2022-12

IMPLEMENTING CONDITION-BASED MAINTENANCE PLUS AS A GROUND MAINTENANCE STRATEGY IN THE MARINE CORPS

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL PROJECT

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December 2022

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This project was funded in part by the NPS Naval Research Program.

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2022	**3. REPORT TYPE AND DATES COVERED** MBA Professional Project

4. TITLE AND SUBTITLE IMPLEMENTING CONDITION-BASED MAINTENANCE PLUS AS A GROUND MAINTENANCE STRATEGY IN THE MARINE CORPS	**5. FUNDING NUMBERS** NPS-22-M273-A
6. AUTHOR(S) Brian J. Harding and Liston H. Pennington IV	

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. This project was funded in part by the NPS Naval Research Program.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

In 2020, Marine Corps Order 4151.22 and Commandant White Letter 2–20 was published to implement Condition-Based Maintenance Plus (CBM+) as a ground maintenance strategy to improve operational availability and reduce life-cycle costs. The Fleet Marine Force is still operating under preventative and corrective maintenance strategies instead of CBM+ strategies. Organizational inertia, such as competing priorities, legacy processes, and inspections, has slowed the integration of CBM+ strategies. We reviewed key policy documents and interviewed fifteen subject-matter experts relevant to Marine Corps ground transport maintenance policies and practices. Based on this information, we conducted a thematic analysis using an organizational change approach to identify barriers and opportunities that impact CBM+ implementation. We found that immediate gains from CBM+ implementation in the Marine Corps can be achieved through a focus on people and process improvements while technology integration continues. The CBM+ strategy supports *Force Design 2030* and *Talent Management 2030* objectives and emphasizing this alignment can build momentum for CBM+. In this paper, we make six specific recommendations that apply organizational change concepts to enable effective CBM+ implementation as a ground maintenance strategy in the Marine Corps.

14. SUBJECT TERMS Condition-Based Maintenance Plus, CBM+, Organizational Change, Predictive Maintenance, Heart of Change, United States Marine Corps, USMC, MCO 4151.22, MCO 4790.2, MCO 4151.25, MCO 4000.57A, ground maintenance strategy, maintenance policy, cross-training, non-value-added, leadership buy-In, *Force Design 2030*, FD2030, *Talent Management 2030*, TM2030	**15. NUMBER OF PAGES** 85
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
December 2022

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ABSTRACT

In 2020, Marine Corps Order 4151.22 and Commandant White Letter 2–20 was published to implement Condition-Based Maintenance Plus (CBM+) as a ground maintenance strategy to improve operational availability and reduce life-cycle costs. The Fleet Marine Force is still operating under preventative and corrective maintenance strategies instead of CBM+ strategies. Organizational inertia, such as competing priorities, legacy processes, and inspections, has slowed the integration of CBM+ strategies. We reviewed key policy documents and interviewed fifteen subject-matter experts relevant to Marine Corps ground transport maintenance policies and practices. Based on this information, we conducted a thematic analysis using an organizational change approach to identify barriers and opportunities that impact CBM+ implementation. We found that immediate gains from CBM+ implementation in the Marine Corps can be achieved through a focus on people and process improvements while technology integration continues. The CBM+ strategy supports *Force Design 2030* and *Talent Management 2030* objectives and emphasizing this alignment can build momentum for CBM+. In this paper, we make six specific recommendations that apply organizational change concepts to enable effective CBM+ implementation as a ground maintenance strategy in the Marine Corps.

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LIST OF ACRONYMS AND ABBREVIATIONS

BDA	beginning, during, after
CBA	capabilities-based assessment
CBM	condition-based maintenance
CBM+	condition-based maintenance plus
CD&I	Combat Development and Integration
CM	corrective maintenance
CMC	Commandant of the Marine Corps
COMMSTRAT	Communication Strategy and Operations
COTS	commercial off the shelf
DC	Deputy Commandant
DOD	Department of Defense
DODI	Department of Defense Instruction
DODIG	Department of Defense Inspector General
DOTMLPF-P	doctrine, organization, training, materiel, leadership and education, personnel, facilities - policy
DRIS	date received in shop
EFV	expeditionary fighting vehicle
ERP	enterprise resource planning
ETP	exception to policy
FMF	Fleet Marine Forces
FSMAO	Field Supply and Maintenance Analysis Office
GCSS-MC	Global Combat Support System-Marine Corps
HQMC	Headquarters Marine Corps
I&L	Installations & Logistics
ICD	Initial Capabilities Document
IDA	Institute for Defense Analysis
IOT&E	initial operational test and evaluation

JLTV	joint light tactical vehicle
LAV	light armored vehicle
LDO	limited duty officer
LVSR	logistics vehicle system replacement
MAW	Marine Aircraft Wing
MCCDC	Marine Corps Combat Development Command
MCO	Marine Corps Order
MCSC	Marine Corps Systems Command
MCT	maintenance cycle time
MEF	Marine Expeditionary Force
MIG	MEF Information Group
MLG	Marine Logistics Group
MRB	Materiel Readiness Branch
MSC	major subordinate command
MT	motor transport
MTVR	medium tactical vehicle replacement
MVP	minimal viable product
PM	preventative maintenance
SME	subject matter expert
SR	service request
TAMCN	table of authorized materiel control number
TM	technical manual

EXECUTIVE SUMMARY

The Marine Corps is undergoing organizational change efforts to integrate Condition-Based Maintenance Plus (CBM+) as a maintenance strategy to support ground equipment across the enterprise. Currently, the Marine Corps ground maintenance is based on preventative and corrective maintenance strategies. Enterprise-wide implementation of CBM+ requires the actions and decisions of several stakeholders throughout the Marine Corps from Headquarters Marine Corps down to unit level commanders, staff, maintainers, and operators. The Marine Corps Orders regarding CBM+, MCO 4790.25 and MCO 4151.22, provide definitions for CBM+, but do not present a means for integration into the ground maintenance strategy or a pathway for refinement of existing orders/processes. The Marine Corps is not prepared in its organization-wide policies, processes, and personnel to be technology-empowered and data-driven in its maintenance strategies. The Marine Corps has an excellent opportunity to achieve quick and early gains in the implementation of CBM+ as a maintenance strategy by making changes to the people and process aspects that will not require additional resources and funding. Making necessary adjustments to get the people and processes working efficiently will facilitate effective technology integration.

We furthered our understanding of CBM+ implementation by reviewing ground maintenance policies and interviewing military and civilian ground maintenance subject matter experts. Based on the information collected, we conducted a thematic analysis to identify barriers to and opportunities for change within the Marine Corps ground maintenance community. An organizational change approach and successful change principles informed our recommendations for CBM+ implementation.

Four major themes emerged as barriers to CBM+ implementation in the Marine Corps. First, there is a lack of clear and consistent understanding of CBM+ across the Fleet Marine Force. Second, there is conflict among various orders and policies that delineate Marine Corps maintenance strategy and many legacy policies directly conflict with CBM+ strategies. Third, inspections heavily influence maintenance actions at the operational unit level and hinder implementation of CBM+ initiatives. Finally, competing priorities reduce focus and capacity necessary to change maintenance strategies.

Four themes emerged as opportunities to support CBM+ implementation. First, leaders within the organization need to drive the CBM+ maintenance strategy implementation process. Second, interim exceptions to policy (ETP) for policies that restrict CBM+ maintenance strategies can accelerate integration. Third, experiences at 3d MLG demonstrate opportunities to remove non-value-added tasks within maintenance processes to achieve measurable and observable gains by integrating CBM+ processes prior to adopting sensors and other technology solutions. Finally, ownership in the change process and the application of cross-training within operational units will make CBM+ implementation more effective.

