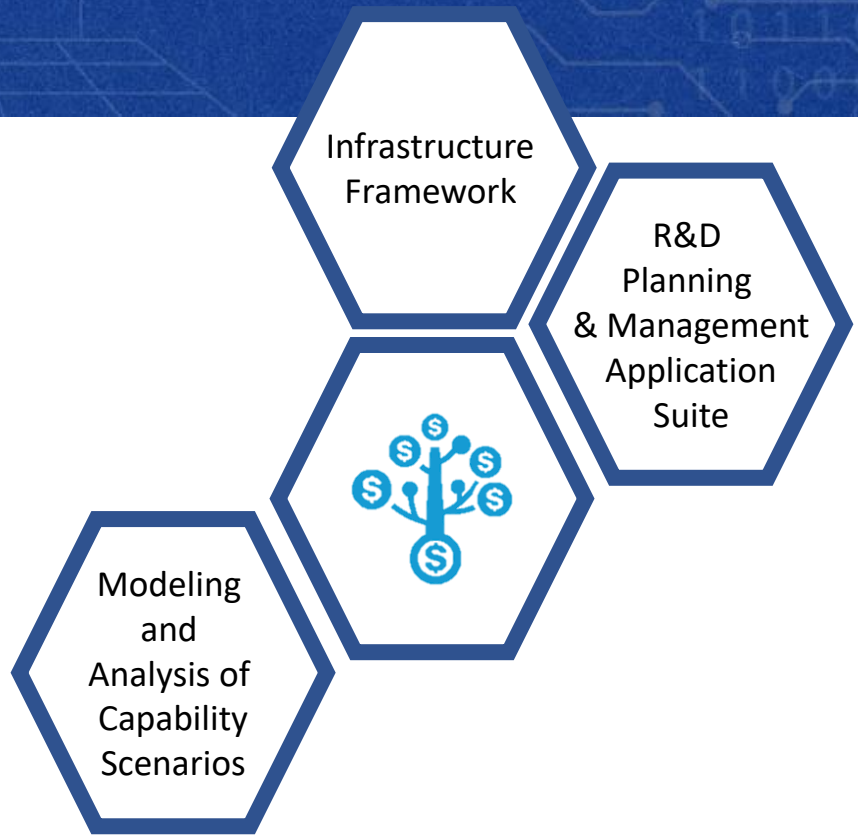
MAXIMIZED ENTERPRISE LEVEL SOLUTIONS!

Capitalizing On and Implementing Hybrid and Multi Cloud IT

Laboratory Directorates and Offices

Capability Based Investment Planning

Conduct capability-based investment planning & portfolio assessment anchored in intelligence-informed enterprise modeling, simulation, and analysis



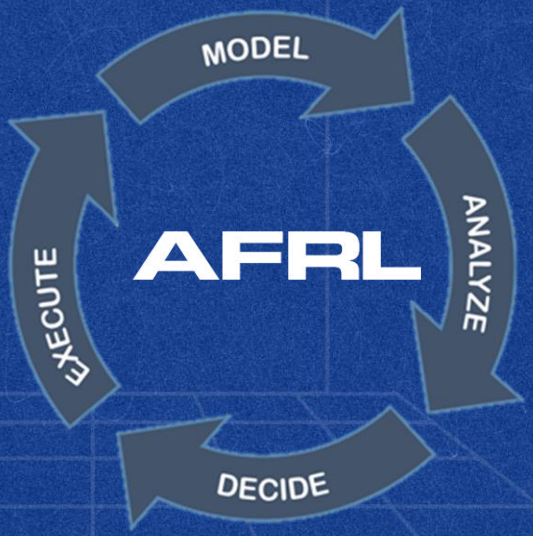
Delivered S&T Capabilities

Threats and Risks

Implementing Integrated Digital Business Execution

Implementing Modeling and Analysis of Capability

Capability Based Investment Planning



Scientist, Engineer, Manager, Specialist

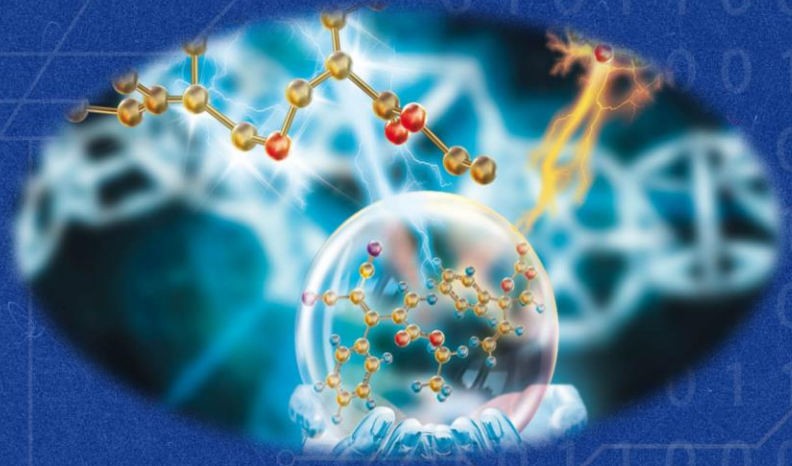
Implementing the Infrastructure Framework Needed for MADE

Opportunities...

for Digital Service Providers

How can YOU help deliver the capabilities needed for this digital transformation?

for Research Providers

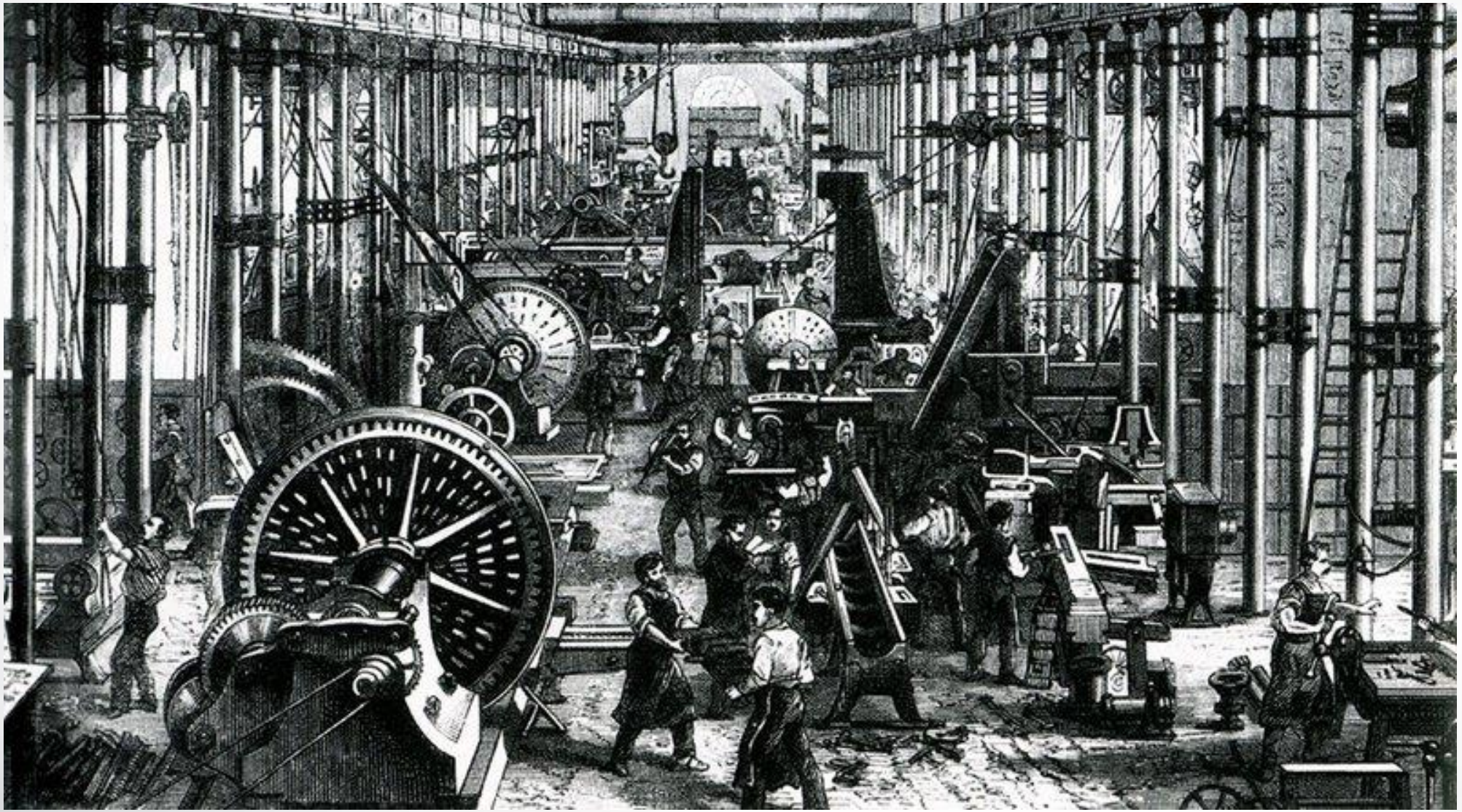


How can YOU leverage these new capabilities in your research activities and deliverables?

