

IBM Cognitive Equipment Advisor: Predictive maintenance for the military

From comic books to AI



Contents

- 2 Military maintenance's colorful past
- 2 The future of maintenance: Predictive and prescriptive
- 3 IBM Cognitive Equipment Advisor
- 4 Use cases
- 4 For more information

If your equipment breaks down during or before a mission, you know you've already lost the battle. What if you knew which part was going to fail and you were able to fix it *before* it broke down. Indeed, you need more than just deep mechanical knowledge to predict and repair breakdowns. No, for this kind of insight, to remain in a constant state of readiness, you need a boost from AI.

Readiness. We talk about it constantly in defense and national security. It's priority number one: making sure the US military is ready to perform required missions everywhere, all the time. This ability to remain constantly 'ready' includes the availability, uptime, and performance of military equipment—everything from propulsion engines and tanks to heating, ventilation and air conditioning (HVAC) systems and office lighting. Readily available equipment saves time, money and lives.

Cognitive technologies that help predict and prevent equipment failures—and prescribe remedies for maintenance technicians—can save money, time and lives. It's been a journey over the years getting to the cognitive era for maintenance; it started with an Army issued comic book.

Military maintenance's colorful past

Some of us may remember the colorful and even a little off-beat *Preventive Maintenance Monthly Magazine*, PS Magazine for short. Published by the Army Materiel Command's Logistics Support Activity (LOGSA), PS began publishing in 1951, using cartoon characters and graphics to make pages of mechanical instructions and equipment repair processes interesting, even funny. PS Magazine is still in production, although they moved to a digital version a few years ago. The idea behind PS is the same goal today's military must advance: keeping maintainers—and the equipment they service—up-to-date.

The future of maintenance: Predictive and prescriptive

Like the move to make PS digital, maintenance has also entered its next phase, and it's much more efficient than flipping the pages of an illustrated magazine to find a fix. Simply put, predictive maintenance applies machine learning, natural language processing and other facets of AI to avoid unplanned downtime. These systems can ingest information from maintenance manuals, images and diagrams, even handwritten notes to find the right fix or to learn a pattern that will cause the eventual breakdown of a piece of equipment. All that knowledge is condensed and applied within minutes or even seconds.

The elements and capabilities of a predictive maintenance solution include the following:



Connect: Gather data from equipment at any location around the world. Achieve real-time visibility from equipment sensors. Gain real-time insight and scoring.



Predict: Preempt issues before they arise with accurate predictions and early warnings. Discover non-obvious patterns and diagnose issues. Know what parts to order and when and where they will be needed. Quickly scale across an entire asset base.



Repair: Lower the cost of disruption and improve performance with step-by-step repair guidance. Provide human assistance and coordinate repairs. Target insights directly to technicians as they execute repairs.



Optimize: Apply reasoning and learning systems via machine learning to continuously optimize the use of systems, equipment, and people.

A predictive maintenance system should:

- Improve overall availability of weapons systems
- Improve asset availability
- Reduce unscheduled maintenance and component failure
- Improve first-time fix and troubleshooting
- Increase technician effectiveness and efficiency

“We set out to see whether we could take the data the Army had, fuse it with additional data sources and uncover some insight to help them to understand if a piece of equipment will be available in a certain timeframe.”

—Travis Edmondson, IBM Solutions Architect.

IBM Cognitive Equipment Advisor

You might have heard about a pilot program with the US Army. IBM Watson® was used to do exactly what we’re talking about here, to predict failures before they happen. The project—a solution that we’ve come to call Cognitive Equipment Advisor—boosted fleet readiness by tracking maintenance of more than 350 Army vehicles. The Watson™ solution’s primary task was to consume and correlate vast amounts of data, including technical manuals, technical maintenance work history, and sensory readings.