Based on our analysis, the following six recommendations would improve CBM+ implementation as a ground maintenance strategy in the Marine Corps:

- **Align CBM+ with *Force Design 2030* and *Talent Management 2030***

  A sense of urgency should be built for CBM+ implementation by communicating to the FMF how CBM+ supports the current CMC priority initiatives. The alignment of CBM+ benefits to the objectives of FD2030 and TM2030 should be communicated throughout the FMF to build a greater sense of urgency to change maintenance strategies.

- **Establish a CBM+ Guiding Coalition**

  A CBM+ guiding coalition would guide, coordinate, and communicate CBM+ implementation throughout the Marine Corps. The guiding coalition should be directed and led by owners of Marine Corps maintenance policy that have sufficient level of authority to initiate and approve enterprise policy change. Existing tools within the Marine Corps policy refinement process, such as the Total Life Cycle Management Cross Functional Team (CFT) model, can be used to establish a CBM+ guiding coalition.

- **Refine and Communicate CBM+ Vision**

  A strategic communication plan needs to be developed to promulgate the vision of a CBM+ maintenance strategy as well as build the knowledge and

education in the force on CBM+ practices, processes, and benefits. We recommend the CBM+ CFT provide an updated CBM+ vision that clarifies its association with FD2030/TM2030 and empowers units to seek out improved maintenance practices and provide bottom-up refinement to the CBM+ CFT.

- **Resolve Conflicts Between Maintenance Policies**

  We recommend creating an environment that fosters short-term wins through interim ETPs and consolidates gains in a single volumized maintenance order. Operational units need to be empowered to seek out process improvements and opportunities to apply CBM+ practices. The restrictive nature of current orders and constraints placed by required non-value-added maintenance actions present obstacles to Marines seeking to update processes to incorporate CBM+ principles.

- **Develop CBM+ Education for Commanders**

  We recommend incorporating CBM+ and maintenance concepts central to Marine Corps maintenance strategy into training and logistics seminars for leaders. Promulgating a CBM+ information paper is an effective tool to provide commanders and FMF CBM+ awareness and education in an expedient manner. CBM+ should be incorporated in the Commander's Materiel Readiness Handbook to improve leaders' familiarity and provide a quick reference to principal components of the Marine Corps maintenance strategy.

- **Utilize FSMAO to Support CBM+ Integration**

  Inspections are an enabling force in the maintenance community that reinforce maintenance strategy and processes. The Field Supply and Maintenance Analysis Office (FSMAO) can be utilized as a key contributor in communicating and enabling the CBM+ vision for Marine

Corps maintenance through evaluating, training, and consolidating best practices of CBM+ processes.

The above recommendations target areas of opportunity for the Marine Corps to generate urgency, empower broad-based action, and solidify CBM+ as a ground maintenance strategy. Our recommendations use available organizational tools within the Marine Corps and provide options for leaders and policymakers to proactively drive CBM+ implementation. There are immediate gains that the Marine Corps can achieve through people and process improvements rather than waiting on the acquisition process and CBM+ technology to mature. Enterprise-wide integration of CBM+ as a ground maintenance strategy plays an important role in enabling logistics as the pacing function for the Marine Corps and supports FD2030/TM2030 objectives.

ACKNOWLEDGMENTS

This project can be contributed to the help of many to bring it to fruition. We appreciate all the support and assistance from the many unnamed professors, staff, and peers that have contributed to our development while at the Naval Postgraduate School. We would like to thank the staff at Headquarter Marine Corps Installations and Logistics, specifically the CBM+ team, for their support, which significantly helped guide our research. Next, we would like to thank the 3d Marine Logistics Group team, specifically Dave Moon and all the interviewees, that offered their time, insights, and resources to help with the research. Their work with CBM+ was instrumental in this project and can provide a roadmap for future success across the enterprise. Additionally, thanks to our faculty advisors, Dr. Eva Regnier and Bryan Hudgens, for guiding us through the research process. But most importantly, we would like to thank our wives and families for tolerating the many late nights and schedule changes to complete this project. Without their enduring support, this project would not have been possible.

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I. INTRODUCTION

The Marine Corps is seeking to integrate Condition-Based Maintenance Plus (CBM+) as a maintenance strategy to support ground equipment across the enterprise, as directed through the publication of Marine Corps Order (MCO) 4151.22 in January 2020 and the Marine Requirements Oversight Counsel approval of the CBM+ Initial Capabilities Document (ICD) on April 14, 2022 (Headquarters Marine Corps [HQMC], 2020a). These two authoritative documents outline the requirement to transition to CBM+ but are not prescriptive in addressing the Marine Corps' current maintenance policies, business practices, cultural habits (personnel behaviors), and data analytics capability shortfalls. The introduction of predictive maintenance strategies such as reliability-centered maintenance and CBM+ represent a fundamental change to how maintenance operations are conducted in the Marine Corps and will face obstacles in addition to technical hurdles. Organizational change literature suggests that the adoption of any new system or maintenance practice will experience friction which can be seen in the current CBM+ implementation efforts. This observed friction necessitates a thorough review of organizational dynamics as they relate to CBM+ as a ground maintenance strategy and an evaluation of requirements for full implementation within the ground components of the Fleet Marine Force (FMF). The review will encompass the three pillars of CBM+, which are people, processes, and technology (HQMC, 2020a). If technological programs required to implement CBM+ are within reach and are currently being pursued, people and processes need to be prepared to support the full embrace of the condition-based and predictive maintenance strategy.

A. PROBLEM STATEMENT

The Marine Corps is not prepared in its organization-wide policies, processes, and personnel to be technology-empowered and data-driven in its maintenance strategies. The Department of Defense (DOD) has emphasized the need for the joint force to adopt CBM+ and enable data-driven decision-making (USD[A&S], 2020). Current Marine Corps policies and practices are designed to support preventative and corrective maintenance strategies, but they are not conducive to enabling effective CBM+ implementation. The addition of CBM+ technology will not cure the problem until the people and processes are prepared for this new

maintenance approach. The Marine Corps still employs excessively long and wasteful maintenance practices, which are then inspected and reinforced by HQMC through the Field Supply and Maintenance Analysis Office (FSMAO) inspection teams.

The DOD has been attempting to improve maintenance practices through the adoption of predictive technologies and models for nearly 20 years, but changes have been slow, and many of the lessons learned are currently stove piped within various branches and units. Case analysis from the implementation of condition-based maintenance (CBM) models in the civilian sector and in other service branches suggest that there are a variety of hurdles that organizations face during the adoption of new maintenance models (Stuetelberg & Thomas, 2021). Though CBM+ is not solely a maintenance system, the Marine Corps has faced challenges with the adoption of new technologies, as seen with Global Combat Support System-Marine Corps (GCSS-MC) (Fincher, 2016). The Army and Air Force have separately been building predictive analytics capabilities and developing policies to enable CBM (Whitaker, 2019). Subordinate units within the Marine Corps have begun to execute policy and operating procedure updates based on the generalized CBM+ guidance available from HQMC, but the approach is not consistent across commands, and current "exceptions to policy" require additional risk to be assumed by the commander (3d Marine Logistics Group [3D MLG], 2021).

