

On Target and On Time

Global logistics awareness through conditions based maintenance +

by Maj Michael Whitaker & Capt Elle Ekman

To successfully support the *Commandant's Planning Guidance and Sustaining the Force*, maintenance, supply, and operational data should be leveraged to inform decision making, support the warfighter, and influence enterprise sustainment. Conditions based maintenance plus (CBM+) is a proven process that can be used to accomplish all these tasks. CBM+ is

the application and integration of appropriate processes, technologies, and knowledge-based capabilities to achieve target availability, reliability, and operation and support costs of Marine Corps' systems and components across their lifecycle.¹

How often do Marines wait on deployment? A convoy carrying ammunition, chow, and fuel halts because of an improvised explosive device or because a vehicle breaks down, and Marines wait hours for information, recovery, repairs, or mission critical supplies. Operations get delayed, and while they may get back on target, they will never get back on time. This wait for information, repairs, or supplies gets longer and becomes riskier as operating environments become more contested and distributed. As Gen David H. Berger pointed out in 2018 while still the Deputy Commandant for Combat Development and Integration, logistics becomes the pacing function for the Fleet Marine Force because every broken truck or failed resupply decreases combat power, impedes agility, and minimizes lethality.

In an alternate reality, instead of waiting, a commander has visibility

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Every downed vehicle impacts the effectiveness of combat forces. (Photo by LCpl Carla O.)

across their vehicle fleet and can see issues as they occur, the parts and knowledge to conduct repairs are already positioned, and a new convoy is readied with minimal disruption. The commander understands the status of their forces, can assess combat power, and makes realtime decisions; commanders can save manpower, maximize lethality, and move on to the next

problem. This alternate reality includes garrison maintenance efforts that ensure the success of artillery shoots or engineers conducting vertical construction. It would enable planning efforts and predictability in sustainment costs on a monthly and yearly basis.

The alternate reality of increased global logistics awareness and improved sustainment is possible with present

technology and historically proven processes. Hardware, software, data, and algorithms combine to enable a concept known as CBM+. CBM+ is a system that changes how Marines act in response to equipment data that is collected, transmitted, stored, and analyzed. This data comes from original manufacturer manuals, historic maintenance and supply data, and sensors feeding realtime information. Instead of focusing on arbitrary time-driven maintenance actions, CBM+ “ensures maintenance is performed when needed rather than on a strict schedule.”² CBM+ allows Marines to predict when something will fail and, because they know about the failure in advance, arrange to have parts on hand to quickly fix equipment. Maintenance becomes less reactive, and Marines will instead be able to effectively plan how to support the force.

Currently, commercial entities and other DOD organizations are using CBM+ to predict equipment failures, plan operations, and complete their missions more efficiently. Caterpillar (CAT), the world’s largest construction equipment manufacturer, is a leader in the practice of conditions monitoring, which it integrates into everything from offshore oil rigs to heavy equipment. Conditions monitoring helps CAT to “make informed decisions based on real-world data” in order to control costs, improve performance, reduce risks, and manage people.³ In one case, CAT used condition monitoring tools, oil analysis, and inspections to track diesel generators on oil rigs, ultimately extending the life of the generator, ensuring the success of the oil rig, and saving \$60,000 per generator.⁴ In other cases, CAT uses their fleet monitoring systems to ensure that operators are trained to operate equipment correctly; owners proactively rebuild engines to prevent unscheduled failures; and managers are constantly improving their operating procedures.⁵ CBM+ is not, however, just for companies like CAT that monitor huge fleets of equipment; smaller companies have also taken advantage of CBM+. FIXD is a company whose mobile application and sensor leverage data feeds from personal vehicles.⁶ Instead of going to a mechanic, drivers have a personal and

mobile vehicle diagnostic tool on their phone.

Other Services have also used CBM+ to improve fleet readiness. In 2018, the Air Force included the B-1 bomber in its CBM+ program that already included the C-5.⁷ The Army also has efforts dedicated to their CBM+ program. They have spent over ten years collecting and analyzing CBM data to inform maintenance, supply, and operator activities. The Marine Corps has much to gain from adopting CBM+ for its own logistical needs. For example, a lance corporal working in the supply management unit will no longer have to guess what parts they should include in the Class IX—supply block for a deployment. Because CBM+ focuses on predicting the

In addition to saving time, the corporal is able to minimize future catastrophic failures.

From an enterprise perspective, equipment data can be transmitted, consolidated, and analyzed to improve fleet sustainment based on accurate cost projections. CBM+ will also save sustainment costs over the lifetime of the equipment. For example, a study completed in 2015 showed that if a predictive sensor, the Expeditionary Fluid Analysis System, was installed across the medium and heavy motor transport fleet, the Marine Corps would save approximately \$6.5 million and approximately 60,000 labor hours over the course of two years.⁸ This particular sensor focuses on monitoring the fluids

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likelihood of a parts failure, the lance corporal will only need to include the parts that are most likely to fail. This minimizes the operational footprint and maximizes the ability to repair equipment in a contested environment with limited reach-back support or transportation options. While this would change how Class IX blocks are built on a small scale for individual units, CBM+ would also enable precise planning on a large scale in support of prepositioning for expeditionary advanced base operations. Minimizing footprints and maximizing equipment availability is necessary for expeditionary advanced base operations, and CBM+ would become a critical enabler.

A corporal responsible for fixing equipment is told to prepare to conduct maintenance on an MTRV that has seen recent fluctuations in its sensor readings. The sensor data allows the corporal to begin troubleshooting the most likely causes and develop a plan for preventive maintenance when the MTRV finally gets back to the shop.

that are closely related to vehicle health and whose changes are often a precursor to equipment failure.