National Institute for Aviation Research

Industry 5.0: The Interaction and Collaboration Between the Human and the Machine – Transitioning to Digital Engineering

“The Industrial Revolution”



Super/Hypersonic Travel

Wearable Technology

2020's technology in the 1990s

"Smart Lives"

Flying Cars

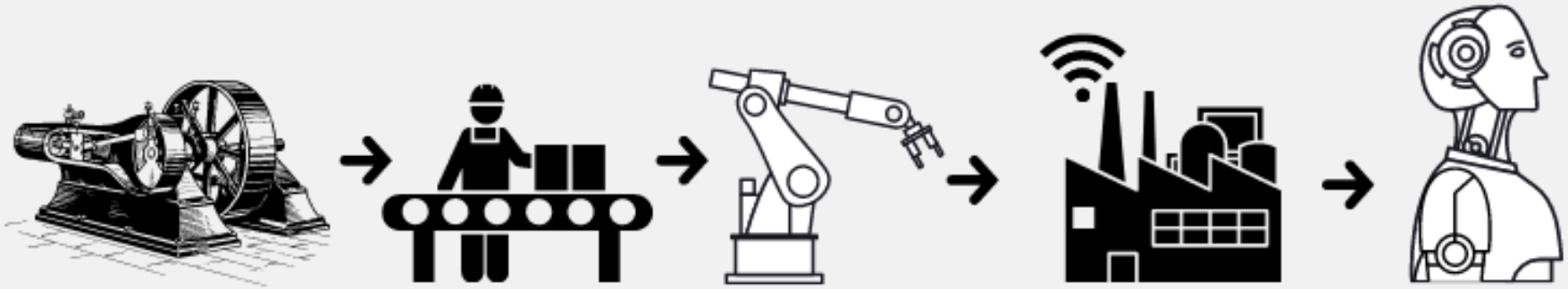
Daily Task Robots

Moon/Mars Colonies

If we survived Y2K…

Industrial

REVOLUTIONS



Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0	Industry 5.0
mechanization, water and steam powers	mass production, electric power, assembly line	computers, automated production, electronics	cyber-physical systems, IoT, networking, machine learning	human-robot collaboration, cognitive systems, customization
1800	1900	2000	2010	2020

Image courtesy of knowhow.distrelec.com

Why Take a Step back from Full Automation??

Case Study: The Plan

- Objective: Survey a fleet of airframes to determine both the “average” fleet condition
  - Find two “average” airframes from a corrosion and fatigue perspective
  - Find one “high” fatigue airframe
  - Find one “high” corrosion airframe
- Constraints
  - Airframe must be > 75% through depot cycle
  - Airframe must be variant that is dominant in the fleet
- Methodology
  - For “high” fatigue airframe assess EFH
  - For “high” corrosion airframe develop environmental severity factor

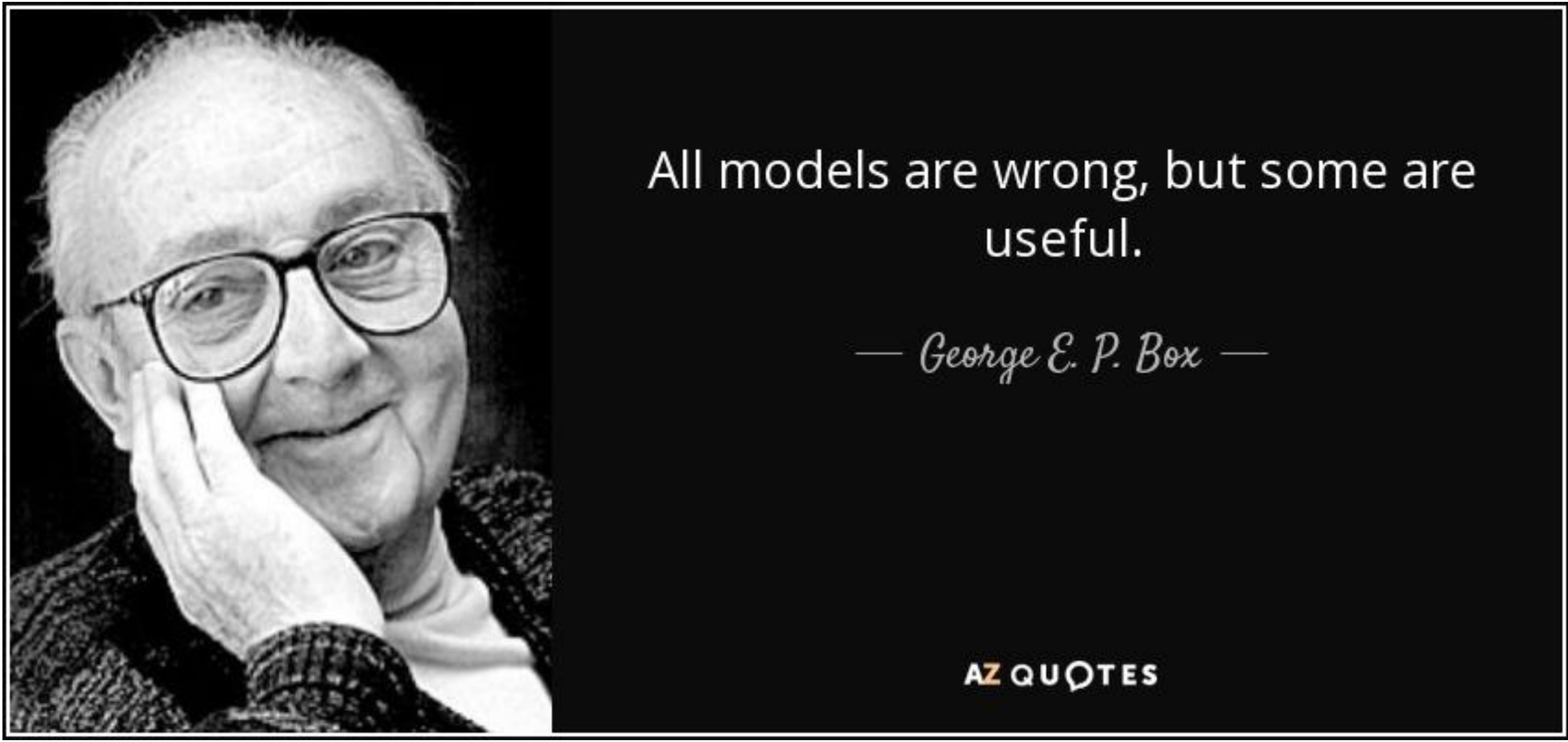
Case Study: Process/Outcome

- Airframe #1 – “volunteered” itself (mishap)
  - Selected for average airframe
- Airframe #2 – “high” fatigue airframe
  - EFH ranked for the fleet
  - Removed airframes just out of depot
  - Results: Higher fatigue findings than airframe #1
- Airframe #3 – “high” corrosion airframe
  - Environmental severity factor developed based on age/basing history
  - Removed airframes just out of depot
  - Results: Less corrosion than airframe #1

Case Study: WHAT HAPPENED??

Answer: Bases with highly corrosive environments prevent and mitigate corrosion better…

4th Airframe Selected by including “tribal knowledge” from maintainers
Found to have the most corrosion of any airframe studied…


All models are wrong, but some are useful.
— George E. P. Box —
AZ QUOTES

Why Co-bot Approach

- Robots perform better than humans at repetitive tasks where all scenarios are well understood.
- Robots operate in black and white…too literal at times
- Humans are easily overwhelmed by data
- Human independent thinking is required in complex situations
- Co-bots make the best of both worlds… black/white tasks – automation; independent thinking – human

So what does this have to do with DoD assets???

