

# **Additive Manufacturing Design Optimization, Corrosion/Environmental Monitoring, Intelligent Maintenance Assessment System**

## **Analatom Technology Overview**

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# Additive Manufacturing Traceability Assurances and Design Optimization S/W Tools

## PROBLEM STATEMENT

- Need for AM Driven Component Design Optimization, Process, and Configuration Management S/W Tools
- DoD Additive Manufacturing Study identified Technology Gaps in Design, Materials, Processes, Standards, Data Management.
- AM Design Optimization Tool to Ensure Component Life, Performance, Inspectability, and Maintenance Efficiency; and ensure design trades.
- AM Part Traceability and Assurance is a key requirement.
- **Standard IT data management systems aggregate data but are unable to link; provide Design Optimization Analytics; and correlate across disparate data sources.**

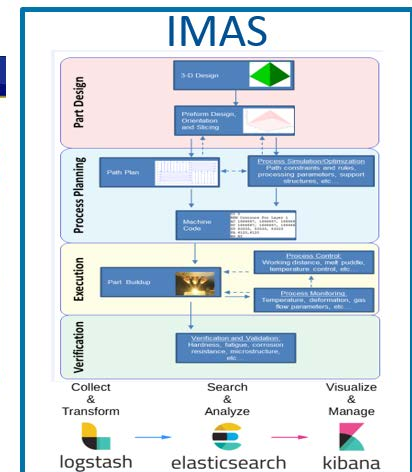
## BENEFITS

- Solution provides AM parts traceability, configuration, process, design optimization assessments, and life performance assurances.
- AM driven component design optimization and integrated S/W tool sets lets the designer explore trades that will maximize maintenance inspectability to ensure life usage performance; enhance monitoring sensor placement and signal transmission; and increase maintenance effectiveness with reduced costs.
- IMAS provides traceability assurance to maintain consistency across builds, test and field prototypes and operational deployments.

## TECHNOLOGY SOLUTION

- Apply “big data” analytic methods that link disparate data sources to provide part traceability and assurances that allow very complex devices to be *reliably* manufactured.
- Analatom’s intelligent management assessment system (IMAS) currently correlates disparate, unstructured information from multiple databases *at every stage of life*, from design specs to in-process quality control data to field maintenance data, tracking the parts in use.
- IMAS provides traceability assurance to maintain consistency across builds, prototypes, and operational AM.
- Leverage SBIR, Fathom Studios, and other efforts to provide AM Component Design Optimization Tool sets.

## GRAPHIC



Linking data across domains – (IBM Watson-like associative index)

# Data-Driven & Goal-Driven Condition-Based Predictive Corrosion Maintenance

## PROBLEM STATEMENT

- Annual corrosion related costs for DoD facilities, infrastructure, and equipment are \$20 billion. Approximately 25% (\$5 billion) occurs at depot-level maintenance for Air Force aircraft and missiles.
- Navy and Marine Corps aviation annual corrosion cost is \$2.6 billion; 26.1% of total maintenance costs (FY 2008-2009).
- Existing/emerging corrosion sensing, logging, and monitoring technologies are not applied as a comprehensive, strategic, integrated solution for corrosion management, maintenance, and mitigation.

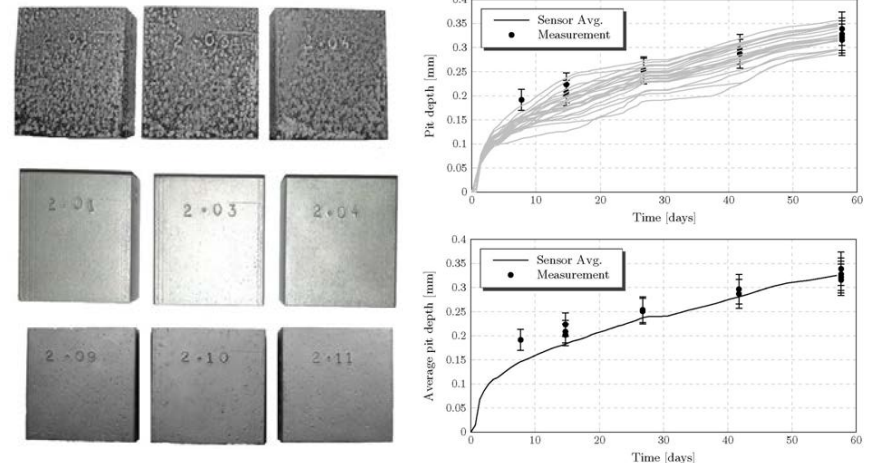
## TECHNOLOGY SOLUTION

- Proposed monitoring/assessment system incorporates in situ corrosion micro-sensors providing continuous data for advanced modeling assessment and prediction of protective coating & CPC condition.
- Assessing/predicting coating degradation and corrosion onset through advanced sensor data management, analytics software, and hybrid coating condition/corrosion modeling establishes the framework for sustainment groups' real-time corrosion assessment of in-service platforms to substantially enhance CBM+ programs.

