AI/ML Applications in aviation: GE Aviation’s experience

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Operating Aircraft is a Complex Endeavor

Complex Asset
and about 39000 commercial A/C in the market

3.9%
expected growth in the industry

Utilization
directly impacted by unplanned maintenance

$25Bn
unplanned maintenance cost at about 33% of total maintenance cost of $78Bn in 2018

Passenger
experience affected by unplanned maintenance events

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Every 2 seconds an aircraft with GE engine technology is taking off somewhere in the world.

2,200+
of these aircraft are in-flight, carrying between 50 and 500 passengers.

300,000+
people in the air right now depending on our engines.

*Includes joint venture engines built by CFM and EA.
CFM International is a 50/50 JV between GE and Safran Engines.
EA is a 50/50 JV between GE and PW.

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Adoption is the critical end point...not technology

Data
- Quantity
- Quality
- Accessibility

Insight
- New Knowledge
  - Actionable
  - Unambiguous

Analysis
- Benchmarking
  - Physics-Based
  - Machine Learning/AI

Action
- People
- Process
- Organization

Instead of managing this as an technology gap, manage it as a (digital) transformation opportunity
Adoption is the critical end point...not technology

Instead of managing this as an technology gap, manage it as a (digital) transformation opportunity

Based on Data
10,000,000,000,000,000,000,000,000

= 10 exabytes

= 10 million terabytes

= 10 billion gigabytes

... OT data generated by the global commercial airline fleet
Big data is here
Edge-to-Cloud ... platform-as-a-service

**EDGE** Connected assets. Edge appliances. Edge Analytics.

**CLOUD** Connect industrial assets with people through data and analytics.

**APPLICATIONS** Visibility and insights for better business outcomes.

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GET CONNECTED | GET INSIGHTS | GET OPTIMIZED

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Based on Data and Specific Analytics
What does “first” come to your mind when you hear the word “Artificial Intelligence”
More Than 100 Years of Aviation Expertise

175 Million flights analyzed

46,689 Years of flight data under management

25 years Digital Services
38,000 installed engines ... in a world of variation
The Digital Twin: A Personalized, Learning Digital Model

1. Business Outcome
2. Adaptable
3. Per Asset/System Model
4. Scalable
5. Continuously Learns

Digital Twins are Learning Physics Models Running at Scale
Digital Twin ... 21st Century Fleet Management - Engine

Customer outcomes ... reactive to proactive

Reduced maintenance burden = removals ↓ disruptions ↓ inspections ↓

CUMULATIVE DAMAGE ANALYTIC VS CYCLES

Harsh environment

Threshold

Analytic enables clear fleet segmentation

Expert-defined thresholds drive action plans

Nominal environment

Individual engines, multiple customers

Outcomes

Major International carrier ... better predictability

56% decrease in disruptions

15% decrease in overhauls

12 additional days of utilization

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Digital Twin ... 21st Century Fleet Management - Aircraft

*Customer outcomes ... reactive to proactive*

Aircraft corrosion prediction

Network Routing

Global Environmental Data (atmospheric sea salt concentration, for example)
Adoption is the critical end point...not technology

Instead of managing this as an technology gap, manage it as a (digital) transformation opportunity
Humble AI
Maximizing value in safety critical manner

Humble AI

Model

Data

Optimization under competence constraint

Self learning
Learn from others
Learn from simulation

Continuous learning

Infeasible

Robust baseline

Learning mode selection

Humble AI

Prediction
Outcome with uncertainty

Prescription
Control input or strategic action or feedback policy

Physical Asset

Tech Stack

MODEL COMPETENCE MONITORING

CONTINUOUS LEARNING

UNCERTAINTY QUANTIFICATION

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Outcomes ... productivity ‘inside’ GE Aviation

- **30% ↑** fidelity with engine digital twin
- **15% ↑** yield at GE’s MRO shop with Digital MRO (dMRO) solution
- **6 Weeks** advance component-level BOM prediction for engine shop visit
- **14% ↑** accuracy with engine digital twin
- **25% ↑** detection rate with engine digital twin

Significant productivity across GE Aviation
AI/ML invention to production journey

1| Analytics Exploration
- Type of problems
  a. When will my part fail
  b. Where is the “strain” in ops
  c. What is the expected cash flow
- Form a “right” team
- Define “catching” org./application
- Required fidelity for ACTION

2| Migrating analytics into Production
- Outcome decides type of production
  a. On-line
  b. Off-line
- Type of analytics decides platform
- Capable of identifying analytic “degradation” with time

3| Things to consider
- Data availability in production
- PoC and Production tech sync-up
- Right balance of the team:
  - Data scientists
  - Software engineers
  - Subject matter expert
  - Business owner
Thank you!