AF Life Cycle Management Center

AFLCMC… Providing the Warfighter's Edge

Sustainability in Acquisition

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AFLCMC/EZP

15 June 2016

OUTLINE

- **AFLCMC/EZP Organizational Chart**
- **DNA – Who we are**
- **Product Support – 12 elements**
- **Sustaining Engineering**
- **Tomorrow's Lifecycle Overview**
- **Focus Areas**
  - **Environmental Considerations**
  - **Corrosion Prevention**
  - **Reliability & Maintainability**
  - **Condition Based Maintenance Plus (CBM+)**
- **Closing: USAF SL Expectations**

AFLCMC/EZP Organization

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Technical Disciplines

Reliability & Maintainability (R&M) Engineering & Sustainment Branch

- Reliability Analysis, Planning, Tracking, & Reporting
- Reliability Centered Maintenance (RCM)
- Condition Based Maintenance Plus (CBM+)
- Engineering Disposition Processes
- Critical Safety Items (CSIs)
- Joint Aeronautical Commander's Group (JACG)
- Aircraft Structural Integrity Management Information System (ASIMIS)

Sustainment Technology Transition Branch

- Airworthiness New Materials and Substitution Lead
- Weapon System Sustainment Technology Enterprise Program (WS-STEP)
- Laser De-Paint Initiative
- Chromium Risk Mitigation Initiative
- Cadmium Risk Mitigation Initiative
- Additive Manufacturing Initiative
- Sustaining Engineering Requirements Support
- AF Corrosion Working Group
- Aircraft Battle Damage Repair Engineering (ABDRE)
- Center Test Authorities (CTAs)
- Corrosion Prevention & Control Office
- Non-Destructive Inspection Office
- Advanced Composites Office
- Metals Technology Office

Applied Engineering & Technology Branch

- Materials Handling Engineering
- Packaging Technology & Engineering
- Electronics Component Engineering

Debbie Naguy
Division Chief

Product Support Engineering Division

Matt Phillips
Tech Director

Frank Erdman
Branch Chief

Reliability Maintainability & Sustainment

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Technical Expert

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Branch Chief

Applied Engineering & Technology

AFLCMC/EZP Nationwide Team

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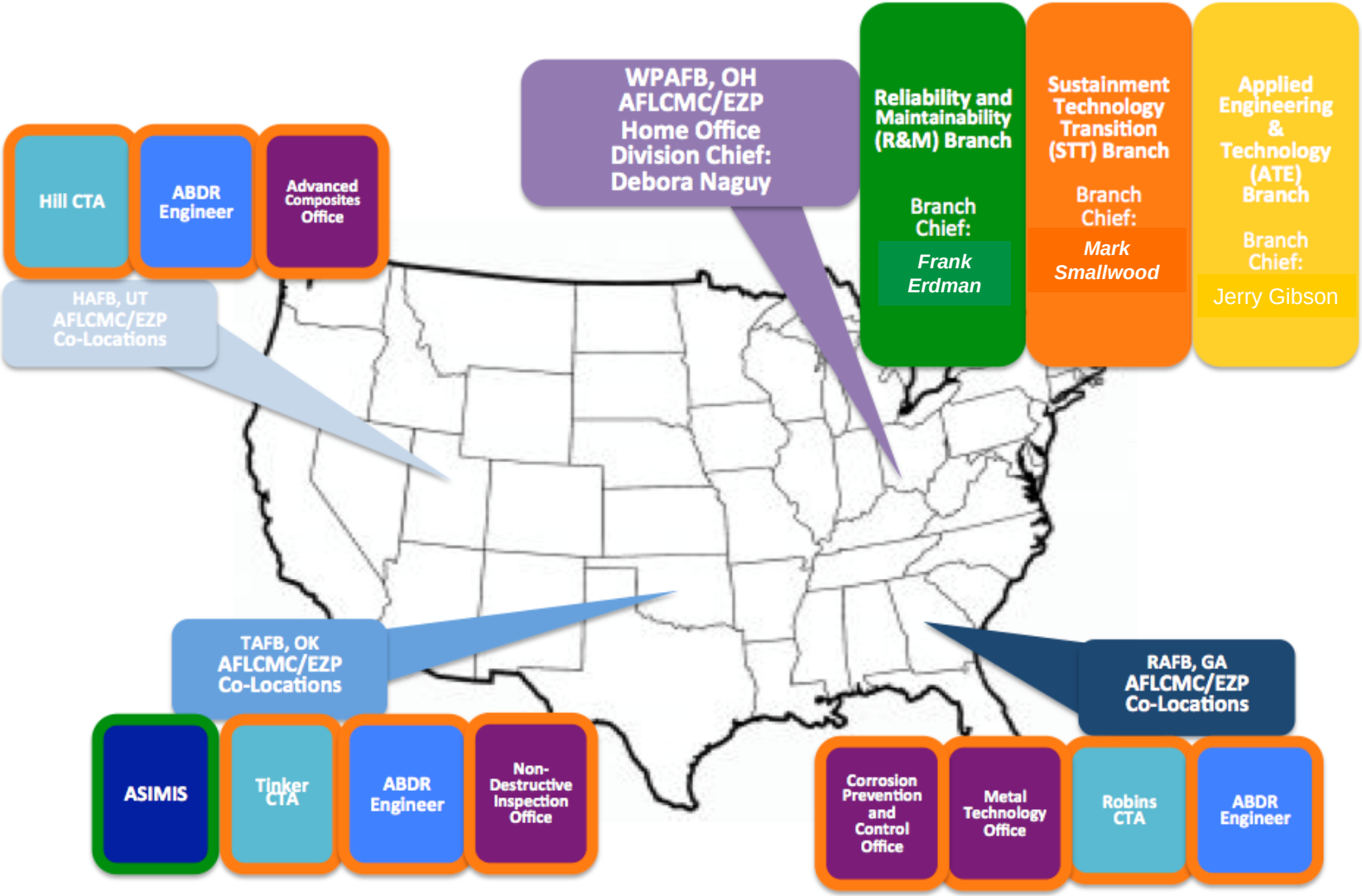

