Condition Based Maintenance For Army Aviation

By Maj. Gen. James H. Pillsbury

Army Aviation is undergoing an unprecedented transformation to improve the maintenance, sustainment and availability of current and future aviation systems. Yesterday's Army sought to keep aviation systems operational through labor-intensive scheduled and reactive unscheduled maintenance programs. Tomorrow's Army will achieve much better system availability and readiness through implementation of the Army's condition based maintenance plus (CBM+) plan, which is a predictive, proactive

U.S. Army, Suzanne M. Day

U.S. Army, Sgt. Tom Pullin

Soldiers of the 1st Infantry Division (Mechanized) perform maintenance on an AH-64 Apache attack helicopter at Forward Operating Base Speicher in Iraq.

and reliability-centered maintenance program.

CBM+ is the transformation of maintenance practices from the Industrial Age to the Information Age through the use of existing and emerging technologies to analyze near real-time and historical aviation weapons systems data to provide a predictive maintenance capability. The Army's vision is to achieve CBM+ by the end of fiscal year 2015. The transition to CBM+ is contingent on incorporating enhanced technology on existing aviation systems and embedding those capabilities into future and developmental aviation systems.

At the tactical level, CBM+ will be new tools, test equipment and embedded on-board diagnostics. These tools will take advantage of current and emerging commercial and nano diagnostic technologies that can translate aircraft condition data (temperature, vibration, cycle time and more)—in combination with environmental factors (desert, arctic, high humidity, usage profiles and more)—into proactive maintenance actions that will be performed only when there is evidence of actual need. CBM+ will enable soldiers and leaders to plan and perform Aviation maintenance at the right place and at the right time, and it will enable logisticians to predict equipment requirements more accurately so that the parts are there when soldiers need them.

To the soldier, CBM+ will be the ability to convert aircraft condition data into proactive maintenance action. Scheduled inspections will be supplemented or replaced because we will have analytical data that will describe the condition of the aircraft and its components.

At the strategic level, CBM+ will be a set of maintenance actions based on a near real-time assessment of equipment status based on feedback from diagnostic sensors and equipment. Data collected from embedded sensors, such as health and usage monitoring systems (HUMS), will be translated over time into predictive trends or metrics which are capable of anticipating when component failures will occur based on the actual operating environment. The predictive approach will allow for the proactive acquisition and delivery of requisite spare parts to perform maintenance before component failure. It will also allow for adjustment of scheduled maintenance tasks based on actual equipment condition.

To the commander, CBM+ will be the ability to meet mission requirements and increase weapons system availability. CBM+ will provide the commander with information to enable better maintenance decision making. CBM+ will bring the commander situational awareness down to the weapon system level.

The Army envisions that CBM+ will revolve around the construction of a data-centric, platform-operating environment within the single Army logistics enterprise. Aviation maintainers from the flight line to the logisticians in Aviation and Missile Command's Integrated Materiel Management Center to the depot at Corpus Christi, Texas, will have visibility of component failures and component availability across the common logistics operating environment and via the end-to-end logistics data warehouse. Using algorithms jointly developed by the Aviation Engineering Directorate (AED), industry leaders, academia and the original equipment manufacturers, CBM+ information systems will monitor critical maintenance data elements and determine component and system health. The result will be better data elements that help Army Aviation evaluate

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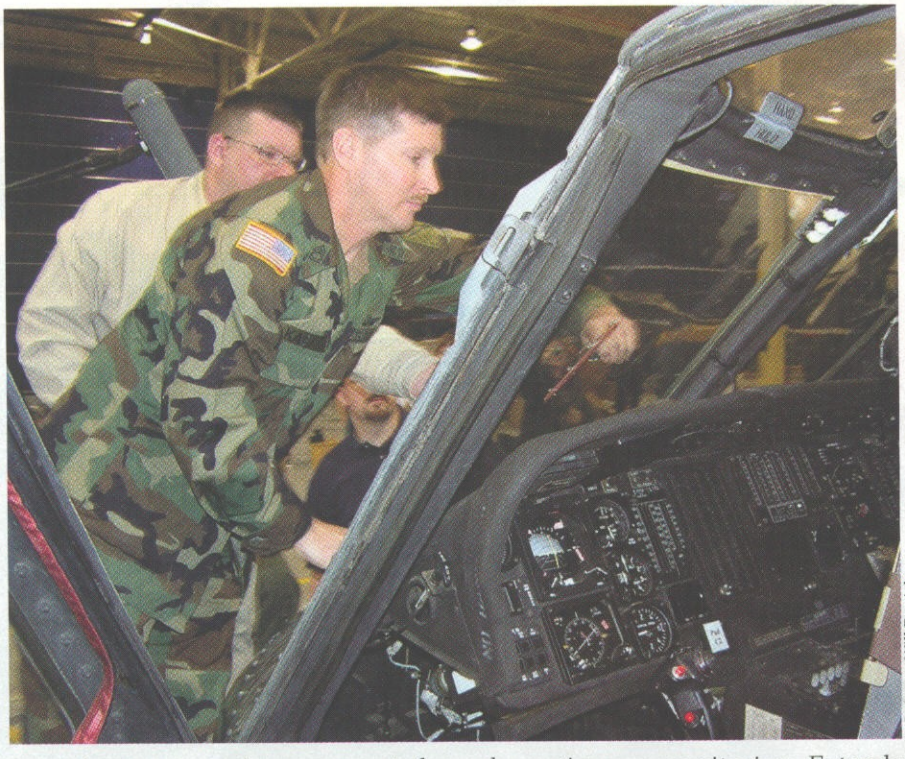