CBM+ has become a newfound priority for Marine Corps leadership and the DOD. Gen Berger stated in his *Commandant’s Planning Guidance* that investments should focus on “data science, machine learning, and artificial intelligence” and “challenges we are confronting in ... predictive maintenance, logistics, intelligence, and training”; that “we have significant data ripe for the application of these tool sets”; and that “it is not acceptable to waste resources because we lack the investments in infrastructure, processes, and personnel.”⁹ The Commandant’s guidance makes clear that the use of data to analyze and influence decision making is paramount. CBM+ is a clear cut example that uses maintenance, supply, and operational data to predict and then influence maintenance actions and concepts of support.

Before the *Commandant’s Planning Guidance* was released, Gen Berger,

while still the Deputy Commandant of Combat Development and Integration, published *Sustaining the Force, a functional concept for Future Installations and Logistics Development*. This document “describes the steps the Marine Corps will take to design, develop, and field a logistics enterprise for the 21st century in support of the future fight as defined in the National Defense Strategy.”¹⁰ One of the document’s lines of effort is enhancing “Global Logistics Awareness.” This focuses the Marine Corps’ efforts to successfully “identify warfighter requirements,” assess “where and when” those requirements are needed, and then adapt to changes in plans and requirements.¹¹ CBM+ is the process that will allow the Marine Corps to take advantage of the sensor-based, data-driven, and networked environment to ensure Global Logistics Awareness. Using sensors on equipment and historic data, Marines can plan for and adapt to changing operational requirements.

Even the former Secretary of Defense, James N. Mattis, turned his focus to readiness when he mandated in 2018 that fighter aircraft readiness needed to be raised to 80 percent.¹² This is what prompted the Air Force to pull data feeds from the Joint Strike Fighter so that they could predict when parts are likely to fail or when inspections are due. Recently, even Congress questioned what the services are doing in regard to predictive maintenance.¹³

This holistic focus on readiness, maintenance, and data analysis has found a foothold within the Marine Corps logistics enterprise. LtGen Charles G. Chiarotti, the Deputy Commandant for Installations and Logistics (DC I&L), reenergized predictive maintenance and CBM+ by forming a cell to focus Marine Corps CBM+ efforts. He recently reiterated his priorities by speaking at the National Defense Industrial Association’s Expeditionary Warfare Conference on 23 October 2019, where he talked about requirements for “precise sustainment.”¹⁴ He said that Marines need “the ability to look at a platform and understand its health; to make decisions far removed from the battlefield and deliver for

sustainment is critical for us.”¹⁵ While prioritized by DC I&L, the effort to make CBM+ maintenance processes a reality involves stakeholders from across the Corps (to include Marine Corps Systems Command and Combat Development and Integration) and is supported by entities like the Penn State Applied Research Lab and joint military agencies. Currently, CBM+ efforts focus on technology, processes, manpower, and policy. A CBM+ Marine Corps order was recently approved, and a Marine Corps CBM+ Roadmap will soon follow. Existing efforts include pilots that focus on weapons systems health through round-counting sensors, improving maintenance processes for legacy equipment, and wireless data transmission.

Operationalizing CBM+ in the Marine Corps will require changes to technology infrastructure, analytic capabilities, policy, and culture. Many of the roadblocks to CBM+, however, are roadblocks that exist systemically throughout the Marine Corps; many of these challenges revolve around the collection of data, data storage and cleaning, access to required systems and tools, having Marines who can perform detailed analysis, cyber security, and unwillingness to change from “how it’s always been done.”

For CBM+, data must be collected from disparate data streams to then be stored, cleaned, and analyzed before Marines can begin to predict how equipment can fail, how critical that failure is to the equipment, and what maintenance steps should happen. Tools based on that data can be used from the operator level to the enterprise level. Once there is an infrastructure to store and aggregate data, new tools like machine learning or artificial intelligence algorithms can drive even greater insights that can return value to Marines and increase their lethality in our increasingly contested and distributed environments.

All of these issues are worth overcoming if it means that gear will not break when it is most needed, and the Corps can use saved sustainment dollars to reinvest in modernization. Most importantly, CBM+ is the only way to

be precise in fights where the Marine Corps has to be on target and on time.

Notes

1. Headquarters Marine Corps, *USMC CBM+ Roadmap* (Draft), (Washington, DC: undated).
2. Ibid.
3. Information is available at <https://www.cat.com>.
4. Ibid.
5. Ibid.
6. Information is available at <https://www.fixdapp.com>.
7. Brad Biagini, “B-1 CBM+ Goes Live!” Air Force Material Command, (November 2019), available at <https://www.afmc.af.mil>.
8. Lance Baughman, “2016 DoD Maintenance Innovation Challenge: USMC Expeditionary Fluid Analysis Capability,” (2016).
9. Gen David H. Berger, *38th Commandant’s Planning Guidance*, (Washington, DC: July 2019).
10. Gen David H. Berger, *Sustaining the Force*, (Washington, DC: May 2019).
11. Ibid.
12. Aaron Mehta, “Mattis Orders Fighter Jet Readiness to Jump to 80% in One Year,” *Defense News*, (October 2018), available at <https://www.defensenews.com>.
13. Congress of the United States, *Fiscal Year 20 National Defense Authorization Act Report on H.R. 2500*, (Washington, DC: 2019), available at <https://armedservices.house.gov>.
14. Todd South, “Not Just Riflemen Anymore: Marines Must Self-sustain in the High-end Fight,” *Marine Corps Times*, (November 2019), available at <https://www.marinecorpstimes.com>.
15. Ibid.