AFLCMC/EZP DNA – It's Who We Are!

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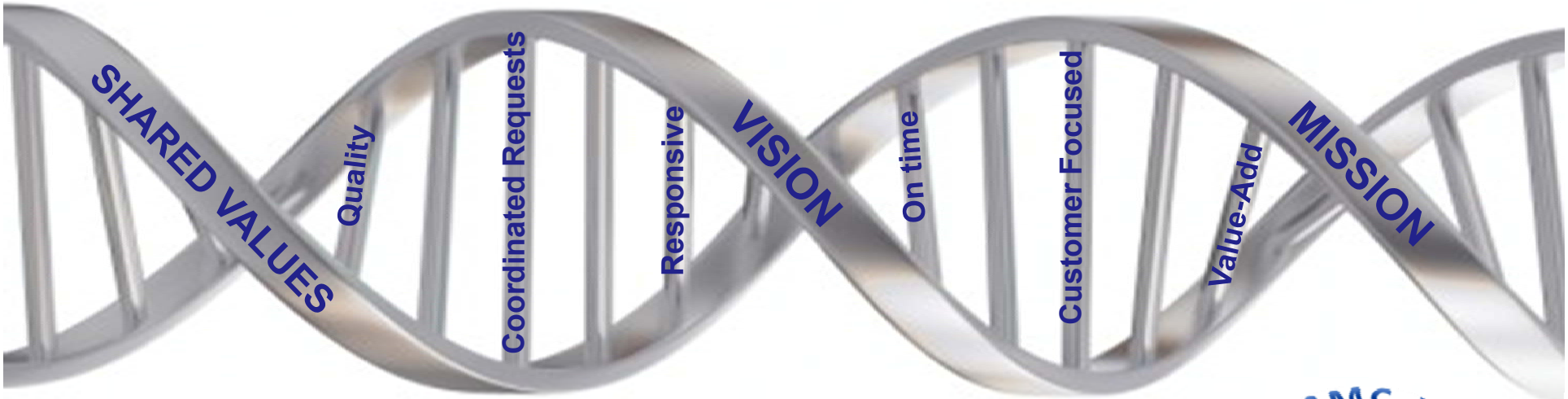
Vision*: Affordable Warfighter Readiness…Innovative Product Support Engineering Capabilities*

