DAU Lunch and Learn
Date: 26 September 2018
Presenter: Marty Sherman
E-mail: martin.Sherman@dau.mil
Phone: 619-591-9804
Agenda

• What Is CBM+?
• Essential Elements of CBM+
• CBM+ Implementation
• Managing a CBM+ Initiative
• Measuring Success
• CBM+ Technologies, Enabling Tools, and Best Practices
• Resources and References
Condition Based Maintenance Plus (CBM+) For Materiel Maintenance

The Secretaries of the Military Departments and the Directors of the Defense Agencies shall:

• Incorporate the requirement for CBM+ in appropriate policy and guidance.
• Develop and establish enterprise level requirements for implementing CBM+.
• Provide resources for CBM+ requirements developed at enterprise and weapon systems levels.
• Identify life cycle sustainment challenges and use CBM+ solutions, as appropriate, to maintain the readiness of new and fielded equipment.
Condition Based Maintenance Plus (CBM+) for Materiel Maintenance

- Integrate common CBM+ technologies, processes, and procedures for similar platforms and components.
- Require implementation of RCM and other appropriate reliability and maintainability analyses.
- Ensure logistics information systems support CBM+ objectives.
- Require program managers design, develop, demonstrate, deploy, and sustain equipment in accordance with CBM+ policy and guidance to achieve required materiel readiness at best value.
A Definition (OSD)

**CBM+:** The application and integration of appropriate processes, technologies, and knowledge-based capabilities to achieve the target availability, reliability, and operation and support costs of DoD systems and components across their life cycle.
At its core, CBM+ is maintenance performed based on evidence of need, integrating RCM analysis with those enabling processes, technologies, and capabilities that enhance the readiness and maintenance effectiveness of DoD systems and components. CBM+ uses a systems engineering approach to collect data, enable analysis, and support the decision-making processes for system acquisition, modernization, sustainment, and operations.
CBM+ Vision

• Desired CBM+ end state is a trained force of maintainers from the tactical field technician to the strategic system analyst working in an interoperable environment to maintain complex systems through the use of CBM+ processes and technologies.
Developed by the CBM + Action Group

- Supplement the CBM+ DoDI.
- Information reference.
- Tool to assist logistics managers with CBM+ project development, implementation, and execution.
- Describes management actions necessary to integrate technologies to increase reliability, availability, operational effectiveness, and maintenance efficiency.
Secretary Mattis

• The first part of the secretary’s three-pronged plan is to restore military readiness as the department builds a more lethal force.

• The second line of effort is to strengthen alliances and attract new partners, the secretary wrote.

• The third line of effort involves bringing business reforms to DoD

CBM+ is well aligned with these priorities!
Warfighter Benefits

• Tactical
• Operational
• Strategic
Technology Focus

- Improves maintenance capabilities and business processes;
- Complements and enhances DoD-wide reliability analysis efforts;
- Involves the integration of support elements to enable enhanced maintenance-centric logistics system response; and
- Facilitates more accurate predictions of impending failures (based on condition data), resulting in dramatic savings and improved weapon system availability, ultimately benefiting the warfighter.
Why CBM+

The life-cycle impact is clear when operations and support (O&S) costs are compared to total ownership costs.
Why CBM+

- Enhance materiel availability at the best possible cost by establishing integrated, predictive maintenance approaches that minimize unscheduled repairs;
- Eliminate unnecessary maintenance activity; and
- Employ the most cost-effective maintenance health management approaches.
CBM to CBM+
What CBM+ Includes

- Hardware
- Design
- Processes

- Communications
- Tools
- Functionality
CBM+ Metrics

- Materiel Availability
- Materiel Reliability
- Ownership Cost
- Mean Down Time
<table>
<thead>
<tr>
<th>CBM+ Objectives and Metrics</th>
<th>MA</th>
<th>MR</th>
<th>OC</th>
<th>MDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance maintenance effectiveness with integrated maintenance and logistics systems</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Incorporate advanced engineering, maintenance, logistics/supply chain, configuration management, and information technologies</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employ weapon system designs that use measurable, consistent, and accurate predictive parameters from embedded CBM+ capabilities</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Improve data about maintenance operations and parts/system performance</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Improve advanced diagnostics, system prognostics, and health management capabilities based on current condition data</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Provide more accurate item tracking capabilities</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reduce maintenance requirements by performing maintenance tasks only upon evidence of need (more proactive/predictive, less preventive and less corrective)</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Enable more effective maintenance training</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Create a smaller maintenance and logistic footprint</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Improve maintenance capabilities, business processes, supply/maintenance planning, and responsiveness leading to optimum weapon system availability</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Minimize unique support equipment and information systems for individual weapon systems</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Improve system maintainability as a part of design modification through the use of reliability analysis</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Provide interoperability/jointness to the warfighter</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Traditional Maintenance

Maintenance programs are structured and managed to achieve inherent performance, safety, and reliability.

