sparkcognition™

Predictive Maintenance For Military Aviation Assets

AN AIR WAR COLLEGE INNOVATION PROJECT

PROBLEM

Warfighters need streamlined maintenance to guarantee aircraft **full mission capable status** with minimum variability.

PROJECT

With limited sensor data, SparkCognition™ developed a predictive maintenance solution for **military aviation assets.**

RESULTS

Generated models predicted failures **months in advance with 70% accuracy**, enabling efficient planning and reducing variability.

Reducing failures of critical systems that impact full mission capable rates and mission readiness will dramatically increase safety and readiness. In the military, it is absolutely essential that aircraft be mission-ready at all times to ensure safety of pilots and successful operations. A warfighter needs predictability on the aircraft to minimize risk, avoid dangerous and expensive failures, and prevent unplanned downtime.

Maintenance practices currently rely on historical rules-based maintenance schedules or are reactive in response to unexpected failures of critical systems. This project sought a more efficient solution that would provide more accurate forewarning so that personnel could plan maintenance more effectively.

The Engagement

SparkCognition™ partnered with SOFWERX to develop an adaptive, artificial intelligence-powered solution to predictive maintenance. The main goal of this solution was to identify major equipment failures across a limited set of historical data provided by SOFWERX. SparkCognition and SOFWERX used aircraft maintenance data and manuals to predict failures of critical systems, with SOFWERX providing the data and validating generated models.

First, SparkCognition analyzed and prepared the provided maintenance data. After preparing data from 120,000 maintenance records, SparkCognition extracted about 9,000 unscheduled maintenance events. Using statistical analysis, SparkCognition determined the most common maintenance tasks. The mean time between failure (MTBF) was also calculated for all aircraft parts to isolate conditions that cause parts to fail faster.

This was further segmented by location to determine common trends and behaviors. Additionally, reliability curves were generated per part, which provided insights into normal wear of parts and uncommon events. *Figure 1* shows an example with two different parts in which the red curve has high probability of early life failure compared to the green curve which requires maintenance only after 15,000 flight hours.

SparkCognition then developed machine learning models to identify what systems will fail based on historical data and provide confidence of the likelihood of failure. Specifically, models used aircraft maintenance data to predict the likelihood of failure of critical systems within 10 flight hours. By creating a normal behavior model, abnormal system behavior is easily identified and can be used to predict failures.

Three models were created:

- *System-level models to alert a technician that the critical system is behaving abnormally and is expected to have a failure*
- *Subcomponent models to provide detail on which subcomponents are behaving the most abnormally*
- *Detailed support information to provide evidence of what the previous models were predicting*