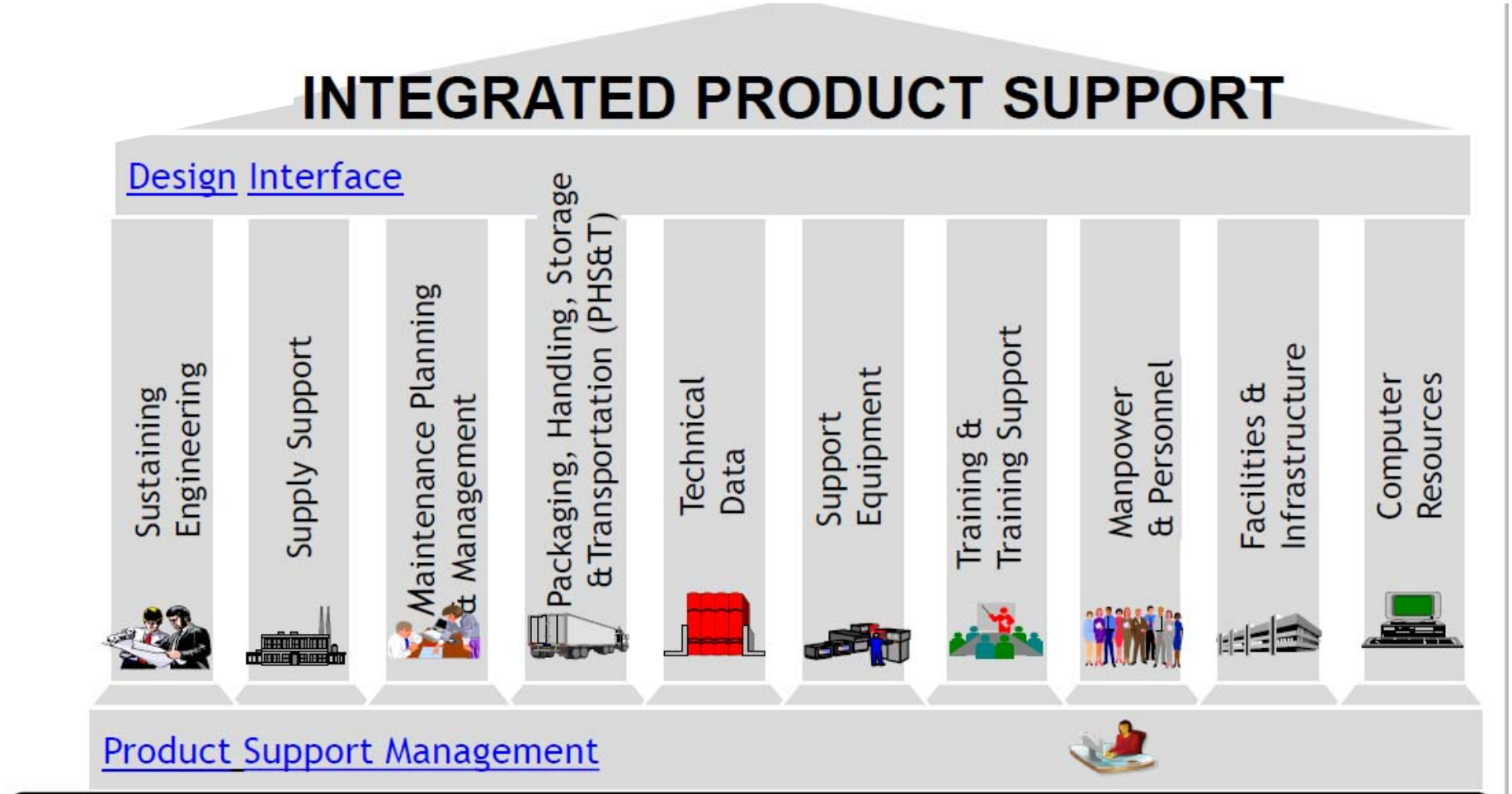
Mission: *Ensure AF Enterprise Focus by Applying Airworthiness Approach that Promotes Cost-Effective Technology and Sustainment Solutions*



We Raise the bar!

AFLCMC / EZP
WE HERD CATS

Product Support: 12 Elements



Product Support is enabled by 12 Integrated Product Support (IPS) Elements designed to deliver system readiness & availability while optimizing system life cycle cost

Ref: www.DAU.mil

Sustaining Engineering Sustainability

- **Life cycle assessments (LCA) throughout the acquisition process:**
  - **DoD systems life cycle – typically 30 year design life**
  - **Resources are costly**
- **Systems must be made more sustainable:**
  - **Meet mission requirements**
  - **Reduce life cycle costs**
  - **Many systems used beyond design life (50+ years)**
- **LCA in the Systems Engineering process**
- **Sustainability must be evaluated in a business case**