Limited research has been conducted into reviewing what comprehensive changes to policies and operating practices are necessary, specifically within the Marine Corps, to enable the successful implementation of CBM+. A few studies have explored organizational change within the DOD and the Marine Corps, implications of CBM in the private sector and the DOD, and the technological requirements to support CBM. Additionally, the Marine Corps conducted a CBM+ Capabilities Based Assessment (CBA) in 2015 and revalidated the assessment in 2020, which highlighted materiel and non-materiel requirements and gaps (HQMC, 2022). The CBA results call for further analysis into specific actions that leaders can take to empower maintainers for proactive CBM+ implementation.

The purpose of this study is to explore policy and procedural improvements across the Marine Corps required to support effective decision-making utilizing CBM+ in the FMF. We increase knowledge through interviewing subject matter experts (SME) and conducting thematic analysis of our interviews and literature. Based on the published experience of industry

and best practices at various levels within the DOD, we observe identifiable barriers and opportunities for change that impact CBM+ and provide recommendations for implementation within the ground components of the FMF. Our recommendations will enable leaders to provide appropriate resources and attention to update and change policies for CBM+ implementation. The findings increase understanding of organizational change within the Marine Corps regarding the adoption of new strategies, technologies, and methods.

B. ORGANIZATION

Chapter II provides additional background and literature review of the origins of CBM+ and the initiatives that the DOD and Marine Corps have taken up to this point to implement CBM+ as a ground maintenance strategy. This chapter also provides a review of organizational change approaches that help guide perspectives and recommendations for the Marine Corps' organizational changes in maintenance strategy. Chapter III describes our methodology for interviews and our process for thematic analysis. Chapter IV details the findings and analysis drawn from key documents, scholarly work, and interviews that helped identify themes for barriers and opportunities for change. Chapter V provides a summary and recommendations concerning Marine Corps CBM+ implementation and how it can be achieved most effectively within its current context and operating environment. Chapter VI provides a summary of key discoveries and concluding thoughts concerning CBM+ implementation in the Marine Corps.

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II. BACKGROUND AND LITERATURE REVIEW

Condition-based maintenance (CBM) is not a new concept and was first discovered in the private sector in the 1940s in the Rio Grande Railway Company to detect leaks in engines in a predictive manner (Prajapti et al., 2012). DOD Instruction 4151.22 defines CBM as "a maintenance practice based on monitoring the condition of equipment to assess whether it will fail during some future period in order to take appropriate action to avoid the consequences of that failure" (DOD, 2020, p. 13). In essence, the goal of CBM is to perform maintenance only when there is evidence of need to improve the operational availability of equipment and reduce cost. The "plus" in CBM+ emphasizes the integration of technology that expands CBM to include a systems-engineering approach to collect data through embedded sensors to enable analysis and maintenance life-cycle decision-making. Essentially, CBM+ leverages technology to be more predictive with maintenance to further enhance operational availability, cost savings, and decision-making ability. In this paper, we reference both CBM and CBM+ intentionally depending on the context in which the term is written. When CBM is addressed, the focus is on monitoring the actual condition of an asset through visual inspections, tests, or analyzing performance data from the onboard sensor capabilities and tools the Marine Corps currently possesses to conduct maintenance and make decisions (HQMC, 2020a). When CBM+ is used, it is emphasizing the use of technology such as embedded sensors and data analytics capabilities that form an ecosystem in the maintenance process as well as referencing the naming convention of a policy or directive.

A. MARINE CORPS' LEGACY GROUND MAINTENANCE STRATEGY

The focus of this paper is maintenance on ground transportation or motor transport (MT) equipment in the Marine Corps due to CBM+ implementation efforts have primarily been tested on MT equipment. MT is surface transportation using wheeled vehicles and it provides elements of the Marine Air-Ground Task Force (MAGTF) with tactical and logistical support to include transportation of people, equipment, and cargo (HQMC, 2001). Every tactical unit has organic MT capability, but combat service support units have

larger inventories and greater maintenance requirements for MT equipment due to their support mission. MT equipment capabilities are expected to operate under all environmental conditions to meet all assigned missions (HQMC, 2001). Maintenance is a critical logistics function that supports the ability of MT equipment to be operationally ready to accomplish its mission.

Marine Corps units currently conduct maintenance utilizing the MCO 4790.2, *Field-Level Maintenance Management Policy*, to direct their maintenance strategy and maintenance production processes and actions. MCO 4790.2 outlines a preventative and corrective maintenance strategy approach. Preventative maintenance (PM) refers to "maintaining equipment on a regular schedule based on elapsed time or counter reading," also known as time-based maintenance (TBM) (HQMC, 2016, p. 3-1). Corrective maintenance (CM) is reactive and involves actions to restore equipment to a serviceable condition (HQMC, 2016). Under the corrective maintenance approach equipment is run-to-failure therefore it is unscheduled when a system or component breaks (HQMC, 2020a).

The current primary metrics to measure overall performance in maintenance is maintenance cycle time (MCT) and equipment readiness. In MCO 4790.2, MCT is defined as "the period of time covered from the initiation of maintenance actions until repairs and maintenance records are complete. Maintenance cycle time begins when the equipment is inducted/accepted into the maintenance activity and ends upon the closeout" (HQMC, 2016, p. 3-5). Equipment readiness, also referred to as operational availability (Ao), is the second primary metric to measure maintenance performance. Equipment readiness or Ao is the total number of a selected equipment type possessed and "mission capable" divided by the total possessed. In simpler terms, readiness indicates the materiel condition of an organization's possessed equipment (MCO 3000.13B, 2020).

B. CBM+ ORDERS AND DIRECTIVES

The DOD realized the value of a CBM+ maintenance strategy from industry and then made its first initiative to implement CBM+ in November 2002 through a memorandum for the secretaries of the Military Departments titled *Condition Based Maintenance Plus*, which was published by the Deputy Under Secretary of Defense

(Logistics and Materiel Readiness) (DOD, 2008). In January 2004, the military services nominated programs to serve as lead for CBM+ research; the Marine Corps selected the Expeditionary Fighting Vehicle (EFV) and the Light Armored Vehicle (LAV) (Cutter & Thompson, 2005). These programs informed CBM+ implementation recommendations in a CBM+ Select Program Survey conducted by LMI Government Consulting in 2005. Subsequently in 2007, the DOD issued DOD Instruction (DODI) 4151.22, *Condition-Based Maintenance Plus (CBM+) for Materiel Maintenance*, which required all Military Departments to implement CBM+ for new weapon system acquisitions while integrating it into existing weapon systems where it was feasible and beneficial (DOD, 2008). Following the DODI 4151.22, the *Condition-Based Maintenance Plus DOD Guidebook* was published in May 2008 to support the Military Departments in their implementation of CBM+ strategy (DOD, 2008). In January 2020, the Marine Corps published MCO 4151.22, *Condition Based Maintenance Plus Order*, to take the next step in implementation (HQMC, 2020a). Most recently, the Secretary of the Navy released a memorandum on May 26, 2022, *Actions to Improve the Department of the Navy Sustainment*, stating, "We must move forward aggressively to adopt and deploy CBM technologies" (Secretary of the Navy, 2022, p. 3).

Department of Defense Directive 4151.18, *Maintenance of Military Materiel*, was published March 21, 2004, and reissued August 31, 2018, in order to reestablish policy and responsibilities associated with performance of DOD maintenance for systems. Change 1 to the directive reassigned the office of primary responsibility for the directive to the Undersecretary of Defense for Acquisition and Sustainment (DOD, 2018a). With a focus on improving the life cycle of military materiel, DOD Directive 4151.18 emphasized the need to adopt corporate business practices that would improve maintenance operations within the DOD. The focus of the practices targeted for adoption was to allow for cost savings, reduced maintenance cycle-time, and increased operational availability through investment in new technologies and corresponding policy updates. Commercial procurements and public-private partnerships were specifically encouraged by the directive to encourage adoption of private-sector practices that would improve the DOD maintenance posture.