DIGITAL TWIN

Wichita State University

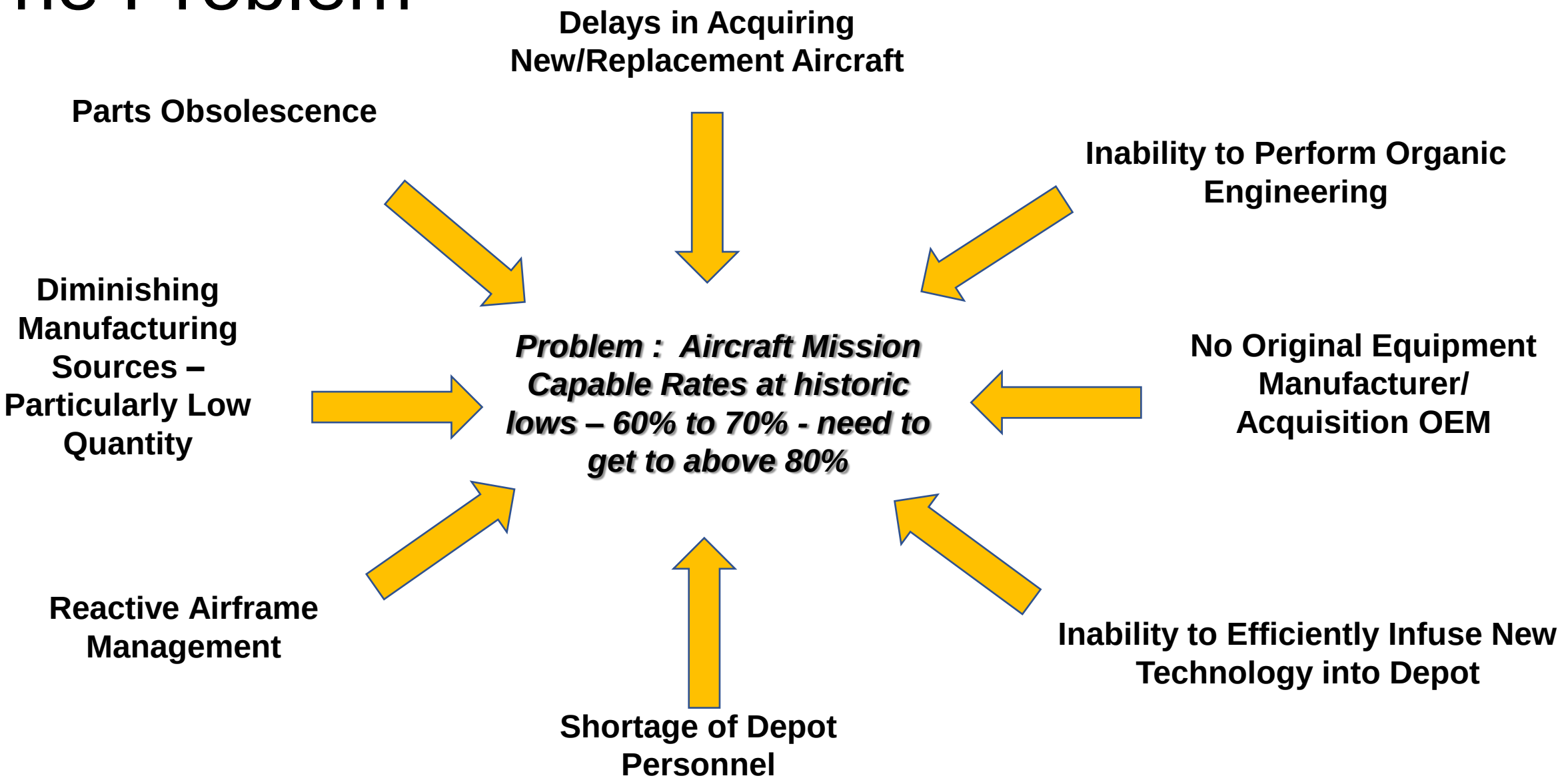
PUSHING THE BOUNDARIES OF DIGITAL ENGINEERING TO ADVANCE LEGACY AIRCRAFT INTO THE DIGITAL AGE

NIAR®

National Institute for Aviation Research

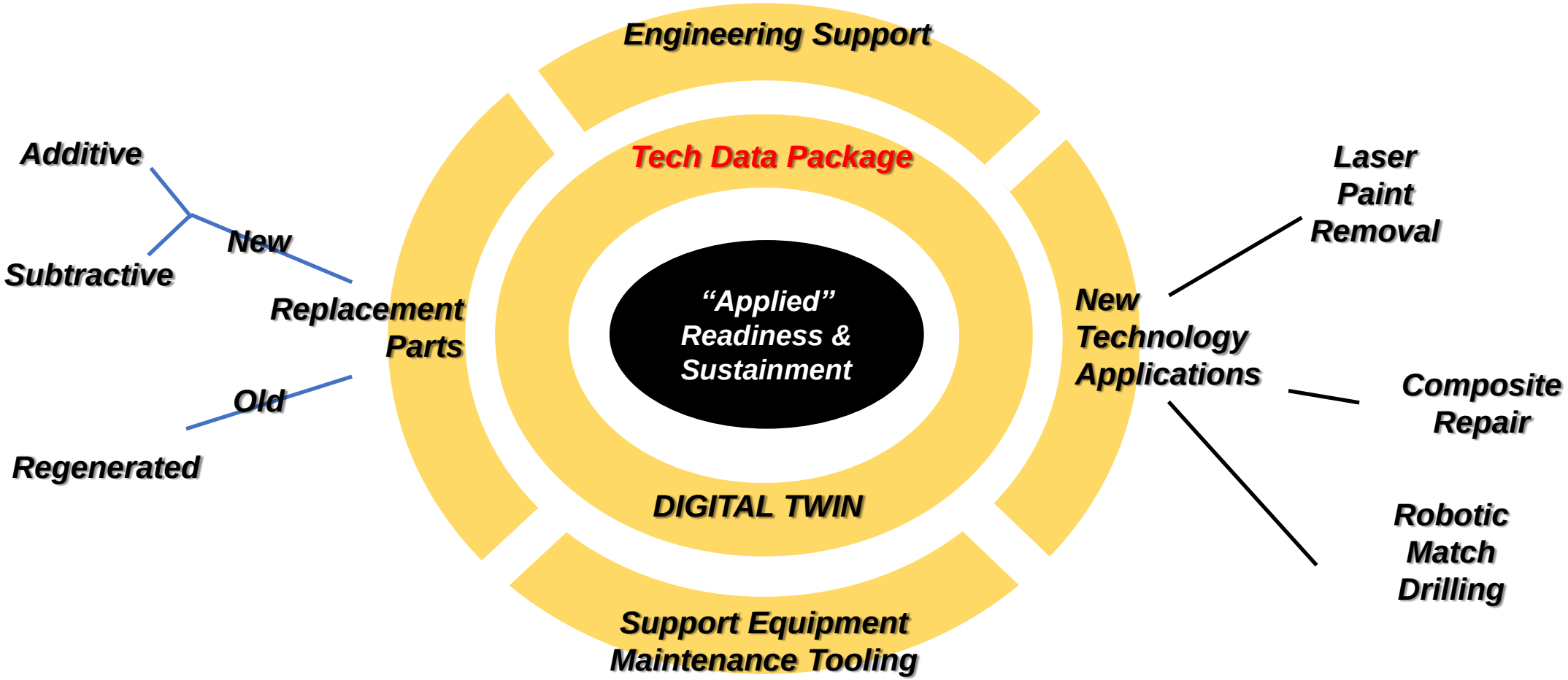
PROPOSED A SOLUTION TO PROBLEM --- BUILT RELATIONSHIPS WITH DOD --- OVER 250 STUDENTS EMPLOYED IN APPLIED LEARNING