Tomorrow's Lifecycle Overview…

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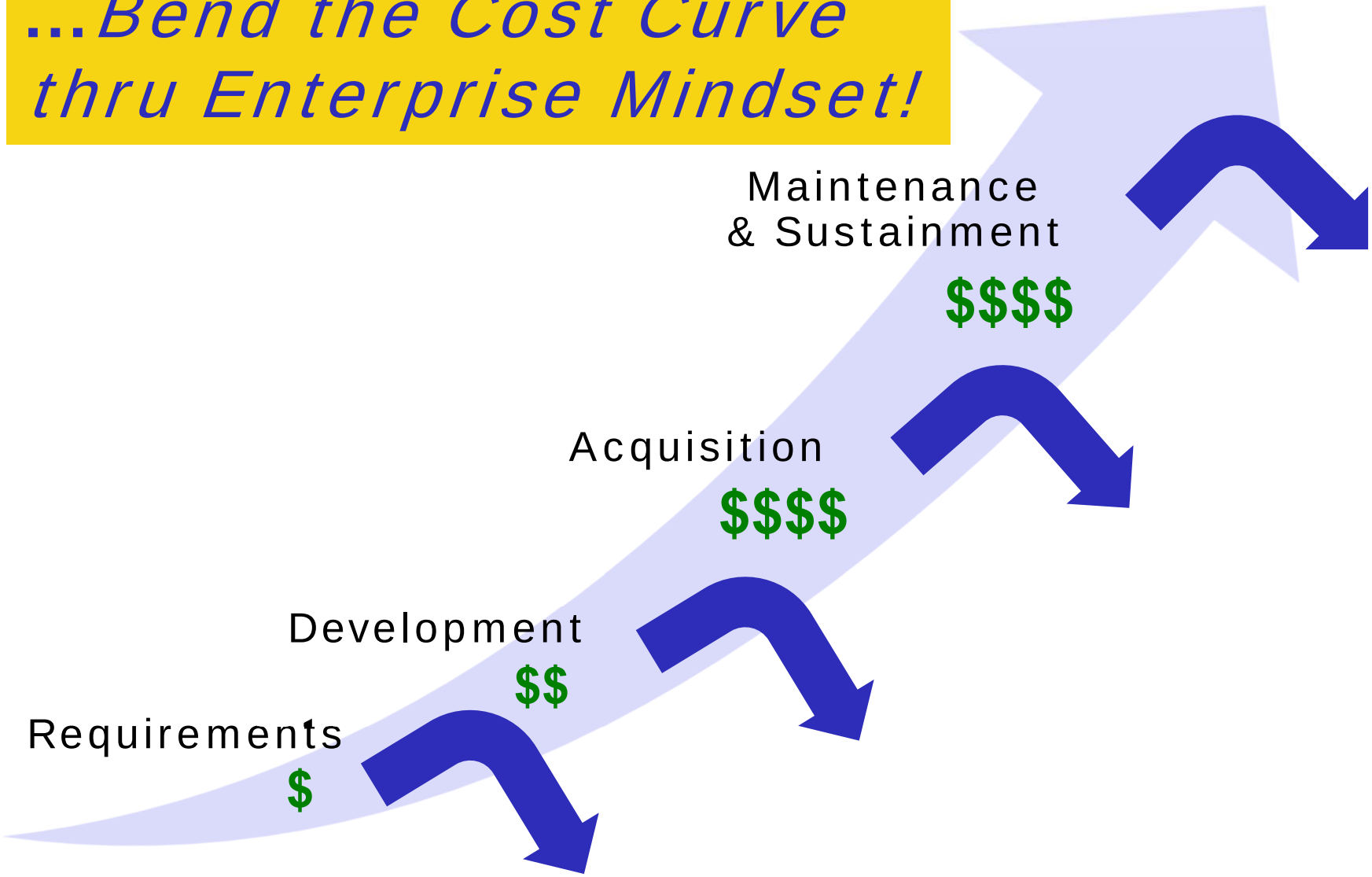
…Bend the Cost Curve thru Enterprise Mindset!



Focus Areas

- Environmental Considerations
- Corrosion Prevention
- Reliability & Maintainability
- Condition Based Maintenance Plus (CBM+)

Environmental Considerations

- **Protect human health and the environment, while ensuring the success of core mission**
- **Consider environment, safety, and occupational health (ESOH) during the system acquisition process and for the duration of the system's lifecycle**
- **Prevent ESOH hazards, where possible, and manage ESOH hazards where they cannot be avoided**

Cr- and Cd- Free Strategy

- Identify Cr and Cd free technology assessment projects/opportunities
  - Capture processes/locations of use
  - Identify past and ongoing future research projects
- Prioritize project opportunities based on cost/ benefit/ mission
  - Evaluate performance via field inspections
- Hold Airworthiness Product Evaluation event
  - Validate technology, cost benefits, enterprise-wide opportunity for technical solutions
  - Identify issues and concerns
  - Identify additional testing requirements
  - Establish fielding strategy
- Communicate strategy to AFLCMC, AFSC and MAJCOM leaders
  - Directors of Engineering and Chief Engineers (CE)
  - Obtain DOE/PM/CE support to expand operational tests