The directive highlighted the need to review and implement data-driven reliability models with technology connecting metrics to decision-makers.

> Maintenance programs for materiel maintained for the Department of Defense shall facilitate, collect, and analyze maintenance-related reliability data. The programs shall include sufficient analytic capability for identifying needed adjustments based on operating experience, materiel condition, and requirements for reliability, maintainability and supportability modifications, and changes to training curricula or delivery methods. The programs shall provide maintenance activities as the means for assessing information generated by prognostic and diagnostic capabilities and for taking appropriate maintenance actions. The programs shall also establish and evaluate performance metrics that promote continuous improvement in maintenance, ensuring responsiveness and best value to operating forces. (DOD, 2018a, p. 5)

Over the last couple of years, the Marine Corps has made deliberate efforts to advance CBM+ implementation by establishing a dedicated CBM+ team at Headquarters Marine Corps Installations and Logistics (HQMC I&L) to lead and collaborate efforts with other key stakeholders including industry, academia, Marine Corps Combat Development Command (MCCDC)/Combat Development and Integration (CD&I), Marine Corps Systems Command (MCSC), and the FMF. This was energized by the commandant, General Berger, in April 2020, with the issuing of White Letter 2–20 titled *Achieving Condition Based Maintenance*, which lays the foundation for CBM+ scaling and to fully embrace *CBM+* (HQMC, 2020b). The Marine Corps' initial CBM+ strategic implementation plan entailed three phases occurring between 2020 and 2023 that involved conducting a minimum viable product (MVP) utilizing 10 MTVRs and 10 JLTVs, then expanding the MVP and data scaling to 300 JLTVs and MTVRs across the Marine Corps operational forces, and later expanding CBM+ to other systems (HQMC I&L, 2021).

In April 2020, the Commandant of the Marine Corps (CMC) published a white letter with the subject of *Achieving Condition Based Maintenance*. The letter highlighted the creation of Marine Corps Order (MCO) 4151.22 which established Condition Based Maintenance Plus (CBM+) as a Marine Corps policy. The CMC reiterated this message with a one-page white letter published in February 2020 that addressed the intentional approach with which CBM+ needed to be pursued for implementation. "CBM+ is an

industry-proven concept that represents a deliberate shift from reactive equipment repair to a proactive, predictive approach. Simply put, it is maintenance based on evidence of need. … Getting to this future state will require an organized and sustained effort across the Corps" (HQMC, 2020b). This letter came on the heels of the Marine Corps' *Condition Based Maintenance Plus (CBM+) Order* published in January 2020 (MCO 4151.22) to achieve buy-in across the enterprise in an effort for total force implementation (HQMC, 2020a).

The Marine Corps CBM+ order provided directive guidance to initiate the DOTMLPF-P process for CD&I. The process would focus on the methods and processes needed for execution and scaling of CBM+ in the Marine Corps. Commanders, maintainers, and the FMF were directed to MCO 4151.22 for additional guidance and received the following commander's intent:

> Achieve the total force implementation and integration of CBM+ concepts throughout the integrated total life cycle framework. This Order will leverage people, processes, and technologies to integrate CBM+ and Reliability Centered Maintenance (RCM) within the Marine Corps' maintenance program to increase operational availability and support to the warfighter. CBM+ includes both hardware and software components… Successful implementation is reliant on data collection and information management practices implemented in accordance with reference (g), and technologies that will provide operational planners, operators, maintainers, maintenance managers, and program managers the right information to maximize the operational availability of MAGTF's PEIs. (HQMC, 2022a, p. 1)

Per the intent, the three pillars for CBM+ are people, processes, and technology, but the primary focus of the order was on data aggregation and acquisition efforts of data logging systems. The heavy focus on technology solutions remained present in the MCO 4151.22 definition of CBM+, which emphasizes the *plus* of CBM+:

> To be most effective, CBM+ requires processes, technology, and capabilities that support RCM analysis and maintenance decision-making. These requirements may include but are not limited to: (l) Automated Information Systems (AIS) for maintenance data collection and process analysis, (2) sensors embedded within equipment platforms to provide operators, crew and maintainers enhanced visibility of equipment condition, and (3) portable equipment to conduct external tests and measurements to

> support RCM analysis. Accordingly, the Marine Corps will acquire or develop Automatic Identification Technology (AIT) and other test, measurement, and diagnostic equipment, and integrate it with existing and emerging AIS to automate and enhance data collection and sharing to support CBM+. (HQMC, 2022a, p. 3)

The order presents data assessment tools as an initial step in CBM+ implementation that will inform processes and procedures rather than a two-way relationship and does not provide guidance on how processes are meant to be evaluated or updated prior to the arrival of technology solutions. The order provides the following tenets of CBM+, which link closely to change strategies and can potentially be leveraged for strategic communications about CBM+ implementation:

> 1. Vision - Establishes CBM+ as the department's key strategy for sustaining weapon system readiness at best cost.
>
> 2. Strategy, Policy, and Planning - Clear and strong guidance, including policy, strategy, action plans, and road maps at all levels, underlies the successful planning, implementation, and sustainment of CBM+ execution.
>
> 3. Organization - CBM+ execution requires a holistic and systematic approach spanning multiple organizations, functional disciplines, and communities.
>
> 4. Resources - Sufficient personnel and funding are essential for development, planning, implementation, and sustainment of any systemic effort.
>
> 5. Technologies and Tools - Appropriate tools and technologies are necessary to execute CBM+ successfully.
>
> 6. Workforce - A workforce trained on basic CBM+ principles is essential. (HQMC, 2020a, p. 2-16)

Despite the numerous initiatives, policies, instructions, a guidebook, and orders published since 2002, full implementation of CBM+ strategy has not yet been realized. An audit report of the DOD's implementation of predictive maintenance strategies to support weapon system sustainment was completed on June 13, 2022 and highlighted that there are still significant actions required across the Military Departments to transition to a CBM+ maintenance strategy (DODIG, 2022). The report stated that progress has been made but

DOD officials did not "develop comprehensive strategic plans," lacked "full visibility of CBM+" projects, and did not "develop training tailored to the appropriate levels in the life-cycle sustainment workforce" (DODIG, 2022, p. 9). Additionally, the DODIG (2022) report identified the challenge of the DOD's transition from a TBM and "run to failure maintenance culture to a predictive maintenance culture" as one of several barriers (DODIG, 2022, p.9). Other challenges to CBM+ implementation identified in the audit report were a "lack of accurate and usable data and algorithms to make maintenance forecasts," "lack of a standardized method to distinguish parts removed based on predictive forecasts," and "limited funding and resources" (DODIG, 2022, p. 9). These findings reveal that there has been a lot of activity, resources, and information published surrounding CBM+, but one of the most significant hurdles is the complete transition from old maintenance practices to newer and more relevant maintenance practices and strategies. There are cultural barriers and organizational inertia factors that need to be identified and resolved.