The Problem



Provide ORGANIZED engineering/technical data for human/co-bot decision making

Solutions with an Additional Problem



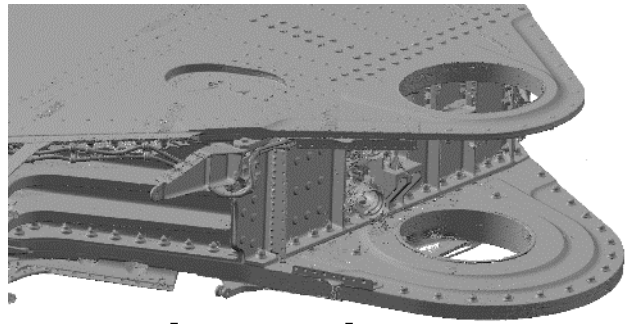
Need the technical data package to efficiently apply technology to the readiness issue

NIAR's Solution : Develop a DIGITAL TWIN

Asset Acquisition

Geometric Digital Twin

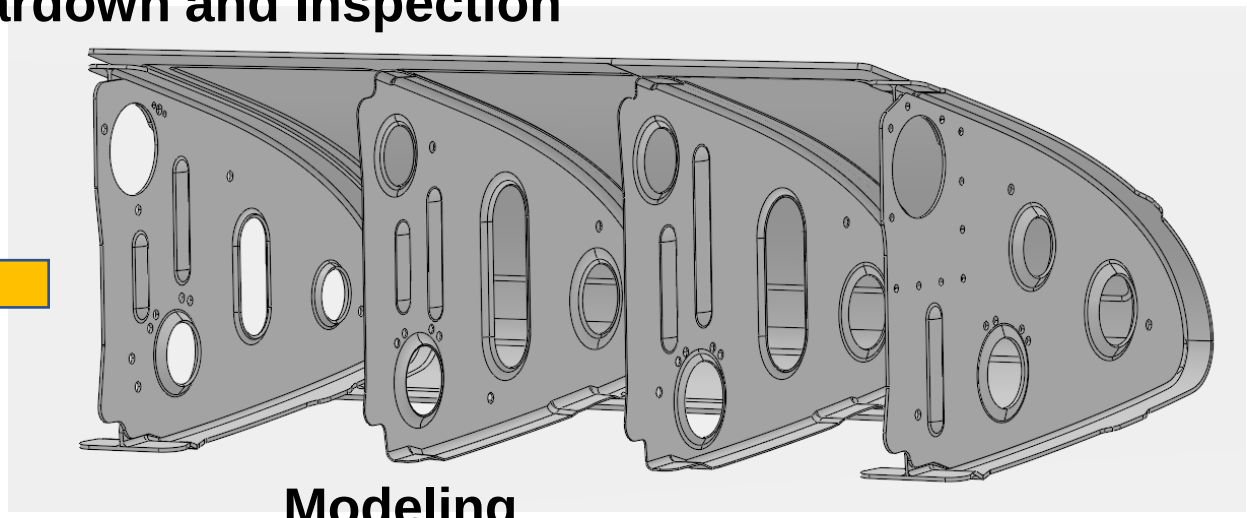
Teardown and Inspection



Scanning and Reverse Engineering

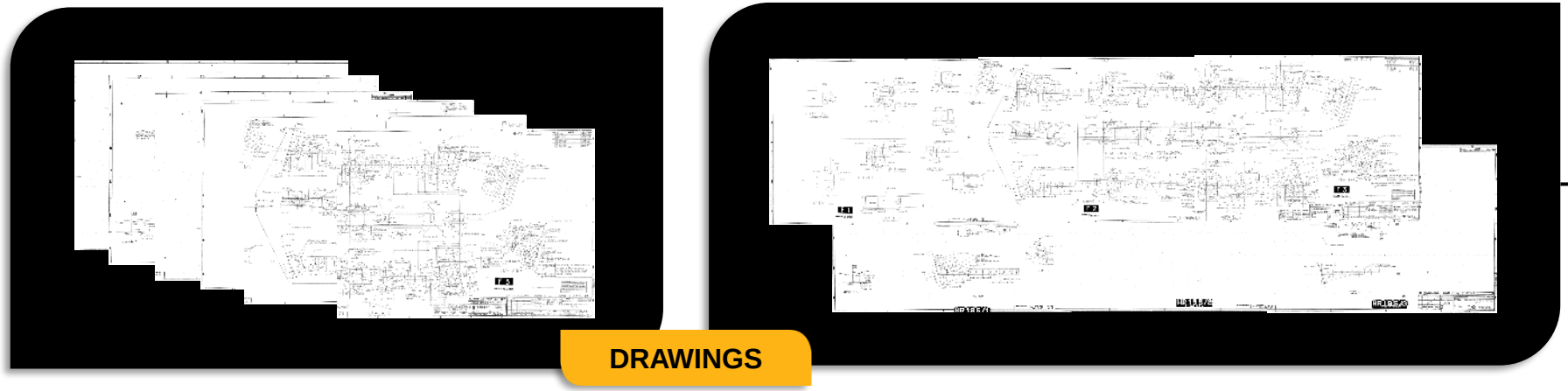
Engineering Analysis

- Creation of GFEM
- Validation of GFEM
- Development of External Loads
- Systems Engineering



