Unwrapping Inspection’s Digital Thread

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The Challenge

How can we get the most out of existing assets?

• Manufacturing improvements, new materials, new revolutionary designs all contribute to the growth and improvement of the Aviation industry

• But are there other methods, too? Has all of the improvement been “unlocked” in current designs and materials? Processes and people?

• No, which is why the Digital Thread can be used to make leaps in improvement and profitability without necessarily investing in new technologies
What is the Digital Thread?

Buzzword, or Disruptive Technology?

• **Digital Thread** seamlessly integrates information through the value chain – from initial capability planning and analysis, through design, manufacturing, testing, and on to final sustainment and disposal phases – meaning that specialists throughout the process can work on the item simultaneously to inform decisions through the life of a system or product.

Data gathered throughout the application life can be analyzed to improve design, manufacturing and operations processes – in near real-time.
What is the Digital Thread?

Planning
Design
Production
Services
Digital Thread Use Case

Where can I apply Digital Thread?

• A routine inspection of an engine reveals an anomaly on a single airfoil

• This feedback is uploaded to a central location where it is noted that there are two other similar occurrences on the same engine type

• Data from the three engines and aircraft is correlated for similarities in parts origin, maintenance records, operations, environment, etc.

• Is there a way to find a common cause? How quickly can it be remedied? Can this be used to prevent other occurrences?
# Consumer vs. Industrial Internet

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ford pickup</td>
<td>• Jet engine powerplant</td>
</tr>
<tr>
<td>• Double-cab</td>
<td>• Single-aisle variant</td>
</tr>
<tr>
<td>• Manual Transmission</td>
<td>• Stage 1 HPT blade replacement in last year</td>
</tr>
<tr>
<td>• Blue</td>
<td>• Greater than 5,000 hours</td>
</tr>
<tr>
<td>• Within 100 miles of my current zip code</td>
<td>• Inspection thread</td>
</tr>
</tbody>
</table>

(30) results in 5 minutes

Today: Manual process
Digital Thread Relies on DATA…

…and doing something with it

1. Gather/Save the Data
2. Structure Data
3. Aggregate Data – Cloud, Data Lake
4. Search, Analyze, Compare Data
5. Make predictive and reactive adjustments

“Get connected, Get insights, Get optimized”

Cloud solutions
What is Predix anyway?

As iOS is to phones/tablets, Predix is to the Industrial Internet…
Predix Architecture

Connect machines
Collect key industrial data from your machines and stream it to the Predix cloud.

Implement services
Leverage services and development tools, so you can focus on solving problems for customers.

Deliver and scale apps
Use the Predix cloud to deploy scalable services and end-to-end apps in secure environments.
How Can I Get Started With BSI?
InspectionWorks Insight - Organize

Insight provides tools to quickly organize your inspection data, no matter the source.

*Inspection applications built in,* allowing you to apply structure (metadata) to raw content.

*Organize by date by default* when there is no additional metadata.

*Menu Directed Inspection support* to interpret MDI based datasets.

*Supporting data as part of the application* allowing you to add conclusions, findings and...
Insight provides tools to quickly filter and find the data you're looking for through our web application.

**Filter** inspection data by “My Inspections/All Inspection,” by Application (LEAP) or by Date

**Filter by object type** such as flagged images, reports, images, videos

**Find & Search** using the metadata you’ve applied, use text based search to quickly find what you’re looking for (ESN, Technician Name, etc.)
InspectionWorks Insight – Report/Share

Quickly generate custom reports and share your completed inspections with others.

**Custom reporting** engine allowing you to generate reports based on application type or other attributes. Supports MS Word and Adobe pdf.

**Managed report templates** within the environment, meaning we’ll handle versioning and maintenance for you. Update once, everyone gets the latest version.

**Publish** data to share with others in your organization.

**Send email notifications** directly from the Insight environment.
Digital Thread Use Case - Conclusions

Compare the digital threads to find commonalities

• Possible conclusions:

  • **DESIGN** - All three engines airfoil sets were of a new design, which allowed for overdrilling detection to be masked by current detection methods

  • **PRODUCTION** – Airfoils were manufactured on second shift, where an optional shift-change calibration procedure was being overlooked

  • **POINT OF USE** – Pilot variation

  • **OTHER** – FOD from a sand storm in Dubai two weeks earlier
The Digital Thread Process

• Save your inspection data!
• Standardize data-gathering processes
• Tag and index the data in a common format
• Aggregate the data in the cloud
• Build apps
• Improve
• Repeat
Digital Thread Feedback Loops

- Design
- Production
- Point of Use
Predix Solutions

Where is Predix used?

• **Monitoring of industrial equipment** for availability and secured operations

• **Predictive analysis** to prevent unplanned downtime or equipment failures

• **Economic optimization** by efficiently operating industrial assets and fleets

• **Intelligent process automation**, such as in manufacturing or transportation

• **Sustainability solutions** for reducing environmental impact of operations
Services and Software

Use these key industrial services to build, test, and run your innovative Industrial Internet applications.

**EDGE SOFTWARE AND SERVICES**

**Connectivity**
- Easily apply this plug-and-play, secure, and reliable connectivity service.

**EdgeManager**
- Use the EdgeManager as a single point of entry for deploying and monitoring devices remotely.

**Machine**
- Create solutions that enable machine-to-cloud, machine-to-machine, and machine-to-human connectivity.

**DATA MANAGEMENT**

**Asset Data**
- Create and store machine asset models and instances.

**Event Hub**
- This industrial-grade messaging system (in beta) handles high-velocity event data, workload data, or other streaming data.

**Time Series**
- Quickly and efficiently manage, ingest, store, and analyze data.

**Blobstore**
- Use this binary large object storage (BL0S) to securely store large byte arrays and raw binary streams.

**Message Queue (AMQP)**
- Use this scalable, high-performance, multi-protocol tool to message between applications.

**Key-Value Store**
- Use this open-source key-value cache and store that can contain strings, hashes, lists, and sets.
Analytics

Predix provides analytics services as a framework for developing and embedding advanced analyses in business operations. This means you can better manage the execution of analytics through configuration, abstraction, and extensible modules.

ANOMALY DETECTION

- Trend Anomaly Detection
  Manage critical time series trend detection.

- High-Dimension Anomaly Detection
  Check multiple sensors for key time series anomaly detection.

- Low-Dimension Anomaly Detection
  Maintain machine health with this critical time series anomaly detection.

- Shift Anomaly Detection
  Enable key time series shift detection.

- Univariate Anomaly Detection
  Improve time series rates-of-change anomaly detection.

- Temporal Anomaly Detection
  Assure accurate and highly detailed time series anomaly detection.

- Kalman Anomaly Detection
  This service identifies statistical anomalies in noisy data.

RELIABILITY ENGINEERING

- Machine Survival Analyzer
  Find reliability or survival probability at a given time or length of time.
Analytics-Past, Present and Future

Why pursue a Predix data-driven model?

- **Descriptive analytics** - describe what’s happening

- **Prescriptive analytics** - what happened and how to remediate it

- **Predictive analytics** - use data to foresee what will happen and to act in advance to optimize outcomes even further

Data analysis unlocks additional performance hiding in existing assets

predix.io/resources