C. GCSS-MC LESSONS LEARNED

A comprehensive review of the Marine Corps' adoption of Global Combat Support System-Marine Corps (GCSS-MC) by the Institute for Defense Analyses (IDA) published September 2018 provided many lessons learned that can be applied to the adoption of new information technology systems in the Marine Corps. The initial intent for GCSS-MC was to replace legacy supply and maintenance programs still in active use from the 1970s with the added potential goal of continuing to develop the platform to support all logistics chain management functions for the Marine Corps, including finance and manpower management activities, under a single system (Aronin et al., 2018). Treating GCSS-MC as an all-encompassing enterprise resource planning (ERP) software program for supply and maintenance activities meant a reliance on master databases and simultaneous information updates that would bring with it inherent complexities. As stated in the IDA report,

> It is generally not possible for an organization to procure a package of ERP software and simply install it with in-house expertise. Most organizations know they will need outside help but there is no single recipe for how to plan for a conversion, pick the software required, configure that software to

> perform the needed functions, and transition from current processes to the new set of processes. (Aronin et al., 2018, p. 9)

The IDA report emphasized the importance of having the appropriate processes and people in place to effectively receive and implement new technologies.

Due to the complexities outlined in the document, GCSS-MC required an extended timeline for implementation with multiple releases, updates, and verification of data over years. The initial Milestone A software procurement approval for GCSS-MC was granted July 2004, but the initial operational test and evaluation (IOT&E) with III MEF was not conducted until May-August 2010, with follow-on adoptions at II and I MEF in subsequent years (Aronin et al., 2018). A key lesson from this case is that there is a significant gap between original consumers for commercial off-the-shelf (COTS) products and the differing requirements the Marine Corps as a consumer would demand. Flexibility in terms of user functionality and interface were necessary for GCSS-MC adoption and will remain requirements for adoption of follow-on information systems. Additionally, the ability to support a detached user is crucial for any systems to be employed in an expeditionary environment that would have either limited or no data connectivity. A mobile capability that could operate on stand-alone systems will also need to be able to support to scale the dynamic demands placed on equipment that often surpass more predictable in repetitive environments in industry. The ability to scale not only applies to the physical equipment such as sensors, but the data processing and analytics capability to make use of the system. This means that transition will be drawn out over an extended period and often simultaneous operation of both new and legacy systems. Complex decisions of how to phase the implementation of an ERP will need to be made.

The report compiled eight conditions for successful implementation for GCSS-MC, the Marine Corps had achieved less than half of those conditions at the time of the report (Aronin et al., 2018). This would read very similarly for the implementation of CBM+ in the Marine Corps and DOD with positive indicators in sustained involvement by senior leadership and willingness to make decisions regarding the implementation of the system, but several negative indicators for successful adoption as well. The Marine Corps would likely be assessed an observable failure regarding the organizational operating model

(structure, processes, and policy) aligning with the implementation of a new data system and regarding a strategy that addresses the fundamental root cause of problems with the Marine Corps maintenance cycle. For full implementation of a program, trade-offs need to be made to continue to advance automated information systems: "either military processes must change to be compliant with those in the commercial world or an organization must bear the cost of developing and maintaining custom solutions for their unique but essential processes" (Aronin et al., 2018, p. 12). Lessons learned from the adoption of GCSS-MC can apply to additional technology integration efforts and provide valuable insights into further Marine Corps organizational change initiatives.

D. CBM+ PRIOR RESEARCH

Whitaker (2019) applied the concept of automated data collection and data analysis to provide real-time monitoring of maintenance conditions for a given piece of ground equipment. The thesis demonstrated that COTS sensing hardware and openly available software can support the data collection and processing requirements necessary to develop an implementable CBM framework for platforms in the Marine Corps. Though the focus of the research was centered on a single statistical model for the Marine Corps Medium Tactical Vehicle Replacement (MTVR) engine, the research demonstrated the utility of data aggregation to identify maintenance trends and improve operational availability of a given component. The research was limited in recommendations for practical implementation, but briefly outlined a CBM "policy that can be used to enhance preventative maintenance methods and decision support capabilities on Marine Corps ground equipment" (Whitaker, 2019, p. v).

It is worth noting that implementation of CBM+ has not garnered universal, immediate success in all organizations that have adopted the maintenance model. Meyer Zu Wickern, in 2018, identified five challenges consistently facing predictive maintenance adoption based on observations in the private sector: "financial and organizational obstacles," "data source limitations," "limits of machine repair activities," "optimization narrowness," and "sentiment towards challenges and outlook" (Meyer Zu Wickern, 2018). The struggles faced in the private sector echo those of the Marine Corps with GCSS-MC

and are cautionary tales to the deliberate nature with which the Marine Corps needs to approach CBM+.

In a study of CBM for land force vehicles for the Australian government, Rajesh and Francis (2012) identified a litany of challenges that implementation of CBM would face. While many of the challenges required technical solutions, multiple challenges arose from organizational inertia and required redress through policy and management solutions. These challenges included cost-benefit analysis that holistically captured CBM implementation; the initial high capital cost; the size of the fleet of vehicles subject to CBM implementation; adoption of transitional technologies while not having an immediate demand signal for acquisition; changes to maintainer skill requirements; identification of the who, what, and how frequent for data requirements; and the lack of overarching CBM policies (Rajesh & Francis, 2012).

Inroads have been made in the Marine Corps regarding the generation of policy, planning groups to identify data requirements, and the conduct of cost-benefit analysis. However, the size of the fleet of vehicles and the intention of a total force implementation remain concerns for the Marine Corps. Different levels of implementation will need to occur with a judicious approach in targeting and prioritizing platforms that would be candidates for a shift in the maintenance strategy.

Stuetelberg and Thomas (2021) conducted a similar study into industry predictive maintenance best practices that could be incorporated into the Marine Corps. While information technology infrastructure was an area that requires considerable investment for effective CBM implementation, the study emphasized the need for the effective application of ERPs. Substantial attention should be given to how the user will interface and make decisions with the data collected by sensors and how a predictive maintenance approach will require adjustments to manpower, training, and procedures (Stuetelberg & Thomas, 2021). The Marine Corps needs to be methodical in its approach and have a deliberate process for trade-off decision points regarding the retrofitting of legacy platforms with sensing technologies.

Approaches and phases with implementation vary widely in industry. Shin and Jun (2015) defined the approaches for implementation as data-driven, model-driven, and hybrid. There is a balance to be struck between the data-driven approach, which has a heavy dependency on the quality of the operational data, and the model-based approach, which incorporates a physical understanding of the platform (Shin & Jun, 2015). Regardless of the model chosen for implementation, there are common conditions that need to be in place prior to adoption. One of the first conditions is to determine which data needs to be captured and which MCTs are appropriate for a given platform. This data will help inform the decision method for determining which maintenance option is most cost-effective. Therefore, preventative maintenance is still a component of a predictive maintenance strategy. Additionally, a decision needs to be made based on the specific platform as to whether CBM is effective for a given platform or part since it is not effective in all cases (Shin & Jun, 2015). As identified in Stuetelberg and Thomas (2021), preventative maintenance models may particularly serve better in instances of limited data collection or compilation capability. CBM, as it is adopted on a by-platform basis, will need to be implemented with consideration for the impacts to other maintenance cycles, personnel, and procedures for related systems. In adopting integrated systems, we need to be particularly cautious when considering CBM+ implementation and ensuring execution aligns with the holistic maintenance strategy.

While CBM+ is heavy with data analytics through growing IT infrastructure and cloud-based computing, CBM+ application is more than just a software solution. Experience from USAF program adoptions point to CBM+ as a "maintenance toolbox" that requires cultural change and adjustments to current maintenance inspection models to succeed (Dayton Aerospace, 2018). Individual platforms will require systematic platform-specific approaches to address key CBM+ enablers such as infrastructure and policies.