Notional Framework for Non-Chrome Implementation

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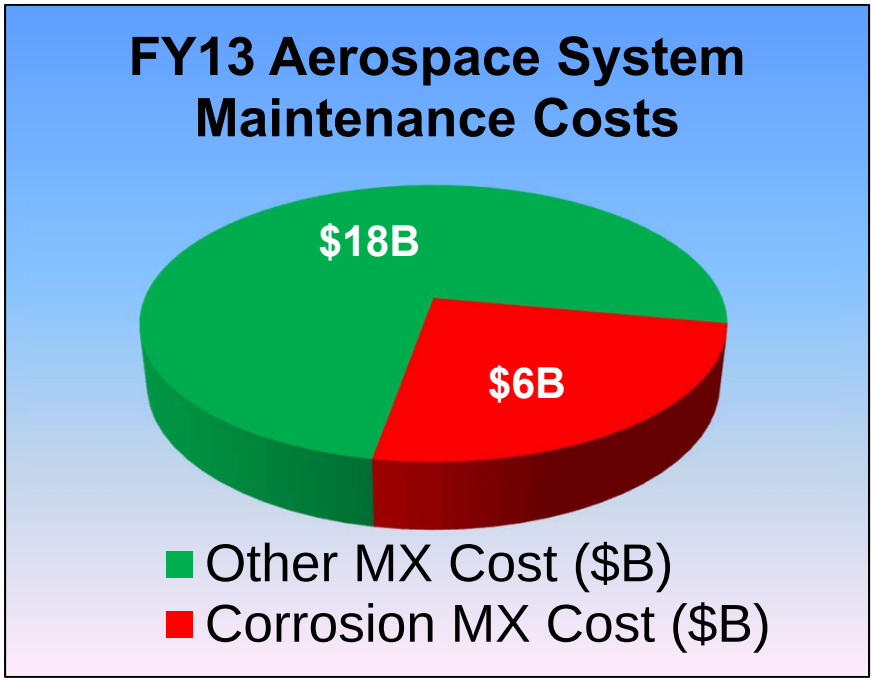
		Corrosion and Mishap Risk Posed by this Application Area *(Green indicates application area will tolerate less capable alternatives)*		Risk Assessment of the Use of CrVI in this Application Area *(Green indicates application poses lower ESOH risks to AF personnel and installation environment)*		Risk Assessment of the Use of Alternatives in this Application Area *(Green indicates adoption of alternatives would not increase risk in these areas)*		
	Example Cad-CrVI Applications	**Life Cycle Corrosion**	**Life Cycle Mishap**	**DoD Worker Exposure Risk if CrVI Used**	**ESOH Life Cycle Cost**	**Corrosion Prevention Performance**	**Technical Maturity Risk**	**Life Cycle Cost**
Near-term Focus Areas for Implementation	Primer on support equipment and infrastructure	Visible and repairable		Larger source of worker CrVI exposure	Larger source of installation ESOH costs			Some alternatives require more frequent inspection and application; alternatives still require exposure controls
	Aircraft Outer Mold Line (OML) Primer	Sometimes necessary to improve performance of outer mold line replacement						
	Bare metal surface treatments/Conversion Coatings/"Sealers"							
	Sealants							
Longer-term Focus Areas	Adhesive bonding primers	Hidden, difficult to inspect or access Frequent corrosion;	Known life cycle structural integrity risk Known life cycle mishap risk	Limited or no expected worker exposure	Limited or no installation ESOH costs			Higher life cycle probability of loss of aircraft or of availability
	Internal Structural primer							
	Fuel tank primers, coatings, and sealants							