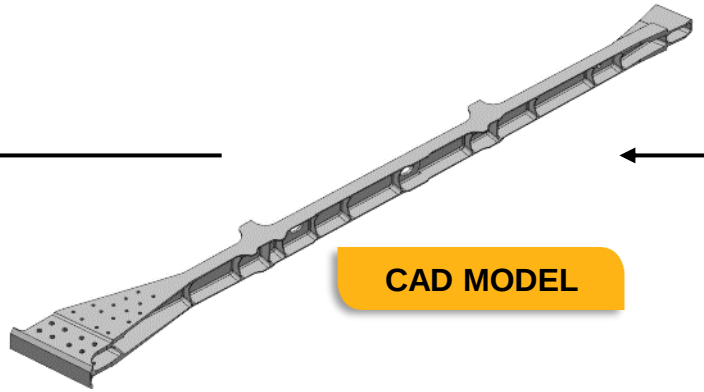
Modeling

NIAR's Solution: Develop a Digital Twin



DRAWINGS

FEA MODEL

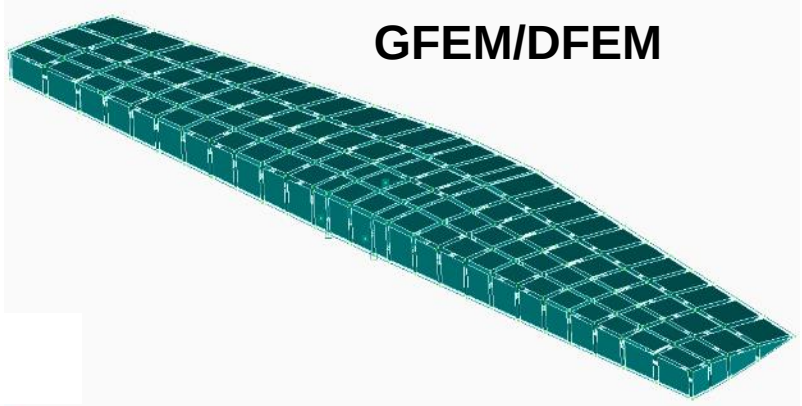


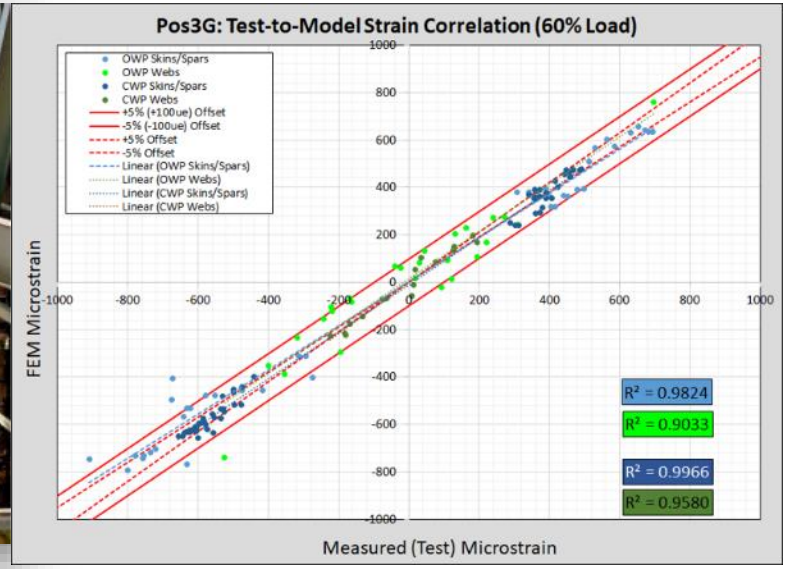
CAD MODEL

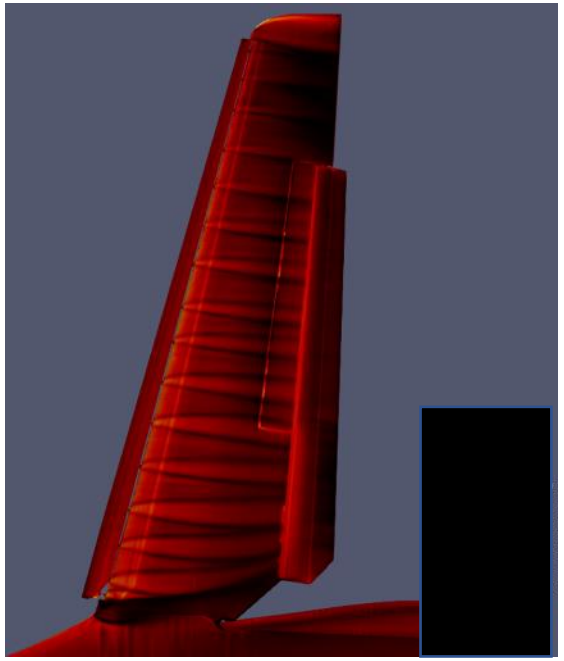
SCAN DATA

All Data is Government Owned

Applying the Digital Twin: Engineering Model Development & Validation







CFD/External Loads

NIAR Wichita State University
National Institute for Aviation Research

Current DoD Twin Programs

F-18 C/D

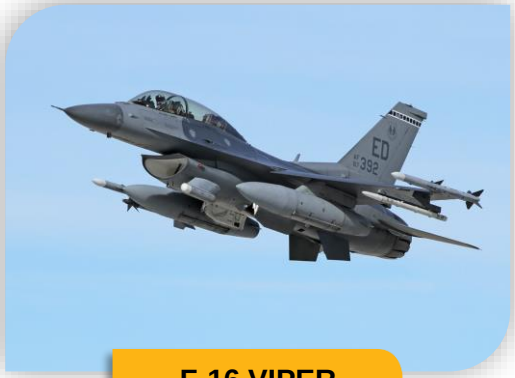
- **230+** AIRCRAFT
- **2035** ? TARGET DATE

B-1B BOMBER

- **45** AIRCRAFT
- **2040** ? TARGET DATE

UH-60 L/M/V

- **2,135** HELICOPTERS
- **2050** ? TARGET DATE



F-16 VIPER

- **939** AIRCRAFT
- **TBD** TARGET DATE

M-113 ARMORED PERSONNEL CARRIER

- **5,000** VEHICLES (4 variants)
- **TBD** TARGET DATE

AH-64 D

- **800** HELICOPTERS
- **TBD** TARGET DATE

T-38 Wing

- **500** AIRCRAFT
- **TBD** TARGET DATE

F-100 ENGINES

- **>1,800** ENGINES
- **TBD** TARGET DATE

New Digital Engineering Programs FY23

B-52 BOMBER

- **76** AIRCRAFT
- ? TARGET DATE

- Begin comprehensive structural digital twin
- Analytical engineering twins with focus on flutter

C-130 Hercules

- **2,500+** AIRCRAFT
- ? TARGET DATE

- Begin hybrid digital twin on outer wing
  - Manufacturing quality where data supports
  - Digital mock-up quality elsewhere

Desired Outcome

- Government Owned Technical Baseline
  - Single Authoritative Source of Truth
    - Manufacturing Quality CAD models of structure
    - Global Finite Element Model with Detailed Finite Element Models of Critical Region
    - Complete set of External Loads that reflect how the airframe is operated
    - Fatigue spectrum
- Ability to develop an integrated team to address fleet management issues in the future
  - OEM
  - SPO
  - NIAR
  - Other Industry/Academia
- Ability to leverage the power of Digital Engineering
  - Increase Aircraft Availability
  - Reduce Sustainment Costs
  - Proactive Posture

Power of Digital Engineering

- Manufacturing of Obsolescent Parts at Desired Quantities
  - A few instead of hundreds
  - Open supply base to include small machine shops
  - Reduce risk of part being manufactured incorrectly
- Integration of Weapons
  - Faster feasibility studies
  - More “what if” assessments
- Systems Logic Modeling
  - Digital Trouble Shooting
- Controlling the Engineering Baseline
  - Faster reaction time to fleet issues
  - Digital design/fit check of repairs
  - Ability to assess operational decisions on asset life
  - Removal of conservative assumptions due to incomplete data (reducing uncertainty)

B-1 Digital Twin Program (2020-2028)

85-0092
4 May 2020
Retired at AMARG for 18 years
Digital Twin Airframe

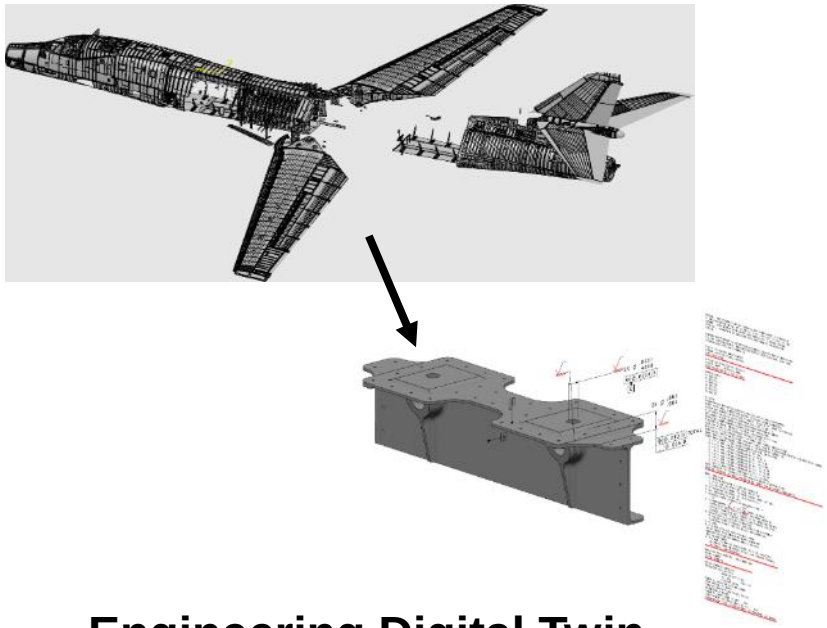
86-0101
5 June 2021
Divested April 21 at Tinker AFB
Teardown of a High Time Fuselage

PA Release # AFLCMC 2022-0224”
Release Date: 1 Aug 2022

B-1 Digital Twin Program

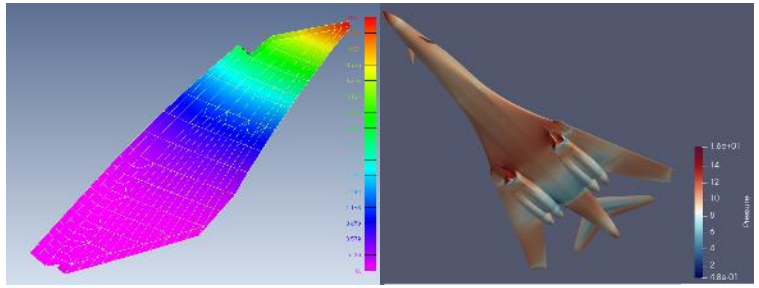
NIAR Wichita State University
National Institute for Aviation Research