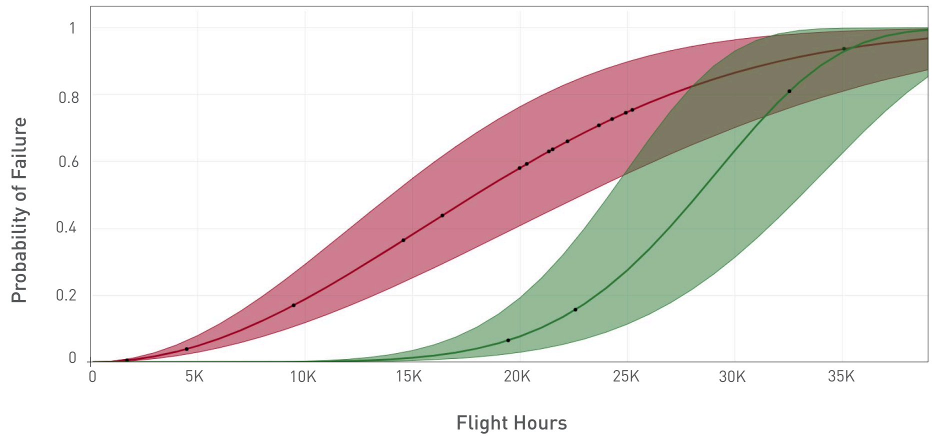

FIGURE 1
Reliability curve comparison for two sample parts

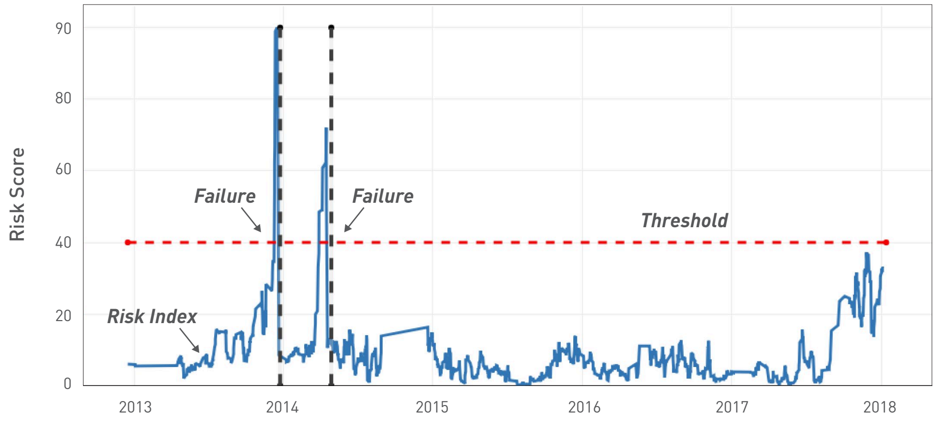

FIGURE 2
Critical system failure model prediction output

Figure 2 shows the output for the critical system failure detection model. In this example, both failures on the critical system are predicted correctly with no false positives.

SparkCognition also generated models to predict failures of a larger critical system (*Figure 3*). As was the case with the first critical system that was modeled, maintenance data for the larger critical system was sparse—data sampling was on average one data point per flight with sporadic sampling across 2-3 years. The process of moving from data ingestion and preparation to machine learning model generation and testing took a total of 12 weeks.

The Results

Models generated by SparkCognition predicted failures in critical systems months in advance. SparkCognition was able to aggregate data from dissimilar sources, prepare the data, and draw initial insights from statistical analysis.

Specifically, in a blind test, SparkCognition models accurately predicted 6 out of 10 maintenance events and 6 out of 7 "no problem" events. This is effectively predicting maintenance events with 70% accuracy, even with extremely sparse data.

These capabilities represent a step-change in aircraft safety, greatly reducing operational risk. The models also reduce costs by eliminating variability of operations, helping with scheduling of maintenance professionals, improving aircraft availability and continuous operations. In addition, they also provide a scalable, sustainable solution, as new data can be added to the generated machine learning models to update outputs, tracking, and predictions.

About SparkCognition™

SparkCognition builds leading artificial intelligence systems to advance the most important interests of society. We help customers analyze complex data, empower decision making, and transform human and industrial productivity with award-winning machine learning technology and expert teams focused on defense, IIoT, and finance. For more information, visit www.sparkcognition.com

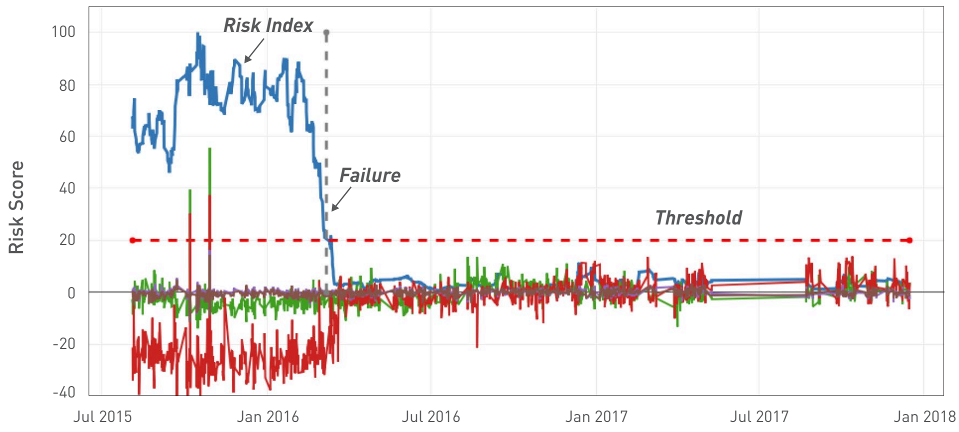

FIGURE 3
Large critical system model prediction output