E. ORGANIZATIONAL CHANGE APPROACH

There are numerous models and frameworks published that can be used to help facilitate organizational change. The approach that guides this analysis of organizational change in the Marine Corps concerning CBM+ implementation is primarily from

internationally recognized experts in strategic change and leadership, Michael Beer and John Kotter. Both experts have served as Harvard Business School professors and have conducted extensive research projects, case studies, and written numerous books and articles on the topics of leading change and organizational effectiveness. Their works have proven to help organizations execute successful large-scale change initiatives over the past several decades. The combination and integration of their change models or frameworks provide a practical guide to help the Marine Corps implement change toward CBM+ within the organization.

Michael Beer, in his 1988 *Harvard Business Review* article, Leading Change, provides a conceptual formula that outlines the critical dimensions of change that must be considered for organizational change to be successful (Beer, 1988):

Amount of Change = (Dissatisfaction × Model × Process) > Cost of Change

Beer's formula describes in simplest terms that for organizational change to be successful, the amount of change required must be stronger and more compelling than the cost it takes to change (Beer, 1988). The "Dissatisfaction" element of the formula relates to the level of dissatisfaction the key organization members have with the status quo of their current state. There needs to be a deliberate effort to increase the level of dissatisfaction with the status quo which can be raised in numerous ways. Beer asserts that information and data about the organization's performance and its environment should reveal the current and prospective problems, and then discussions should be generated to elevate the impacts. "Information about the concerns of employees and their perceptions about how the company is being run can be a powerful tool for creating 'dissatisfaction' among managers" (Beer, 1988). Beer further contends that relying solely on data alone is not sufficient; there needs to be a dialogue about the meaning of the data to reveal underlying assumptions and come to a shared explanation of stakeholder difficulties within the organization.

The "Model" in the formula refers to a vision of the future state of the organization. This includes the behaviors, attitudes, structures, and systems that must be developed for change to occur. Beer stated, "The future state envisioned should reflect the

multidimensional nature of organizations" (Beer, 1988). The vision developed needs to connect with the people in the organization and address the numerous dimensions of the organization. It is valuable to have an organizational unit that exhibits the success of the change envisioned to build credibility and be an example for other organizational units to learn from.

The "Process" in the formula recognizes that organizational change takes time to see results. Beer describes, "the process for change is a *sequence* of events, speeches, meetings, educational programs, personnel decisions and other events aimed at helping employees, including top management, learn new perspectives, skills, attitudes, and behaviors" (Beer, 1988). He further emphasizes the benefit of involving people within the organization in developing the processes of change noting that people will become more committed when they are part of creating the solutions. A well-planned process that is shaped by the participation of people in the organization provides a greater chance of successful change.

Lastly, the "Cost of Change" in the formula indicates the losses stakeholders expect because of change. Beer explains typical losses stakeholders experience due to organizational change being power, relationships, rewards, and identity (Beer, 1988). Beer states, "it is the fear of losses that is the cause of resistance to change" (Beer, 1988). Therefore, to achieve successful organizational change a good understanding of the resistance level is necessary to determine the strength in dissatisfaction with status quo, vision, and processes to overcome the cost of change.

Kotter's 2012 eight-stage process of creating major change reinforces and describes in greater detail the practical application of Beer's conceptual formula. Kotter asserts that each of these eight process stages needs to be achieved to create enduring change within an organization. Additionally, Kotter's examination of success stories has revealed two important patterns regarding organizational change. First, in alignment with Beer's formula, Kotter states that, "useful change tends to be associated with a multistep process that creates power and motivation sufficient to overcome all sources of inertia" (Kotter, 2012, p.22). Second, change must be "driven by high-quality leadership, not just excellent management," for a change process to be employed effectively (Kotter, 2012, p.22). These

two important observations, backed by extensive research, are used to underpin recommended solutions to implementing change in the Marine Corps. Figure 1 is a summary table of the eight-stage process as well as an in-depth description that will guide recommendations.

Figure 1. John Kotter's 8-Stage Process for Leading Change. Source: Kotter (2012).

A key factor of effective change that is often overlooked or underappreciated is the *heart of change* (Kotter & Cohen, 2002). Most change initiatives in large organizations place the heaviest focus on policy, process, structure, operations, data, and analysis and not enough on things that appeal to emotions and inspires people in the organization to act and

change. John Kotter and Dan Cohen, understood the significant value and importance of connecting with people's emotions to spark behavior change and action that leads to success, so they wrote a book called *The Heart of Change* and an accompanying field guide. Change can be very hard, therefore successful transformation cannot solely be accomplished by structural and operational changes within the organization, but people's behaviors also need to change (Kotter & Cohen, 2002). Changing behaviors requires intentional focus on connecting with people and providing them a compelling vision that positively impacts them and the organization as a whole in the long run.

The Heart of Change outlines two approaches to change: "analysis-think-change" and "see-feel-change" (Kotter & Cohen, 2002). Most companies in the business world and in military or governmental organizations lean toward "analysis-think-change" methods. However, the "see-feel-change" method which targets people's emotions caused behavior change more so than "analysis-think-change."

In a 2021 published book by Kotter titled, *Change: How Organizations Achieve Hard-To-Imagine Results in Uncertain and Volatile Times*, he dives into the science of change and how that impacts success (Kotter et al., 2021). After extensive research and observations of hundreds of companies Kotter states, "Without sufficient communication of a rational and emotionally compelling case for change, it was nearly impossible to achieve buy-in that inspired and mobilized the action required to drive and sustain difficult changes" (Kotter et al., 2021). He goes on to say, "We have seen that the most successful large-scale change efforts start with a clearly articulated, compelling, and emotionally inspiring opportunity." A key concept emphasized in Kotter's study on change, is the focus on communicating the opportunities that the change provides. This opportunity seeking communication reinforces a compelling vision to initiate and maintain momentum for behavior change which leads to holistic organization change.

F. 3D MARINE LOGISTICS GROUP CBM+ IMPLEMENTATION

The Commanding General for 3d Marine Logistics Group (MLG) published the *3d MLG Condition Based Maintenance Plus (CBM+) Implementation Report* 14 October 2022 (3d MLG, 2022). The report captured the results of modified maintenance induction

processes for "D" Table of Authorized Materiel Control Number (TAMCN) equipment at 3d MLG over the previous year in concert with a policy waiver. The policy waiver will be later referred to in our paper as an exception to policy (ETP), for MCO 4790.2 granted by the Deputy Commandant Installations and Logistics (DC I&L) and provided detailed data and recommendations for process improvements. In the absence of immediately available technology that supports CBM+ efforts, the 3d MLG CBM+ strategy focused on people and process improvements. An example of 3d MLG's improvements was the removal of non-value-added administrative steps in the maintenance cycle which minimized maintenance costs, reduced maintenance cycle time, and improved production. Change effort successes were measured in improvements to the maintenance downtime, preventative maintenance monetary costs, labor man-hours, and days in the administrative maintenance process as seen in Table 1.

Table 1. Executive Summary Results 3d MLG 2022 Report.
Source: 3d MLG (2022).