## BENEFITS

- **Heightened military capability** by ensuring maintenance is condition-based, resulting in shortened procedures & reduced depot times.
- **Accelerated military development** when domain experts/engineers can identify areas frequently maintained to improve structural & material designs.
- **Reduced costs and increased ROI** by identifying failure modalities in critical components. Proposed CBM+ compatible system reduces life cycle costs associated with unnecessary maintenance, particularly for inaccessible critical components.

## GRAPHIC



Comparison of Coupon Measured & Sensor Data Computed Pit Depths.



# Intelligent Maintenance Assessment



*AFLCMC... Providing the Warfighter's Edge*

## Problem

- Unexpected aircraft system failures limit mission capabilities and jeopardize safety.
- Unscheduled maintenance tasks requires increased costs and disrupts planned activities in repair facilities.
- Current Remaining Useful Life (RUL) / prediction methods are not realistic.
- Support engineers “fight fires” to recover time associated with unplanned tasks.
- Aircraft availability requirements leads to higher “spares” cost within operational environments.

## Status

- IMAS cluster delivered to Mercer Engineering Research Center for tool validation.
- 18 months of DFDR, MX, SHM, Faults Data associated with 10 C130J Aircraft training and operational environments have been correlated.
- Hard landing structural and Fuel Management system degradation correlations are undergoing validation by MERC analytics engineering team supporting WR USAF C130 SPO.
- IMAS has generated preliminary evidence that supports finding data driven propulsion system RUL and systemic root cause NFF co-associated with specific DFDR patterns.

## Technology

- Analatom Inc.’s Intelligent Maintenance Assessment System (IMAS) utilizes IBM Watson-Like “associative memory” tech stack to discover degradation patterns in CBM+ data (DFDR, SHM, MX, Faults).
- Actual aircraft degradation / failure data increases ability to generate data driven RUL and avoid costs associated with unplanned disruptions.
- These methods were utilized at an aviation OEM saving \$100 million in support engineering & inventory costs with 10x ROI.
- IMAS utilizes clustered NVIDIA GPUs and Livermore National Labs FastBit database technology proven at Petascale within DoE applications.

## Way Forward

- Validate IMAS scaling out to support engineering cost reductions for C-130 fleet.
- Transition capability to UH-60 platform.
- Incorporate testing in OEM quality control or MROU activities.

# Intelligent Management Assessment System (IMAS)

MXD

## Initiative Description:

- IMAS enables move from scheduled to predictive maintenance.
- While massive amounts of data are typically available from multiple sources, they are not easily digested or correlated. COTS ERP systems organize data via algorithms based on statistical analysis. Oftentimes critical outliers are dismissed in the process.
- IMAS is a scalable, cost effective system with an correlative indexing capability that correlates disparate data sources and identifies potential failures that assures preventative maintenance actions are taken before a catastrophic failure occurs.
- IMAS is based on Big Data Analytics technology similar to IBM Watson, developed for a major aerospace OEM achieved 10X ROI, \$100M inventory savings and has 5 minute query report capability.
- This project will prove that IMAS is a generalized capability applicable to all services.

## What's been accomplished:

- Phase I and II SBIR (Small Business Innovation Research) Program complete. \$1.5M STTP (SBIR Technology Transition Plan) awarded and underway with the Air Force.
- SBIR projects showed a potential \$15M annual savings (\$150M 10 years) for C130. Also demonstrated multiple data sources can be linked successfully in IMAS.

## Anticipated Deliverables:

- Demonstration/pilot of IMAS applied to the support services for UH60 helicopter .
- Validated BCA for NAVSEA applications.

## J4 Goal:

Deliver integrated joint logistics capabilities

## JLEnt Strat Dir:

Partnering: Engage industry to improve sustainability and reduce lifecycle costs

## Requirements:

- Increase reliability
- Deliver increased operational availability through CBM+
- Deliver joint interoperable mx capability

## Cost:

\$250K

## Resources:

- CTMA Coop. Agreement
- CBM+ AFLCMC
- NAVSEA, NSWC

Applicability

Risk

Value

Joint Logistics

Total