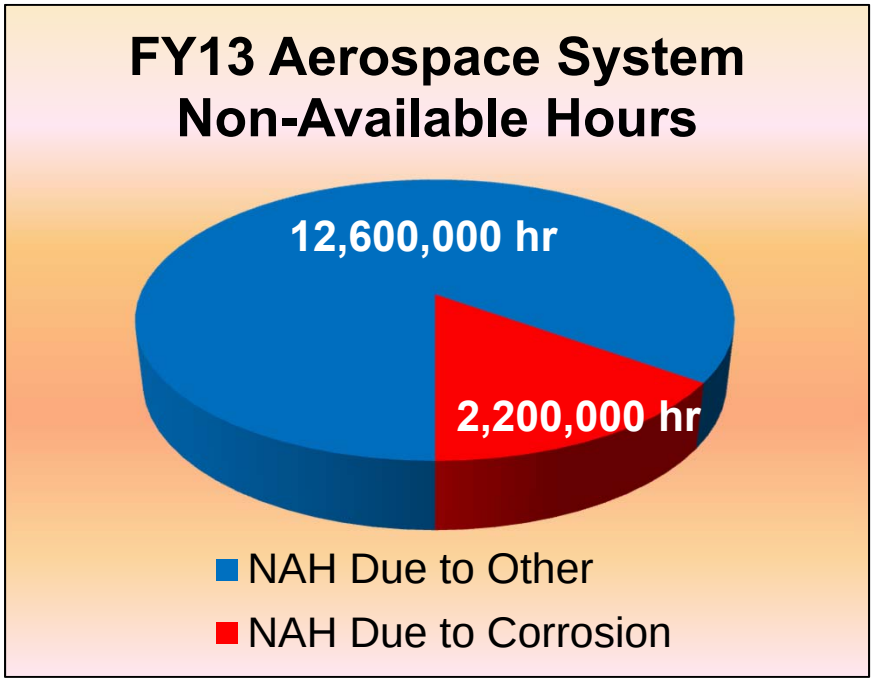
Cd Alternatives Efforts

- **LHE Zn-Ni Cd alternative for Landing Gear at Hill approved on all organic weapon systems**
  - Delegated OSS&E authority for non-CLS systems
  - C-17 to switch to Zn-Ni through OEM authority
- **LHE Zn-Ni Cd alternative for fasteners**
- **Alternatives for Cd brush repair of components under investigation**
  - Novel Brush Plating System Dalistick Station for depot/field repairs
- **Technology solution needed for non-Cd connectors**
  - Unique electrical connector requirements

Corrosion Prevention

Corrosion Prevention and Control Costs

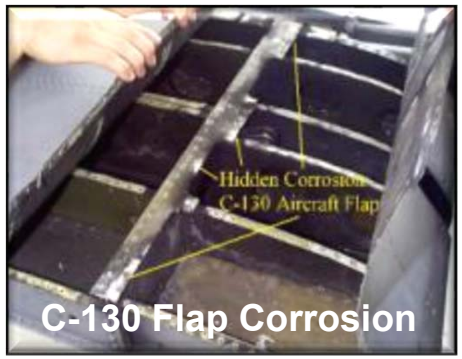




- **The depot portion of corrosion MX is $3.4B**
- **LMI Data FY13**
- **Only Aircraft and Missiles**
- **25% of the total maintenance budget and about 15% of all system non-available hours**

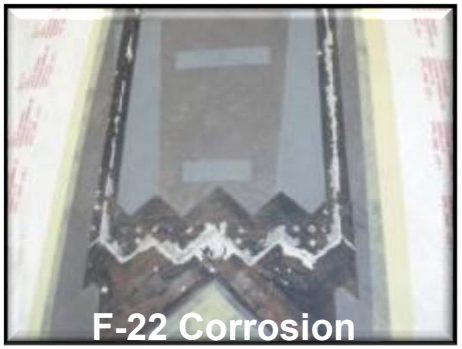
Corrosion Impacts

- ROM WAG: 40% of Programmed Depot Maintenance is corrosion-related
- C-130 Sloping Longeron – adds 24 days to PDM, costs $77K
- F-16 Wing Pylon Fitting – 49 of 68 found corroded – wing replacements required
- 1 KC-135, 1 E-8, 1 C-130 condemned for corrosion
- KC-135 – top concern for fleet life thru 2040
  - Groundings due to engine strut corrosion – repair cost estimate $2.9M/aircraft
- HC-130s at Patrick AFB – 6 aircraft (entire fleet) condemned due to corrosion



C-130 Flap Corrosion

C-130 Depaint


F-22 Corrosion

Corrosion Prevention and Control
AF CPCO Foundation

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Vision
- *Effective AF CPCO = Increased Readiness + Cost Savings + Reduced Airworthiness Risks*

Mission
- *Act as a centralized resource providing CPC technical expertise and shared learning for WS performance, equipment integrity, and life cycle sustainment*
- *Provide expertise for acquisition programs to decrease O&S costs and system downtime*

Objective
- *Deliver high quality, effective and applicable customer service across CPC spectrum [for AF WS platforms] to improve availability and reduce costs*

Tagline
- *Prevent corrosion where possible then control! – Rust never sleeps!*

Values
- *CPC offers numerous advantages across technical performance, safety, financial, and aircraft availability*
- *Corrosion is an engineering competency used to optimize equipment "uptime" and integrity, and to identify and minimize airworthiness risk associated with equipment/structural failure.*
- *Corrosion planning is a critical factor across the total lifecycle and all integrity areas.*

Leverage Systems Engineering Principles!

Corrosion Prevention and Control Road Map

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CPCO Center Of Excellence

- ***Dynamic and innovative center that delivers corrosion technical engineering expertise to reduce costs, increase system availability & enhanced safety***

Near Term Objectives

- Corrosion Engineering workforce development
- Enterprise wide technology focus
- Increase support to Program Offices (trends, technical assistance, site surveys, transition to system support, etc.)
- Technology insertion across Life Cycle
- Strategic thinking to implement "art of the possible"
- Increase Integrity Programs support (MECSIP, PSIP, AVIP)
- Reconstitute Corrosion Lab within AFCPCO

CPCO today

- Focus on foundational expertise and continuity to sustainment activities (field, depot, engineering)
- ASIP support