Goal Name	Measurable Points	Pre-CBM+ Avg	Goal	Post-CBM+ Avg
Balance Maintenance Effort	CM Days Deadline	44.25 Days	30-70 Days	**24.2 Days**
	PM Cost	$ 85K	$ 75K	**$ 32K**
	PM Man-Hours	3176 Hours	2,150 Hours	**83 Hours**
Reduce Days in Shop	DRIS to SR Close	103.56 Days	50-70 Days	**27.46 Days**

The report was able to display year-over-year improvements in MCT, days in shop, and days deadline as a result of CBM+ process improvements. Figure 2 presents the trends in maintenance cycle from 2017 through 2022.

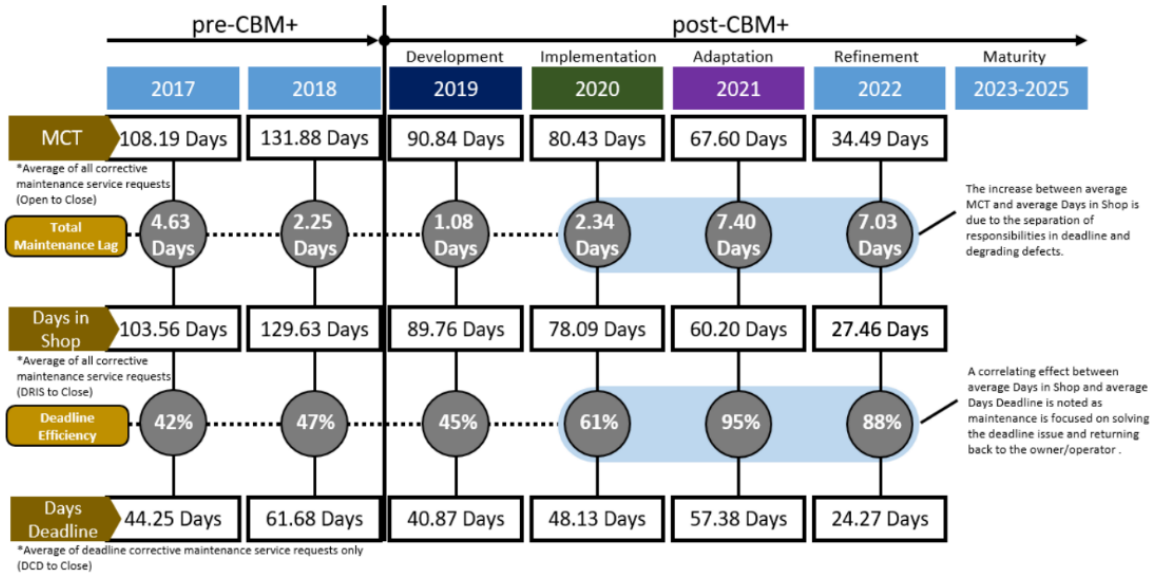

Figure 2. 3d MLG Pre-CBM+/Post-CBM+ CM Data Metrics. Source: 3d MLG (2022).

The 3d MLG report identified lessons learned and provided recommendations for scaling efforts to be adopted in the Marine Corps. Key takeaways from the report include the importance of capitalizing on incremental gains, incorporating stewardship/ownership in CBM+ implementation efforts, adequate communication about and training for changes to the maintenance strategy, and engagement with leaders to ensure changes are adopted.

While the 3d MLG ETP period only applied to D TAMCNs at a single major subordinate command (MSC), the improvements and efficiencies achieved through process change and people development, reflect a functional approach to CBM+ that is primed for incorporation at the enterprise-level. In his endorsement on the report, the Commanding General for 3d MLG, Brigadier General Adam L. Chalkley, advocated that, "3d MLG has marked out a trail for the enterprise to follow to achieve the future state of maintenance in more minor distributed elements. Additionally, 3d MLG CBM+ implementation demonstrates that immediate positive results will occur when embraced by the service" (3d MLG, 2022). The lessons learned from 3d MLG are revisited in the fourth and fifth chapters of our paper.

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III. METHODOLOGY

We reviewed Marine Corps policies, practices, and organizational structure to identify key roles, information flows, and policy directives in the maintenance community that influence maintenance decision-making and CBM+ implementation. We furthered our understanding by interviewing military and civilian SMEs within the FMF, supporting establishments, and other DOD organizations. We identified and synthesized themes and patterns in the information collected. Then we conducted thematic analysis to identify barriers to and opportunities for change within the Marine Corps maintenance community. An organizational change approach and a theoretical concept of successful change principles informed our development of recommendations for implementation to lead to effective CBM+. The major steps of the methodology were:

1. Identify key roles based upon Marine Corps structure and SMEs associated with each role.
2. Review relevant guidance and policy procedure documents.
3. Conduct interviews with SMEs to address research questions.
4. Capture trends from SME responses.
5. Synthesize and analyze (based on organizational change models).
6. Identify significant barriers to adoption (thematic analysis).
7. Make recommendations for implementation.

A. CBM+ KEY STAKEHOLDERS

CBM+ implementation requires the actions and decisions of several stakeholders throughout the Marine Corps organization from Headquarters Marine Corps (HQMC) down to unit level commanders, staff, maintainers, and operators. Marine Corps requirements are generated from office of Combat Development and Integration (CD&I), directed by a lieutenant general acting in the capacity of Deputy Commandant (DC) CD&I. With respect to CBM+, there is a Materiel Readiness Branch, Logistics Combat Element

Integration Division, that facilitates and creates the requirements documents. These requirements documents influence and drive the policy and acquisitions decisions. Policy is established at the HQMC level, therefore policy concerning maintenance in the Marine Corps is published within the HQMC Installations and Logistics (I&L) office directed by a Lieutenant General acting in the capacity of DC I&L. Acquisitions is the responsibility of Marine Corps Systems Command (MCSC), commanded by a Brigadier General. In October 2022, a CBM+ Program Office was established to support the implementation of CBM+ by procuring the technology and equipment necessary to fulfill the CBM+ requirements published by CD&I.

Key stakeholders in the Marine Corps operational forces include the Marine Expeditionary Forces (MEF), primarily the Commander and G-4 leaders; the Major Subordinate Commands (MSC) which include the Divisions, Marine Logistics Groups, MEF Information Groups (MIG), and the Marine Aircraft Wings (MAW). Additionally, leaders, key staff, and maintenance personnel resident in the regiments and battalions contribute to the success of CBM+ implementation and execution. The MEF G-4 and staff are responsible for directing actions within the MEF to improve the materiel readiness which includes close coordination with weapon system program offices for guidance as well as disseminating policy direction to subordinate commands. It will be vital for the MEF G-4 to understand the CBM+ vision and proper execution to effectively communicate CBM+ implementation efforts to the MEF leadership and subordinate elements.

B. RESEARCH PARTICIPANTS

Fifteen maintenance and logistics Marines were interviewed during the research process. Interviews ranged from an hour to two hours with select interviewees being interviewed a second time. At the enterprise level, six Marines were interviewed with participation from individuals at HQMC CD&I, I&L, and SYSCOM. At the Major Subordinate Command, two senior Marines and a senior logistics analyst were interviewed. At the operational unit level, six maintenance officers and three maintenance chiefs were interviewed. Interviewees were selected based on prior knowledge and experience with CBM+ implementation efforts within the Marine Corps. Most respondents were selected

from 3d MLG and were participants in 3d MLG's implementation process. Participants within 3d MLG were able to juxtapose CBM+ practices with legacy maintenance policies using experiences prior to and after their time with 3d MLG. Interviewees had an in-depth understanding of legacy maintenance strategies and CBM+ implementation.

C. INTERVIEW QUESTIONS

The questions developed for interviews conducted with SME and key billet holders were based on the following two overarching research questions:

- Primary Research Question: What are the key factors impacting CBM+ implementation in the Marine Corps? What decisions and actions can the organization and leaders take to support the management of CBM+ adoption?