Structural Digital



Engineering Digital Twin

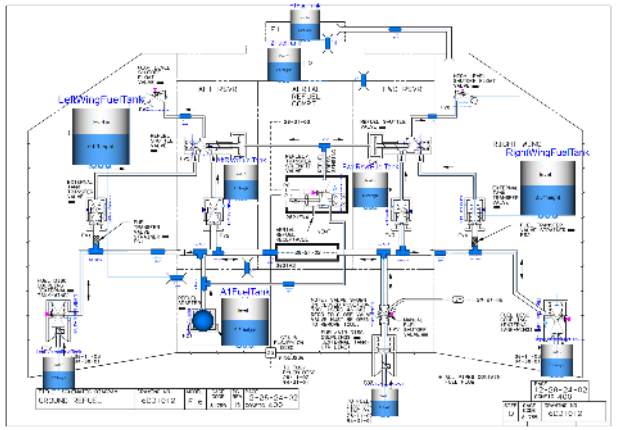
- Global FEM
- External Loads



Structural Analysis

- Create Government owned GFEM and detailed FEM of critical areas
- Generate a Government owned fatigue spectrum
- Perform Damage Tolerance Analysis
- Perform Life/Inspection Interval Assessment
- Support Repairs and Design Changes
- Other ASIP Support
- Single Flight Probability of Failure

MBSE/Digital Fault Isolation



Teardown & Inspection of High Time Fuselage

Weapon Integration

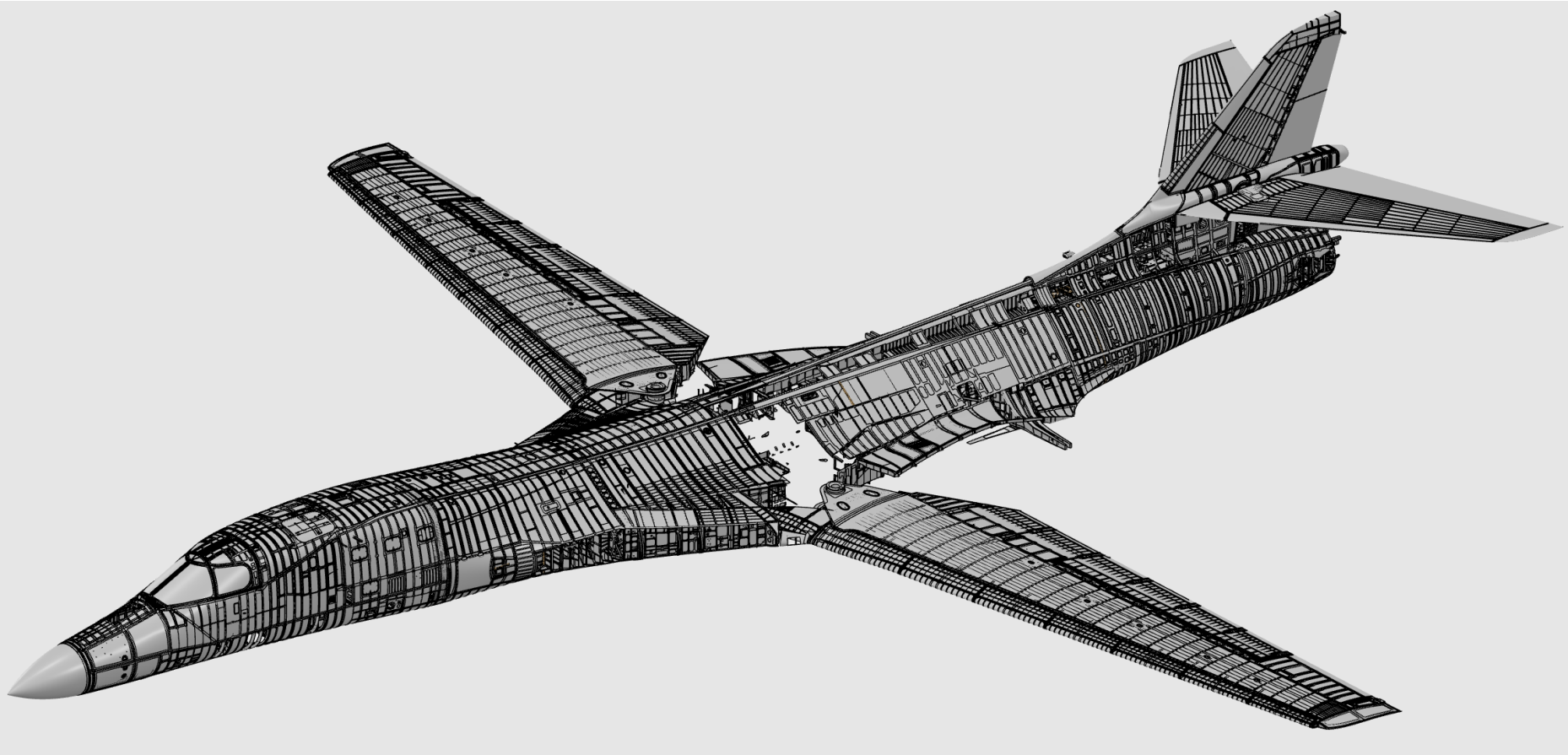
- Feasibility Studies on Weapons
- Perform Safe Separation Studies

High Performance Computing

- 1 Secret/ 1 Unclassified HPC
- 200 Nodes Each
- 2PB SSD and HDD Storage Each
- 2PB HDD Backup Storage Each
- Available for DoD use ONLY

PA Release # AFLCMC 2022-0224"
Release Date: 1 Aug 2022

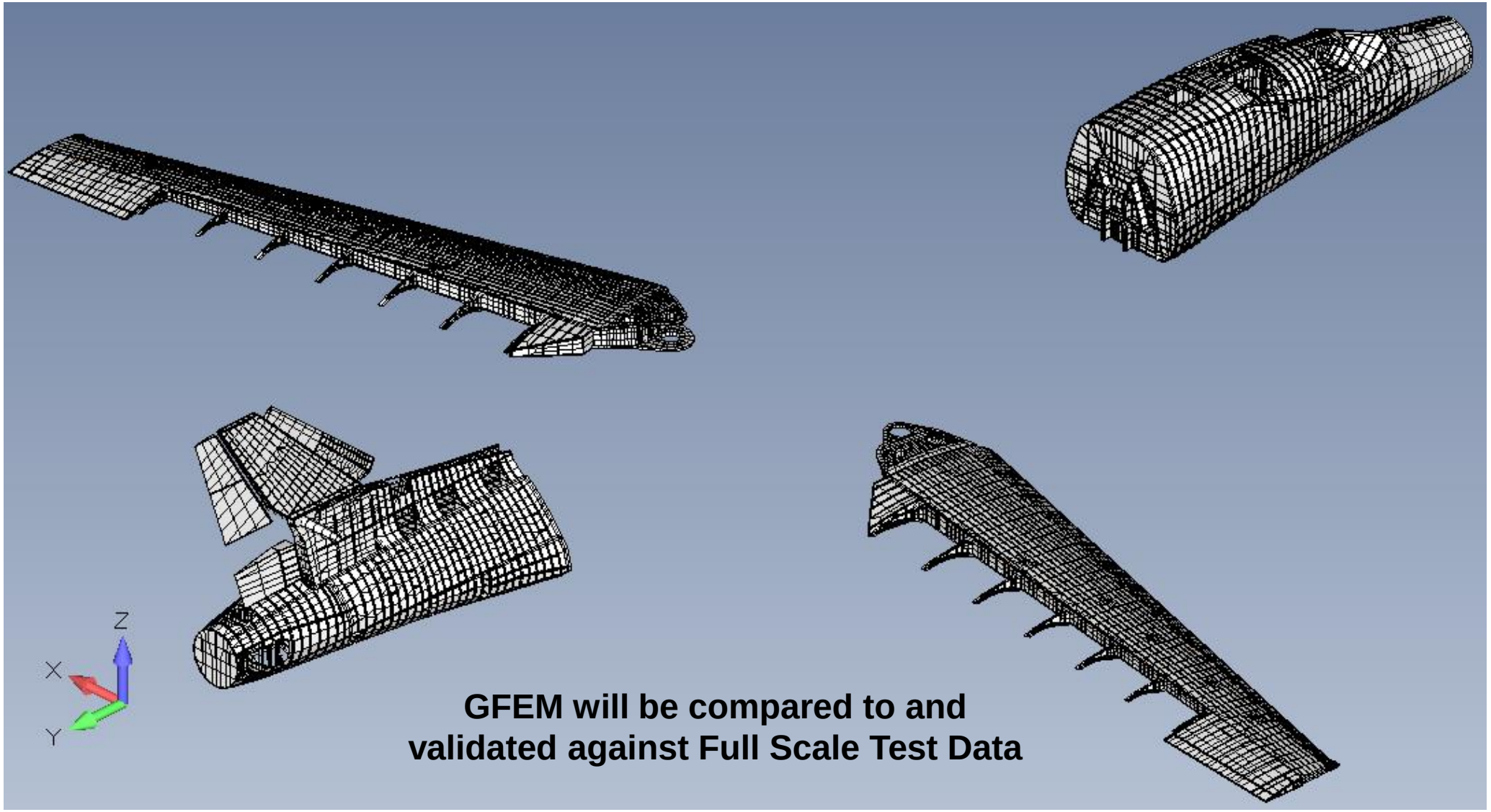
B-1 Geometric Twin Status



35,610 Parts Identified
32,141 Parts Scanned
31,874 Parts Inspected
24,916 Part Modeled
21,923 Models Checked
17,810 Models Released

