Predictive Maintenance in Defense and Smart Manufacturing
Outline

➢ Transforming the Maintenance Practice
➢ The Motivation
➢ System Health Management Perspective
➢ A Common Architecture Framework
➢ Path to Self-Adaptive Health Management
➢ Lessons Learned
➢ Challenges
Transforming the Maintenance Practice

The Goal - deliver higher asset availability, mission effectiveness and lower maintenance costs.

The Objective - change the ratio of the current maintenance mix over time.

DDTs should increase over time

DDT: Data Directed Task
Why Predictive Maintenance?

- Improve Safety!
- Reduce Cost!
- Improve fleet management!
- Improve product quality!
- Reduce Downtime!
- Improve Availability!
- Improve customer experience!
- Improve product yield!

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Autonomous Systems are here to stay!
System Health Management Perspective

The immune system protects the body against disease or other potentially damaging foreign bodies.

A self-adaptive health management system provides autonomous, self-adaptive control to extend vehicle operation in the presence of system degradation.

“Created System”

- System degrades with age or exposure to damaging environment.
- System’s inherent sensing mechanisms monitor system health.
- System’s self-healing is supplemented with changes in system operation & maintenance.

Inherent Self-protection mechanisms

“Engineered System”
System Health Management Principles

![Diagram of System Health Management Principles]

Proactive Alert Identifiers
System Architecture Framework

IVHM is the unified capability of a system of systems to assess current or future state of member system health and integrate that picture of system health within a framework of available resources and operational demand. (SAE ARP6803)

Integrated Vehicle Health Management (IVHM)

- Aviation
- Automotive
- Defense
“ACM can be defined as the unified capability of a manufacturing system (i.e., the asset) to assess its current and future state of health and integrate that knowledge of the system state of health with enterprise applications to meet production operations demand.”
System Operational Processes

DA: Data Acquisition  DM: Datta Manipulation  SD: State Detection  HA: Health Assessment
PA: Prognostic Assessment  AG: Advisory Generation  (Reference Model based on ISO 13374)
Path to Self-adaptive Health Management

We’re here!

SAE IVHM Capability Level

IVHM System Sophistication

MANUAL DIAGNOSIS & REPAIR PROCESS PERFORMED BY TECHNICIAN

DIAGNOSIS & REPAIR AUGMENTED BY PROGNOSIS & PREDICTIVE ANALYTICS

Limited On-Vehicle Warning Indicators

Enhanced Diagnostics Using Scan Tools

Telematics Providing Real-Time Data

Component Level Proactive Alerts

Integrated Vehicle Health Mgmt.

Self-Adaptive Health Mgmt.

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Defense Aviation & Ground Vehicles

Smart Manufacturing

Automotive
What we have learned to date...

➢ **CBM/Predictive Maintenance** requires a systematic maturity model of Capability Levels *(SAE JA6268)*...there is no silver bullet!

➢ **Use of Standards** (ARINC, OBD) has enabled IVHM in commercial aviation & automotive industries.

➢ **“Health-Ready Components”** and **Standards** are Key to unlocking the potential of IVHM in any domain.

➢ **System solutions** should be based on operational use cases; asset maintenance, fleet management, manufacturing operations planning, etc.

➢ **Infrastructure investments** without having a consistent collection, transformation, exchange and quality of asset data deliver limited value to stakeholders.

➢ **Consistent collection of the “right data”** and derivation of the right asset health indicators are essential to predictive analytics.
Challenges

Data Ownership:
- Equipment OEM dependence & data ownership issues.
- Maintenance and Logistics organizations limit access to their data.
- “Perceived value” and “classification” of raw asset data and maintenance information limit rapid dissemination across the enterprise.

Data Connectivity:
- Non-integrated data supply chain.
- At/off-platform test and maintenance information is still captured into paper records or within isolated databases.
- Maintenance and logistics information systems may limit the ability of users to extract relevant data in a form that can be communicated to other enterprise systems.

Data Quality:
- Inconsistent/non-continuous data collection
- Dissimilar preservation of data source context (Values, Meta Data)
- The data collected across operations and maintenance activities is in numerous non-standard formats.
Data Standards Needed

➢ Standards needed for data collection, transformation and exchange.

➢ Data Connectivity
➢ Data Ownership
➢ Data Quality
➢ Data Interoperability

Health-Ready Assets

Predictive Analytics
Thank you!

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