Maintenance tasks restore safety and reliability to their required levels when deterioration has occurred.

Maintenance programs are structured for meeting the readiness and sustainability objectives, including mobilization and surge capabilities.

DoD maintenance activities employ concepts that optimize process technologies, organizational structures, and operating concepts to deliver efficient and effective performance to the operating forces.
Categories of Maintenance

Reactive maintenance (also called corrective maintenance) is performed for items that are selected to run to failure or those that fail in an unplanned or unscheduled manner. An item may be on a schedule for periodic maintenance, but if it fails prematurely, it will require maintenance to fix. Reactive maintenance of a reparable item is almost always unscheduled in the sense the failure occurred unpredictably. Reactive maintenance restores an item to a serviceable condition after the failure has occurred.
Categories of Maintenance

Proactive maintenance is considered either preventive or predictive in nature (i.e. inspection, test, servicing, overhaul, complete replacement):

• Preventive/scheduled maintenance can be based on calendar time, equipment-operating time, or a cycle. Preventive maintenance may be either scheduled (based on predetermined intervals) or unscheduled (detection of a condition that may lead to failure/degradation).

• Predictive maintenance can be diagnostic (identifies an impending failure) or prognostic (capability to forecast the remaining equipment life).
Maintenance Approaches

Corrective Maintenance
"Run-to-failure maintenance"

- Breakdown maintenance
  - High risk of secondary failure
  - High production downtime
  - High cost of spare parts
  - Overtime labor
  - Safety hazardous
  + Machines are not "over maintained"
  + No condition monitoring related costs

Preventive Maintenance
"Fix it before it breaks"

- Scheduled maintenance
- Historical maintenance
- Calendar based maintenance

Predictive Maintenance
"If it isn't broke, don't fix it"

- Condition based maintenance

Proactive Maintenance
"Fix it at the right time"

- Prognostic maintenance
- Reliability centered maintenance

Legend:
+ Pros
- Cons

Legend:
+ Pros
- Cons

Failure Rates

- High investment costs
- Additional skills required
- Additional time invested upfront
- Requires a change in philosophy from management and down
+ Equipment life is extended
+ Reduced downtime
+ Reduced overall maintenance costs
+ Equipment reliability improved
+ Fewer failures, thus fewer secondary failures

Change in Maintenance Strategy
Maintenance Approaches

Enabled through CBM+
Essential Elements of CBM+
CBM+ Environment

- System health monitoring using applicable and effective embedded sensors, on- and off-system decision-support systems, and analysis tools
- Condition-driven maintenance actions at the maintainer level directed by decision-support capabilities based on timely and accurate information flow
- Reliability analysis, such as RCM
- Statistical analysis
- Automatic entry and retrieval of highly accurate maintenance data
CBM+ Environment

- Integrated maintenance and logistics/supply chain, configuration management, and financial information systems
- Configuration management and asset visibility
- In-service history-based maintenance planning, equipment scheduling, and life usage tracking (trend analysis)
- Remote diagnostics, subject matter experts, and mentorship arrangements
- Low ambiguity fault detection, isolation, and prediction
CBM+ Environment

- Interactive electronic technical manuals (IETMs)
- Open architecture, data-based interactive training, and technical assistance capability
- Widespread use of electronic portable or point-of-maintenance aids
- Information feedback among field personnel, weapon system and combat support developers, and materiel support developers.
CBM+ Business Needs

1. Predict equipment failures
2. Holistic view of equipment condition
3. Greater accuracy in failure prediction
4. Reduce the cost of ownership
5. Improve equipment and component reliability
6. Reduce equipment mean down time (logistics responsiveness)
7. Optimize equipment performance (availability)
A decision to move ahead with CBM+ should rest, at least in part, on preparation of a credible business case analysis (BCA).
CBM+ And RCM

• The RCM analytical approach helps the maintenance manager in identifying potential failures and supporting the selection of viable courses-of-action. RCM tools help define the optimal failure management strategies and provide the inputs to construct the business case for implementation of the designated CBM+ strategy.