Data as of 1 May 23

GFEM Status



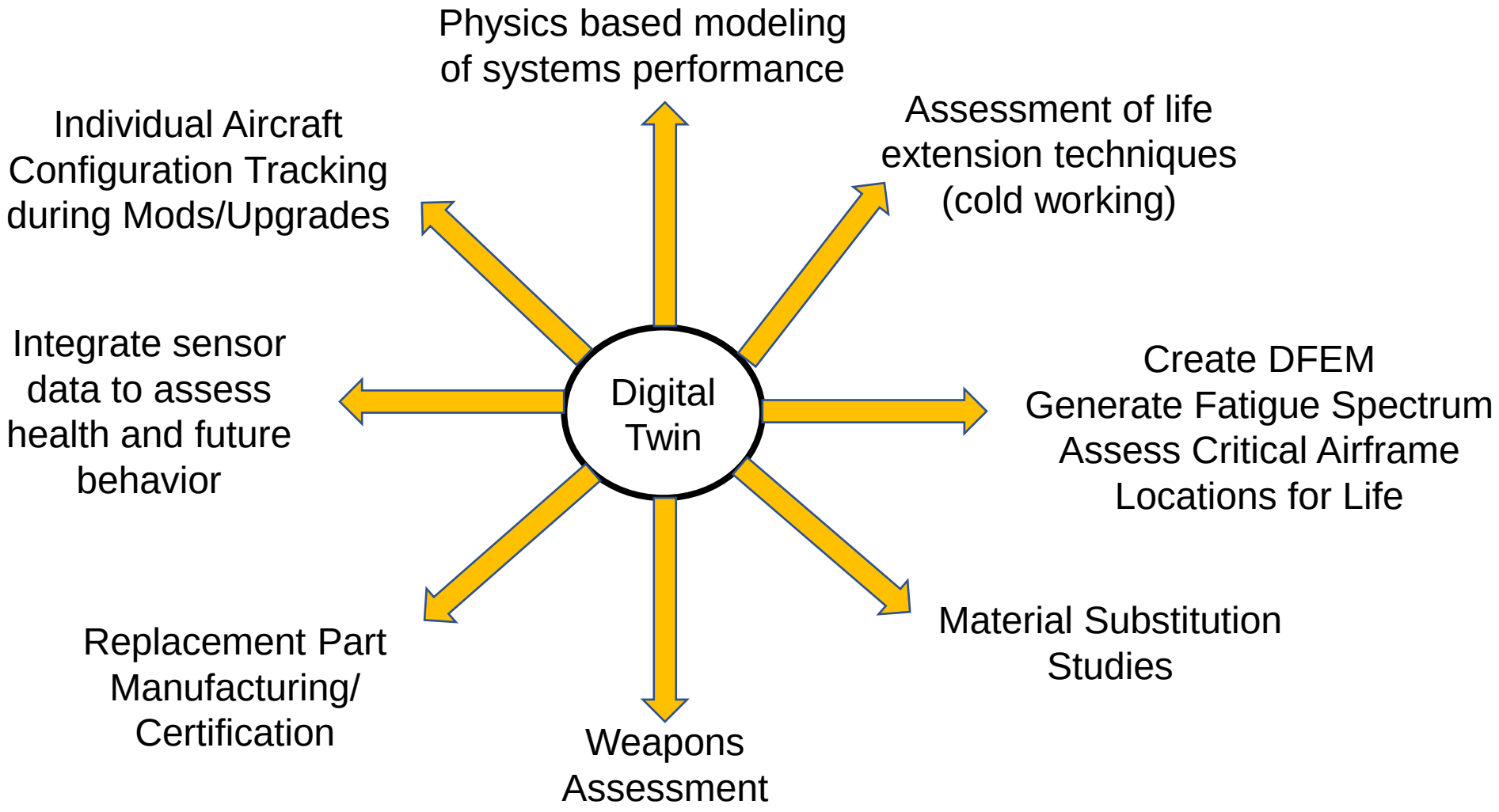
PA Release # AFLCMC 2022-0224”
Release Date: 1 Aug 2022

Digital Twin Benefits to Date B-1

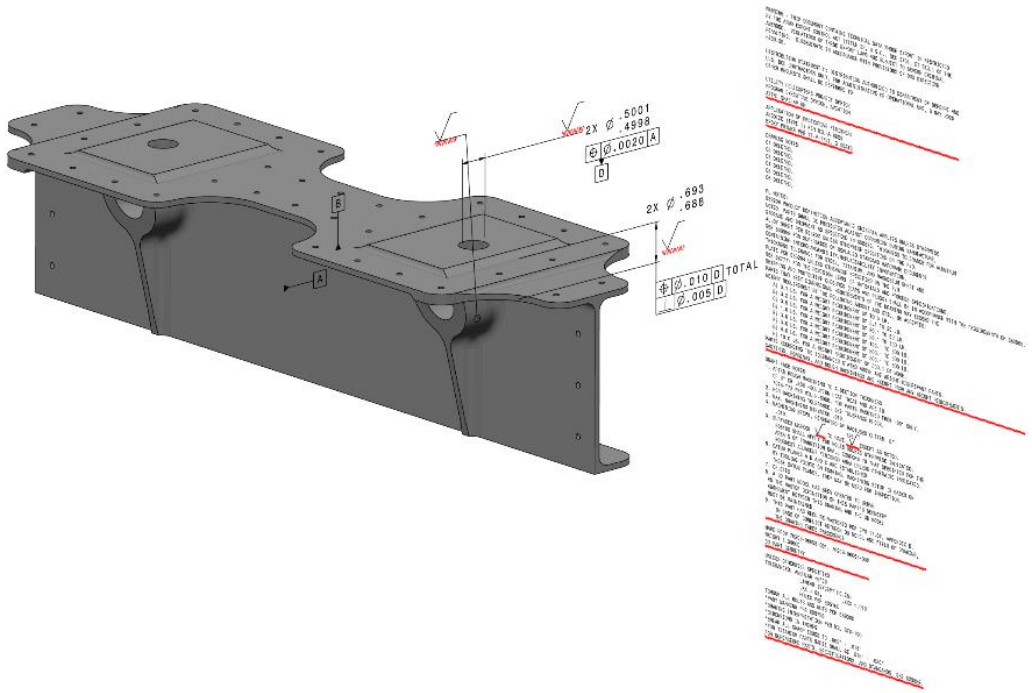
- Depot Support Equipment
  - OML Loft of Nacelles provided to develop new PDM stands (Jan 22)
  - OML Loft of Forward Intermediate Fuselage provided to develop new PDM stands (Jun 22)
- Visualization of Fleet Inspection Data
  - Digitized Wing assembly provided to Nlign for SPO to visualize the location of inspection findings (Jun 22)
- Manufacture of Parts
  - 8 Skin models provided to SPO to enable local manufacture for repair of airframe (Jul 22)
- Support of Robotic Drilling Technique to support Future Mod
  - 6 Forward Intermediate Fuselage skin models provided to support development of technology to support future modification (Jul 22)