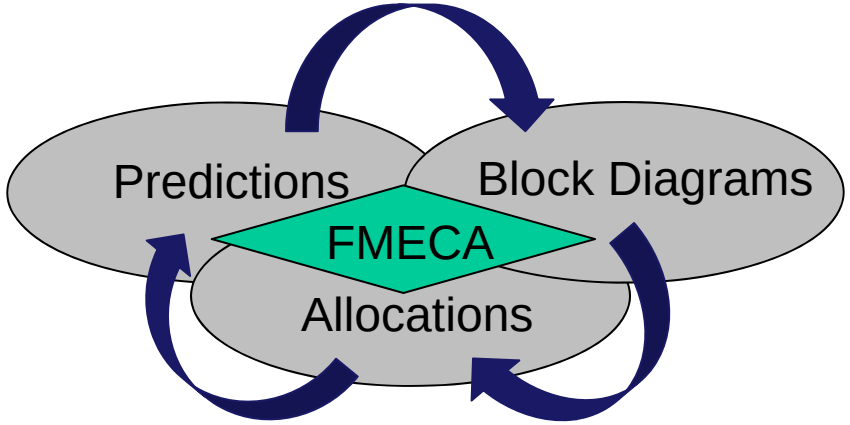
Reliability & Maintainability (R&M)

- **Reliability and Maintainability are key enablers to life cycle sustainment**
  - **R&M must be designed into the system**
  - **Cannot afford to fix problems after fielding**

The goal of R&M engineering is to optimize readiness, mission performance and cost.

Reliability Design Process

- **Continuous refinement of the design to meet system and reliability requirements**
  - **Reliability design strategies**
  - **Maintainability design strategies**
- **Functional FMECA is centerpiece of design activities**
  - **Defines impact caused by loss of functionality**
  - **Key output of Design for Reliability**



Reliability and maintainability design strategies reduce sustainment costs

FMECA

- **F**ailure **M**odes, **E**ffects, and **C**riticality **A**nalysis **(FMECA)**
- **Initiated at component level failures**
  - **Propagates failure mode and its effect on the entire system**
  - **End effects are ranked by severity and criticality**
    - **Ranking categories 1 (least severe) through category 4 (most severe)**
    - **Criticality combines severity and occurrence**
    - **Defining impacts in terms of mission and safety**
- **Essential to system safety analysis**
- **Launching point for Reliability Centered Maintenance (RCM)**
- **FMECA Data Item Description (DI-SESS-81495A)**

Reliability Design Strategies

- **Add redundancy**
  - **Degrades logistics reliability**
- **Part selection**
  - **Replacing components with a more reliable component**
- **Reduce parts count**
  - **Simplify design and eliminate components**
  - **Less parts = less failures**
- **Parts de-rating**
  - **Requiring higher safety for components**
  - **"De-rating" components**
  - **Cost is limiting factor**

Mission reliability – Probability to successfully complete the mission.

Logistics reliability – Rate at which the aircraft requires maintenance.

Goal is to optimize *mission reliability* with no impact on *logistics reliability at the LOWEST COST*.

Maintainability

- **Maintainability: *ease of completing maintenance***
  - **Usually beneath the outer mold line (OML)**
- **Physical architecture of the design impacts maintainability**

Design changes to increase maintainability can make system larger and add weight.

PHASES OF REPAIR

Fault Isolation & Troubleshooting → Component Access → Repair → Close Out → Functional Test

Sustainment R&M

- **Main focus – aircraft availability to support mission tasking**
- **Mission Capable (MC) Rate is the status of the aircraft at all times, which must be reported by squadrons**
  - **Fully Mission Capable (FMC) – All aircraft systems are capable**
  - **Partially Mission Capable (PMC) – 1 or more defined missions cannot be performed; must report failed system**
  - **Not Mission Capable (NMC) – no missions can be performed; must report failed system**
- **MC rate not always included in program's requirements document (legacy programs)**
- **Part shortages is one of the largest impacts to MC rate**
  - **Failures that drive part removals are a main driver**
- **Other metrics of interest to operational community**
  - **Break rate / Abort rate**
  - **Fix Rate**
  - **MMH/FH**

Increasing Aircraft Availability

- **Two ways to improve aircraft availability**
  - **Improve reliability – less failures**
    - **Example: Increase reliability of failing parts**
  - **Improve maintainability – faster repairs**
    - **Example: Changing outer panel to a non-LO to remove LO requirements during part repair increases maintainability.**
- **Must also consider *cost***
  - **Reliability Centered Maintenance (RCM)**
    - **Maintain system safety, improve aircraft availability, and reduce cost**
    - **Optimizing maintenance**
      - » **In terms of safety, aircraft availability, and cost**
      - » **Depending on the reliability of the part and its failure effects**
    - **Begins during development and continues from sustainment through system disposal**
    - **Strategies for failure management**
      - » **Scheduled inspection – drives on-condition maintenance**
      - » **Force replacement – life-limited or time change items**
      - » **CBM+ - forecasting failures to demonstrate mitigation or prevention of failures**