• CBM+ builds on the foundation of RCM, but complements and expands on RCM by applying a broad spectrum of procedures, capabilities, and tools to improve execution of the maintenance analysis process.
CBM+ Infrastructure

- Analytics
- Decision support
- Human interfaces
- Data management
- Communications
- Health assessment
- Condition monitoring
- Sensors
Full development of an integrated architecture requires the preparation of three types of DoD AF architecture views: operational (OV), systems (SV), and technical standards (TV) views,
CBM+ Architecture

- Verification of fidelity of design to performance specifications
- Validation that the products and capabilities work as intended:
  - Data exchange between the platform and the enterprise is in conformance to open standards and data protocols
  - The CBM+ data strategy transmits the appropriate data
  - The data strategy facilitates interoperability with third-party software applications that also conform to the key open standards and data protocols
  - Selected analytical capabilities provide effective human interfaces and credible results.
Open Systems and Data Structures

The open-systems concept is an essential element of CBM+ because a comprehensive CBM+ implementation often will be executed in an environment that includes different sensor technologies, multiple information systems, different data models, collection mechanisms across organizational boundaries, and different enterprise systems environments.

It is essential that data strategies include the sharing of CBM+ data across organizational boundaries and at all levels: tactical, operational, and strategic. Because of the variety of possible CBM+ applications in DoD, there are a multitude of possible approaches to data storage and interchange.
# Getting Started Checklist

1. Understand that CBM+ is a continuous improvement initiative over the life cycle of a weapon system or equipment.

2. Ensure full understanding of the planning, implementation, and operations phases of CBM+ by the implementation team, functional managers, stakeholders, and customers.

3. Initiate the CBM+ planning phase and complete the processes needed to develop a CBM+ strategy and to begin the selection of applicable technologies.

4. Build on planning phase actions by managing the implementation phase as a time-phased execution of process changes, technology insertion, organizational realignments, and equipment changes.

5. In the operations phase, incrementally deploy CBM+ capabilities to operational user locations and continue through full execution of required CBM+ capabilities.

6. Continuously assess CBM+ progress and overcome barriers to successful execution as they occur.

7. Discontinue or modify CBM+ capabilities for specific weapon systems and equipment as requirements evolve with the cessation of use or replacement of those capabilities.
Across The Lifecycle

CBM+ implementation can be divided into three phases that complement DoD’s total system life-cycle acquisition strategy: the planning phase, the implementation phase, and the operations phase.
Managing a CBM+ Initiative/Project

• Policy
• Requirements identification
• Resources strategy
• Implementation strategy
• Reliability relationship
• Technology applications
• Architecture and data strategy
• Metrics assessment
• Human factors and interfaces
• Continuous process improvement
CBM+ And PBL

As CBM+ helps focus the maintenance process on maximizing weapons and equipment readiness with optimum resource allocation, it fully complements the PBL concept. In fact, it becomes an essential factor in attaining the performance-based objectives in the area of maintenance.
CBM+ And Systems Engineering

CBM+ has the greatest leverage in the early stages of development, when the program design is most flexible. The life-cycle logistician must ensure CBM+ implementation is addressed in the system’s design and also ensure the maintenance support concept and plans will be flexible and responsive enough to support the design and resultant or evolving system.
Implementation of CBM+ is not a single event. It is an evolutionary effort that progresses incrementally. DoD managers at all organizational levels, including logistics activities, PMs, depot- and field-level maintainers, and operational commanders face similar management issues during CBM+ implementation. A good manager periodically steps back, reviews the organization’s progress, and assesses the initiative results to date.
Although no single set of performance measures is universally appropriate for every organization or every organizational level, significant strides have been made to identify basic enterprise-level metrics for DoD logistics activities. Once metrics are identified and a baseline of credible data is accumulated, the implementation team will use these metrics form the initiative and ultimately manage the CBM+ maintenance capability.
Measuring Success

Metrics for CBM+ fall into two categories:

- Implementation metrics
- Operating metrics (i.e., readiness and costs).
Operating Metrics

Metrics for CBM+ fall into two categories:

- **Materiel availability**—maximize readiness and availability of weapon systems and equipment
- **Materiel reliability**—improve reliability of weapon systems, equipment, and components
- **Ownership costs**—reduce life-cycle ownership costs
- **Mean down time**—reduce
Operating Metrics

Metrics for CBM+ fall into two categories:

- Logistics Footprint
- Maintenance Cycle Times
- Quality (reduced repeat discrepancies, A-799, Y-code, etc)
CBM+ Technologies/Enabling Tools

- Embedded and off-system sensors
- Portable maintenance aids/IETMs
- Serial Item Management (SIM)
- Item Unique Identification (IUID)
- Software applications/Data warehouses
- CBM+ Implementation Plan Template
CBM+ Best Practices

- Design
- Functionality
- Processes
• **CLL 029** Condition Based Maintenance (CBM+)

• **DoD Directive 4151.18 “Maintenance of Military Materiel”**

• **DoDI 4151.22 “Condition Based Maintenance Plus (CBM+) for Materiel Maintenance”**

• **Condition Based Maintenance Plus DoD Guidebook**

• **OSD CBM+ Website**

• **Performance Based Logistics CoP**

• **Logistics CoP**

• **CBM+ ACQuipedia Article**