PA Release # AFLCMC 2022-0224”
Release Date: 1 Aug 2022

Looking Forward



Applying the Digital Twin: Replacement Parts



Additive

Subtractive

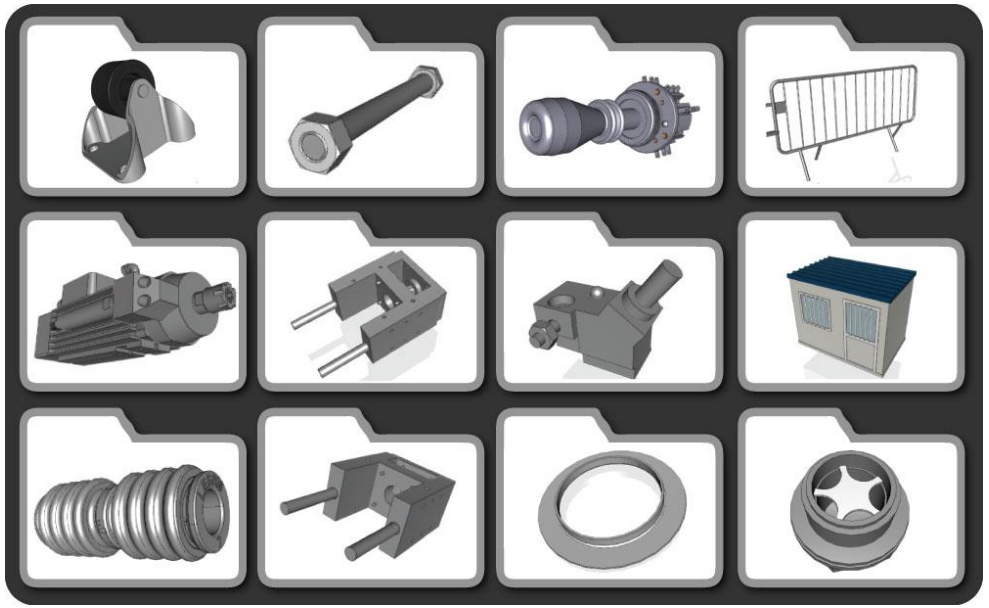
Digital file ready for selected manufacturing method

Digital Library vs. Physical Warehouse

Government owned CAD models **reduce** the **risk** of parts not fitting the first time

Reduces time to translate from 2D tech data to machine ready data

Likely will result in **less unfilled** part requests



Opens the **supply base** to “mom & pop” machine shops

Eliminates high part quantity requirements

Increases competition as the supply base is larger

Conclusions

“Digital Twin”

- A collection of CAD models stored in a database doesn’t constitute a true Digital Transformation
  - We need to look at the entire way we do business (procurement through sustainment…if this is truly **LIFE CYCLE MANAGEMENT**)
  - We need to focus on **ALL** stakeholders, not just engineers
  - But we also need to bite off manageable chunks to avoid being overwhelmed
- We need to do more than just collect data
  - We need to make sure it’s the **RIGHT** data!
  - We need to have a plan on how to **USE** the data!
- Everyone has their own concept of Digital Twin
  - **And that’s okay!**
  - Every problem is not the same, so every solution shouldn’t be either!

Industry 4.0 vs. Industry 5.0

- Don’t automate for automation sake
- Focus on **risk management**, not **risk avoidance**
- Make sure you understand the problem and all possible decision points
  - Analyze all situations to see if “independent thinking” could ever be needed/beneficial
  - **Trust but verify!**

Empower humans and augment our natural abilities

National Institute for Aviation Research

• Dr. Melinda Laubach-Hock

• NIAR Director of Sustainment

• melinda.Laubach-hock@idp.wichita.edu

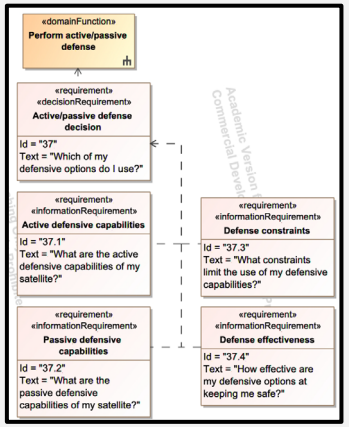
• 316-978-8205

HSI meets MBSE

The AFIT of Today is the Air Force of Tomorrow.

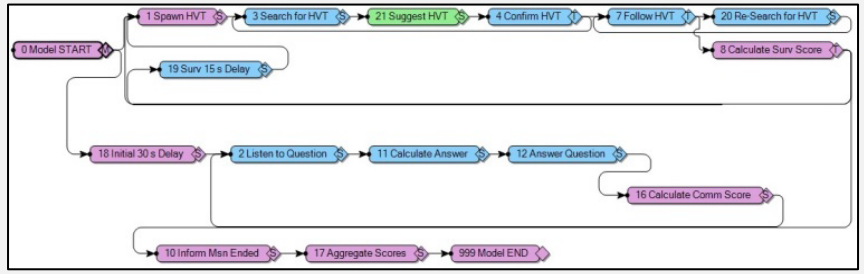
Human Engineering Artifacts

- Represent results of cognitive task analysis
- Trace operator's information requirements
- Trace to interface elements supporting requirements



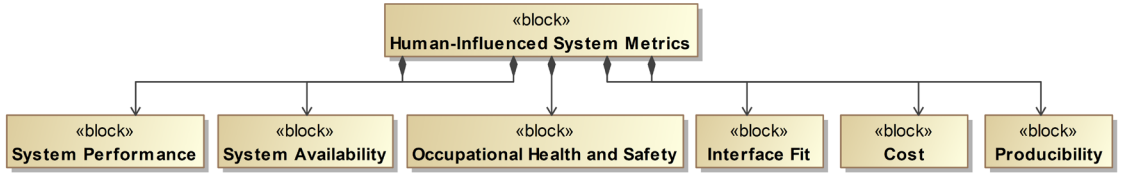
Integrated Modeling

- Illustrate Integration of Cameo and Human Engineering Tools (IMPRINT, FRAM, etc)

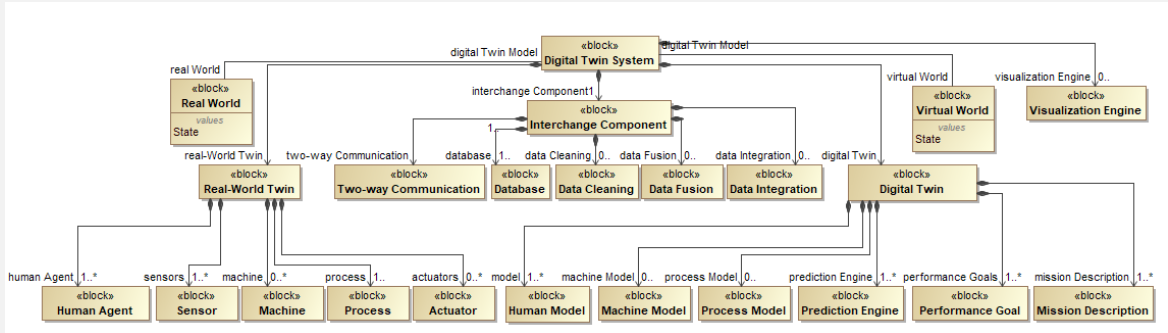


Metrics

- Relate System and Human Metrics
- Focus on Metrics to Illustrate System Trades
- Manufacturing, Maintenance, Operation



Human Digital Twin



Use of Models and Mathematics in Software

University of CINCINNATI

NSA use case

- Utilize Cryptol to create models
  - Helps convey mathematical models of cryptography in terms to support correct software builds
- Enables the ability to evaluate code for correctness
- Supports implementation of standards
- Provides basis to transition capabilities to services and support acquisition of NSA compliant cryptography
- Curriculum at UC has enabled the development of thousands of students that have learned this capability and work across the DoD enterprise

Use case of AI/ML Systems Engineering

- With proper tooling, prove that we can do analysis of systems to help us learn more about these systems
  - Reverse engineering and forensics
  - Provides baseline to transform into models
  - Supports informing users of the architectures of a system
    - Enables analysis to support enhancing cybersecurity

Automated Validation is Key to Descriptive Modeling Success

- Automated validation is critical to ensuring style guide compliance, model completeness, and consistency
- Building an example model is important to ensuring a style and associated validation rules achieve their intended goals (including successful model federation)
- Novice modelers expose gaps and errors in style conventions and rules when constructing example models
- Creating example models and automated validation rules is expensive (hundreds of hours of junior and senior modeler time is required), but NOT creating them costs MORE (and results in perpetual review costs)
- Automated validation provides training benefits in addition to enhancing model quality and consistency
- See *Here There Be Dragons: An Initial Study of Undetected Errors in Unvalidated SysML Models*, 2023 MBSE Cyber Experience Symposium, for an initial analysis
- See https://udmercy.academia.edu/MichaelVinarcik