NATIONAL CENTER FOR MANUFACTURING SCIENCES

Predictive Maintenance Technology: Portable Devices Optimize Asset Availability, Reduce Costs

NCMS has long been at the forefront of advancing predictive maintenance by leading many technology development initiatives that have brought together experts from industry, academia, and government. This Technology Brief series on predictive maintenance covers NCMS initiatives that have advanced predictive maintenance in several key areas: (1) telematics, (2) AI and ML, (3) portable maintenance devices, and (4) vehicles, including electric and autonomous.

Introduction

In the constantly advancing field of predictive maintenance technology, portable maintenance devices are an important tool, providing technicians with immediate access to data, enabling on-site analysis, and improving the efficiency of inspections and repairs. NCMS has led multiple collaborations to develop and demonstrate portable maintenance devices. This Technology Brief—the third of a four-part series—covers how two portable maintenance devices developed in NCMS initiatives advanced predictive maintenance. The first, a portable fluid analysis device, the Portable Fluid Analyzer Plus (PFA+), provides comprehensive laboratory results of oil and other fluids on-site, in real time. The PFA+ is an extremely valuable tool in many industries such as commercial fleets, mining, and municipalities. The second is a security-enhanced, portable maintenance support device (SE MSD), a ruggedized laptop that incorporates data pulled from vehicle sensors and embedded diagnostics, which are essential for predictive maintenance. The resulting system enables technicians to securely oversee predictive maintenance processes while in the field. Improvements made to the SE MSD during the NCMS initiative established a framework for enhancing the cybersecurity of the predictive maintenance technology used in commercial maintenance support devices.

Portable Fluid Analysis Device

A long-standing commercial problem across the globe is the inaccessibility of fluid analysis, for motorized assets, when needed at the point of inspection. Traditionally, fluid analysis was dominated by a laboratory-based process that required maintenance professionals to send fluid samples in containers to a remote laboratory for analysis. Results could take weeks or even months. NCMS initiatives played a key role in enabling mobile assets, including ships, to gain access to comprehensive fluid analysis without the delay times and potential errors associated with laboratory-based fluid analysis.

This project—a collaboration between NCMS, the US Navy, the US Marine Corps, and industry partner AMETEK Spectro Scientific—improved the capabilities of a valuable predictive maintenance technology: the PFA+, a battery-operated, portable device that measures fuels, oils, and hydraulics at the push of a button. Samples can be collected from machines—including gas-powered turbines, generators, diesel engines, gearboxes, pumps, and hydraulic

systems—and immediately tested on site. Consisting of a single, central interface, the system performs fluid inspection, at the point of use, for nearly any fluid of interest, with results available in 15 minutes.

The PFA+ displays the status of fuels, lubricants, and hydraulics used in assets and includes information on contamination, density, viscosity, and oil key properties such as cetane number, biodiesel content, base number, water levels, and more. Along with supplying maintenance professionals with critical machinery and fluid health information, the PFA+ issues maintenance guidance including diagnostic messages and recommendations for next machinery actions. In this NCMS predictive maintenance technology initiative, the team successfully proved out the devices in the laboratory and in the field. Additionally, the team improved the user interface of the software and created a desktop application that allows for databases to be reviewed and updated as necessary.

The PFA+ is a hands-free, simple platform for a wide range of industries where oil and fluid inspection are important, such as commercial fleets, mining, and municipalities. Research on portable fluid analyzers such as the PFA+ has identified significant benefits of these devices. The PFA+ provides a quick, inexpensive method to detect contaminants that could destroy asset components. By using the PFA+, maintenance professionals gain immediate insight into the condition of component parts, decreasing the likelihood of costly breakdowns, extending the service life of lubricants used in assets, optimizing labor resources, and minimizing disposal costs and environmental impact.

The predictive maintenance technology developed and demonstrated in this NCMS initiative is currently being used in a wide range of industries including manufacturing, defense, aviation, transportation, oil and gas, and heavy machinery. For example, the City of Boston uses the PFA+ to support their vehicle fleet of 1,100. This enables mechanics to take corrective action almost immediately, improving garage throughput and minimizing vehicle downtime. Additionally, a Northeast metal processing plant uses the PFA+ and its accompanying software for on-site oil analysis to reduce unplanned downtime across 1,400 assets.