U.S. Army, Will Daniel

SFC Paul Kagi of the 2nd Battalion, 224th Aviation Regiment, Virginia Army National Guard, applies a DSCR-developed laminate to the windshield of a Black Hawk helicopter.

the way it designs, builds and supports future systems with new and dynamic maintenance programs.

Working with the Program Executive Office, Aviation, and its respective project managers for Apache, Black Hawk, armed reconnaissance helicopter and Chinook, the Army began installing a limited number of aircraft with HUMS technologies to conduct digital source collection demonstrations. The project manager for Test Measurement and Diagnostic Equipment is conducting the demonstrations using two HUMS systems. One is the vibration management enhancement program (VMEP), which monitors rotor track and balance, as well as the drive train. It has been installed on 87 Apaches, Black Hawks and Chinooks, and is planned to be installed on another 52 aircraft. VMEP will eventually be replaced by the modern signal processing unit (MSPU), which is a more sophisticated system that monitors VMEP elements, as well as engine diagnostics, structural usage and regime recognition. The second HUMS system being used to collect data is the integrated mechanical diagnostics-health and usage monitoring system (IMD-HUMS). Like the MSPU, IMD-HUMS is a sophisticated diagnostic system that has already been installed on 30 Black Hawks now in Iraq.

The demonstrations will continue into fiscal year 2008, but we are already beginning to see substantial results in the reduction of maintenance man-hours (MMH) for the affected components and in improved systems availability on those aircraft having HUMS. In each demonstration to date, data collected have allowed the AED to issue air worthiness releases (AWR) resulting in reduced inspections and maintenance man-hours. The AWR return on investment to date includes:

- AH-64 A/D main rotor swashplate. Avoids an inspection event associated with rotor track and balance and a maintenance test flight which would occur after the part accrues 1,750 flight hours. The MMH saved per aircraft per inspection is 7.4 hours. Downtime saved per aircraft is 5.9 hours.
- AH-64A/D auxillary power unit clutch. Eliminates vibration checks at installation and phase. Extends APU mount inspection from 250 hours to 500 hours. MMH saved per aircraft per inspection is 28 hours. Downtime saved per aircraft is 9 hours.
- AH-64A/D forward hanger bearing. Provides safety improvement through continuous monitoring. Extends time between overhaul (TBO) from 2,500 hours to 2,750 hours.
- AH-64A/D aft hanger bearing. Provides safety improvement through continuous monitoring. Extends TBO from 2,500 hours to 2,750 hours.
- UH-60A/L oil cooler axial fan bearing. Replaces a 120-hour inspection with permanent application of condition based maintenance monitoring. Extends time between overhaul from 2,500 hours to 3,000 hours. MMH saved per aircraft per inspection is .75 hours. Downtime saved per aircraft is .6 hours.
- UH-60A/L engine output drive shaft. Replaces a 120-hour inspection requirement with permanent application of condition based maintenance monitoring. MMH saved per aircraft per inspection is 3.3 hours. Downtime saved per aircraft is 1.8 hours.

Once fully implemented, CBM+ will enable Army Aviation maintainers to plan, sequence and perform needed supply and maintenance actions with minimal impact on operations. Because CBM+ will be supported by automated maintenance information systems which seamlessly integrate requirements and performance data, we predict that CBM+ will lead to more efficient maintenance practices and procedures, improved operational availability and reduced costs associated with a smaller logistics footprint. These changes will require dedicated resources and commitment, but the transition to CBM+ is a critical task in achieving the full transformation of Army Aviation.

Adopting the tenants of the Army's CBM+ Plan will enable us to meet the Chief of Staff of the Army's intent of reducing the Aviation logistics tail, and will ensure that Aviation commanders have the requisite combat power available when needed. ★