Condition Based Maintenance Plus (CBM+)

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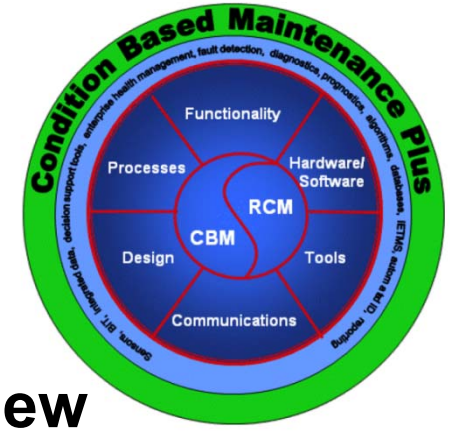
- **CBM+ is an industry-proven, data-driven *methodology***
  - **Drives decisions based on specific <u>condition</u> of components/systems**
  - **Enables well-informed decision making and courses of maintenance action for new and legacy systems (CBM+ is platform agnostic)**



- **CBM promotes maintenance only upon *evidence of need* and not as a function of time**
- **CBM+ improves asset health/readiness by integrating predictive methods to determine remaining useful life and preemptive maintenance actions to prevent failure**

CBM+ KPPs and Goals

Aircraft Availability

- Optimize scheduled maintenance to minimize downtime
- Reduce unscheduled maintenance
- Ensure spare parts availability
- Minimize downtime when mission aborts occur

Mission Impacts

- Identify causes of mission aborts
- Prevent mission aborts
- Reduce mission abort rate

Maintenance Cost Drivers

- Labor manhours and time to repair
- Component reliability and time between failures
- Spare parts and inventory costs
- Cannibalizations

CBM+ Approach

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CRAWL – *Immediate Value*

- Capitalize on existing pockets of excellence
- New perspective utilization of existing data and domain expertise
- Enhanced field Mx operations (MOB/AOR)
- Standardized processes to adopt predictive prognostics and monitoring
- Enhanced data integrity tools/suites & training

WALK – *Mid-Term Outlook*

- Field + Depot Mx data set mash-ups and indicators
- Integration of corrosion, NDI, and other key conditional information sets (sensor feeds)
- Enhanced data integrity tools qualified for enterprise
- Cyber secure, collaborative and full-scale accessible environment

RUN – *Game-Changers*

- Active CBM+ monitoring across USAF enterprise (organic + CLS)
- Real-time, state of the art data integrity systems
- Full-scale use of AIT and point of Mx tools
- Fully integrated engineering, supply & logistics operations = no unplanned Mx

Ultimate Goal: Reduce…to Eventually *No Unplanned Mx!*

Activities Today

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FY15/16 Pilot Programs: B-1 & C-5

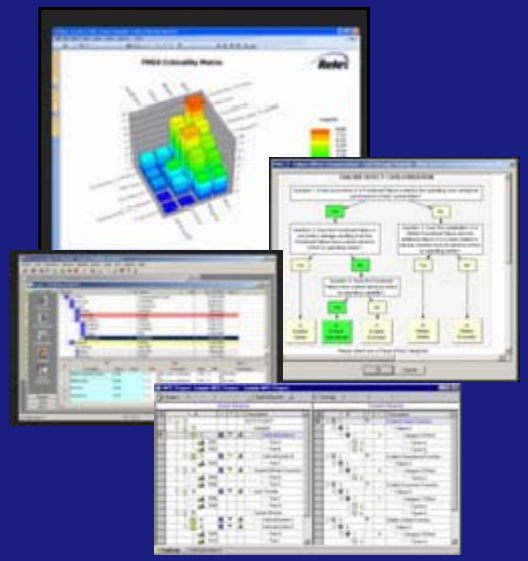
- CBM+ monitoring of select LRUs/sub-systems
- Focus Field Mx (MOB drivers)

CBM+ Enabling Technology & Processes

COTS vs. FOSS

- Data Cleansing tools
- Data Analytics (engineering)
- Next Gen Data Collection Systems

AF Enterprise Standardization



- Implementation or enhancement of "best practices"
- Standard tools and practices

Closing: USAF Senior Leader Expectations

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"In addition to strategic agility, our nation demands an Air Force capable of harnessing diverse ideas and perspectives. Diversity, total force integration, and building internal and external partnerships provide the nation with the Air Force it expects, deserves, and needs."

Honorable Secretary Deborah Lee James

30 Jul 2014

"…how do we stay the best Air Force in the world? This is a journey…you don't stay great for a couple of days, it's a journey…That's what our new strategic framework is intended to be, the idea is a call to the future that's looking down the road to keep us moving in a consistent direction."

General Mark Welsh, III, Air Force Chief of Staff

15 Sept 2014

AIR FORCE LCMC