Security Enhanced Maintenance Support Device

Another NCMS predictive maintenance technology initiative designed a second portable predictive maintenance device: a ruggedized laptop that provides maintenance professionals with connectivity to vehicle health sensors, diagnostic aids, and predictive maintenance capabilities. The Security Enhanced Maintenance Support Device (SE MSD) was designed by a team of experts from the US Army, Detroit Defense, General Dynamics Land Systems, and Penn State University. Although the SE MSD was designed for military use, its cybersecurity software and other predictive maintenance capabilities can be transitioned to commercial maintenance devices.

Cybersecurity systems offer protection for in-house predictive maintenance systems that utilize a maintenance facility's computers to gather and analyze vehicle sensor data. However, this set-up is rarely portable. While mobile maintenance support devices can and often do have cybersecurity, the level of protection varies widely depending on the device, manufacturer, and industry. Although modern commercial maintenance support devices often have built-in cybersecurity, many systems use older technology that is more vulnerable to attack. This NCMS predictive maintenance technology initiative incorporated the latest cybersecurity protections into the SE MSD, following the DOD's rigorous risk management framework.

The initiative also enhanced the SE MSD's predictive maintenance capabilities. Due to the work done in this initiative, the SE MSD contains several capabilities that are not present in all commercial predictive maintenance support devices: an onboard data repository, a vehicle health monitoring system (VHMS), and a digital logbook of maintenance tasks and work orders.

The SE MSD continuously collects information from electronic systems and sensors, then stores this information in an onboard data repository. Data is transmitted for analysis through prognostic algorithms that can be incorporated

either into the asset's diagnostic system or deployed on external equipment to give advance warning of failure. The SE MSD's provision of information—including usage, health, status, and configuration data—enables off-vehicle analysis that optimizes maintenance work.

The SE MSD also contains another valuable predictive maintenance technology: a vehicle health monitoring system (VHM) that connects to the Combat Support Automated Information System Interface (CAISI), a US Army wireless networking system that provides secure, encrypted data communications in tactical, deployed environments. Commercial maintenance support devices that serve industries with assets requiring a high level of security, and industries with assets that operate in a geographically distributed network, would benefit from the capabilities developed in this NCMS initiative.

An additional capability of the SE MSD is a digital logbook, which includes maintenance management features that log maintenance actions and manage work orders. This digital logbook capability can be leveraged in commercial systems for secure, paperless management of maintenance activities to reduce costs and improve efficiencies. By providing a centralized hub, digital logbooks enable real-time tracking, seamless team collaboration, and data-driven decision making.

Commercial maintenance support devices can integrate the capabilities of the SE MSD. With this predictive maintenance technology, maintenance managers and industry suppliers will gain access to an at-vehicle/at-platform maintenance device that collects, stores, and securely transfers vehicle maintenance information. Such capabilities display real-time diagnostics that ensure maintenance professionals complete repairs before failure occurs.

Benefits of Portable Devices for Predictive Maintenance

Portable maintenance devices are an important tool in the field of predictive maintenance technology. By enabling real-time data collection and fluid inspection at the site of vehicle, asset, or equipment operation, these devices allow maintenance professionals to quickly detect anomalies, leading to more timely maintenance interventions, reduced downtime, lower costs, and extended asset life.

The use of the PFA+ has already been extremely beneficial for the Navy and the Marine Corps, and the commercial equivalent is currently serving a wide range of industries including power generation, commercial aviation, mobile service, heavy equipment, marine vessels, and upstream oil and gas production. For organizations seeking to improve the cybersecurity and predictive maintenance capabilities of their maintenance support devices, the capabilities of the SE MSD can be integrated into commercial maintenance devices. These capabilities are especially useful in the commercial automotive and transportation industries to provide rapid, on-platform vehicle diagnostics.

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About NCMS

The National Center for Manufacturing Sciences (NCMS) is a cross-industry technology development consortium, dedicated to improving the competitiveness and strength of the US industrial base. As a member-based organization, it leverages its network of industry, government, and academic partners to develop, demonstrate, and transition innovative technologies efficiently, with less risk and lower cost.

NCMS enables world-class member companies to work effectively with other members and partners on new opportunities—bringing together highly capable companies with providers and end users who need their innovations. NCMS members and partners benefit from an accelerated progression of idea creation through execution.