- Ingested 15 years of maintenance history and more than five billion sensor readings to generate predictive models, health status, and forecasts for 335 brigade vehicles. Visualizes 30-day health by fleet, variant and bumper number, and recommends repairs, parts, skills, TOs, etc ranked by probability.
- Machine learning models analyzed top drivers of adverse events. A dashboard lets users view vehicle and component health and other actionable insights. Then the system prescribes actions to mitigate risk and downtime.

Put to the test, Watson’s cognitive capabilities predicted and diagnosed equipment component failures, and then prescribed maintenance actions for technicians. Commanders could view the status of a unit so they could make better-informed decisions. They were alerted up to 60 days before a vehicle would break down. Additionally, Watson helped technicians and logisticians see which parts to order and what to keep in stock.

“Imagine the ability of a soldier or end user in the Department of Defense to be able to take their phone and just hold it out and then look at it and say, ‘Oh, OK, I need to change the alternator,’” Edmondson says.

Based on that predictive failure, a soldier could then comb through reams of unstructured data to understand what he or she is going to do about this prediction. Do they need to get a whole new vehicle? What maintenance procedure or what troubleshooting steps are needed? What do they need to do to resolve this?

The Army is not the only branch that’s applied Cognitive Equipment Advisor to its vehicles. Read on for more examples.

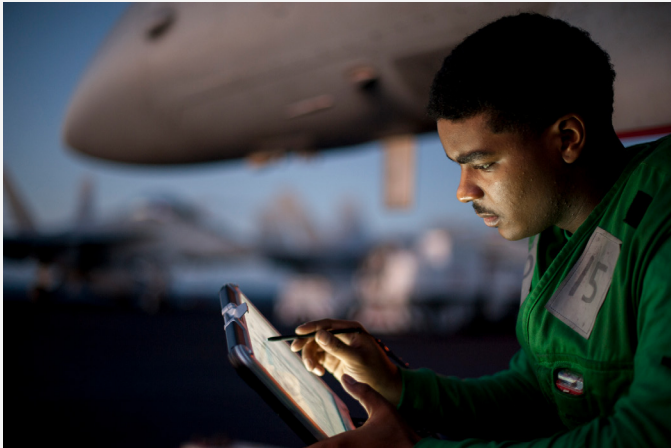
“Predictive maintenance allows us to get ahead of equipment failures. We’re talking about an effort that saves money in the billions annually. That’s the potential here. And not only that: when we can swap vehicles out, or we can swap a component out for repair we can significantly increase the probability of success. Now we’re talking about reducing risk to soldiers. We’re talking about saving soldiers’ lives.”

—Retired Col. John Kuenzli

Use cases

Propulsion Machine Learning

In this project, a DoD client was integrating Cognitive Equipment Advisor capabilities to enable reliability-centered analyses to identify required maintenance actions, which would save money and time. The client needed a way to access insights on propulsion engines from thousands of data files. A human analyst would look through data (See image below) and pull out engine serial number, date, major failure, and other information. Then the analyst would plot out the information and figure out the causes of failure, then decide when engines need to be pulled off and maintained. The reliability models were thus created from a year's worth of engine experts manually poring through records.



IBM worked with the client and taught the Cognitive Equipment Advisor how to pull out the key information, even how to detect the natural language to clarify the codes. The system was able to predict engine failures by up to 90 percent of the time, reducing the time needed from 12 months to weeks.

Spectrum Efficient National Surveillance Radar (SENSR):

This pilot program is a cross-agency program to replace more than 600 radar systems and create more efficient surveillance without compromising services. Edge computing analyzes data at the sensor to identify anomalies and potential security risks in real time. Stream processing engines analyze incoming data points and in-flight transactions for routing and immediate assessments.

For more information

Take our Defense AI assessment, or download our Defense AI toolkit.

Come visit the University of South Carolina Watson IoT Lab's Predictive Maintenance division. Visit IBM demonstration center where clients—and potential clients—can see predictive maintenance in action.

Schedule a visit.

If you'd like to learn more about AI in the military and if your agency is AI-ready, take the Defense AI assessment. You can also learn how the marines are using AI for force management.

Read more(link).

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