- Secondary Research Question: If we make the assumption that technological systems required to implement CBM+ are within reach, what business processes need to be in place to facilitate the CBM+ maintenance strategy?

The following set of questions were asked of all participants:

1. What is your billet and unit? What prior experience or exposure do you have with CBM+ and legacy maintenance practices?
2. How would you define or explain CBM+?
3. Has your unit utilized the CBM+ MCO and guidebook? Is it integrated in your SOPs? If so, how long has it been integrated and how are the concepts employed?
4. How/what do you perceive the overall vision for CBM+ in the Marine Corps? Is it compelling? What do you find compelling about the maintenance strategy?

5. What are the critical drivers for maintenance practices and processes within the Marine Corps? Do the drivers create an effective sense of urgency at your command?

6. What would create a greater sense of urgency for CBM+ adoption? Is the burden of the status quo greater than the cost to change? What competes for focus of effort with CBM+ adoption?

7. How are CBM+ processes being employed within your command? How does this differ from previous commands and adjacent commands?

8. What enabled the implementation of the CBM+ processes?

9. What challenges have you experienced in executing CBM+?

10. What data do maintenance decision makers need to inform improving operational availability? Are we able to harvest that data with current technology and tools? How would condition data need to be presented to leaders?

11. Does CBM+ change how readiness is presented to commanding officers and other leaders within the organization? What understanding do commanders need of CBM+ and the Marine Corps' maintenance strategy?

12. Is there friction in the readiness reporting process that will impede CBM+ adoption? Does readiness reporting need to change and how?

13. Is change to maintenance policies by incorporating CBM+ a disruptive process that impacts operations or is it an incremental change? Is there a tolerance level for disruptive change to maintenance strategy?

14. How do ground units and higher headquarters interact regarding ground maintenance? How are lessons learned and process improvements communicated unit to unit? How are lessons shared and promulgated across the enterprise?

15. How do inspections influence the decision-making process by maintenance personnel and leaders within the organization?

16. What other barriers or change opportunities exist within the organization that could impact the success or failure of CBM+ as a maintenance strategy?

17. What singular change could have the greatest influence on CBM+ adoption?

D. THEMATIC ANALYSIS

Responses from interviewees were consolidated into two overarching categories of barriers and opportunities for change. Under each category common themes were determined based on frequency of response from interviewees and emphasis placed during interview sessions. The themes presented in Chapter IV reflect a combination of our interviews and organizational change literature. Our recommendations offer a response to these themes.

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IV. FINDINGS AND ANALYSIS

The findings and analysis presented in this chapter are organized into eight major themes that were discovered during the interview and research process. The eight themes are split into two categories; barriers identified and opportunities for change. Analysis of our themes is presented through an organizational change approach as it applies to CBM+ and Marine Corps maintenance strategies. Recommendations related to these themes will outlined in the subsequent chapter.

A. BARRIERS IDENTIFIED

In our interviews and research four major themes emerged as barriers to CBM+ implementation in the Marine Corps. The first theme was a lack of clear and consistent understanding of CBM+ across the FMF. The second theme was conflict between various orders and policies that delineated Marine Corps maintenance strategy. The third theme identified how inspections heavily influence maintenance actions at the operational unit level. The final theme highlighted the effects competing priorities have on focus and capacity necessary to change maintenance strategies.

1. CBM+ Not Understood Throughout the FMF

Gaps in the CBM+ policy, emphasis on technology solutions, and legacy maintenance practices prevent a clear understanding of the CBM+ vision and maintenance strategy. There appears to be a stove-piping of efforts to adopt CBM+ which has led to a slowing of implementation efforts. Slowed implementation efforts can be tied to an inconsistent interpretation of the vision for CBM+ in the Marine Corps, which varied based on respondents, billets, and duty station. In various parts of the organization, the CBM+ vision is incomplete, not fully understood, or ineffectively communicated throughout the organization. This incongruency is characteristic of maintenance practices in the Marine Corps and was observed in the 3d MLG report.

> There was a complete compartmentalization and disassociation of focus of effort, alignment of priorities, organizational cohesiveness, and integration/ unification of perspectives in the tactical maintenance effort. This

> contributes to the proliferation of the layering of additional responsibilities on the maintenance activity serving as an additional maintenance management check and backstop for owner/operator maintenance. There is an institutional culture of accepting the current maintenance policy without questioning the value process steps in the greater mission of combat readiness, material condition maintenance, and data inputs/capture. (3d MLG, 2022, p. 101)

3d MLG's observation highlights the added administrative burden and requirements placed on maintainers which results from separate and sometimes conflicting visions of the Marine Corps maintenance strategy.

Maintenance officers interviewed expressed that there were different visions of CBM+ implementation in the Marine Corps between HQMC elements and operational units. The most important difference is between a focus on processes versus a focus on technology as the prioritized effort for accomplishing the vision. One interviewee summarized,

> So the focus is technology at the high level, and at the 3rd MLG level, my level, it was focused around process and change management, change expectation management, because it's not going to fix you overnight. It's going to take time to get to where we need to be. But I don't think technology is the answer right off the bat. I think we change our process. (Maintenance SME, interview, 2022)

In developing 3d MLG's implementation plan, policies were crafted to nest within the CBM+ implementation intent and provide an obtainable pathway to achieve the vision. The 3d MLG CBM+ implementation report summarized the need for executable policy to address gaps in the enterprise implementation plan.

> The policy represents the organization's "what" in terms of the goal and intentions of the program. The policy to be effective must be set at the highest level available. Therefore, 3d MLG had an enterprise policy that stipulated an overarching goal but did not necessarily provide more tactical implementation guidance. 3d MLG carefully built upon the enterprise policy and filled in the gaps focusing on people and processes. (3d MLG, 2022, p. 65)

3d MLG's ability to execute CBM+ implementation was through a focus on people and processes with intermediate guidance by the MSC to enable unit level execution. However, outside of 3d MLG and HQMC, maintenance officers and chiefs agreed that the

CBM+ vision is not being successfully communicated throughout the FMF. A maintenance officer interviewee expressed that, "the vision of CBM+ is not being received at the lowest level. They do not know what CBM+ is" (Maintenance SME, interview, 2022). In most cases, unless a unit is part of a proof of principle, the CBM+ order and guidebook are rarely used or applied to local maintenance practices. Interviewees suggested the lack of knowledge or engagement with the CBM+ vision across the FMF was closely associated to a perceived lack of immediate usefulness (HQMC, interview, 2022). The perception is that CBM+ appears as a technology centered program that will be available in the future rather than a process that can be applied to current practices for immediate gains. Credible feedback from the FMF is not being implemented in policy to further enable implementation. 3d MLG found that,

> Changes must be able to be generalized enough to be portable and transferable from garrison to the field and back, as well as capable of implementation across the force both horizontally and vertically. However, interpretation cannot be so general that it becomes ineffective. A balance must be initiated where it isn't 'one size fits all.' (3d MLG, 2022, p. 60)

Changes to maintenance practices and policies in the Marine Corps to implement CBM+ as a strategy must be digestible with clear intent and goals. For change to maintenance strategy to be fully accepted, disruptive thinking needs to be embraced as a part of the culture put forth by the vision for CBM+ adoption. 3d MLG described the relationship between disruptive thinking and CBM+ policy changes as follows:

> This analysis has been a catalyst for disruptive thinking among motor transport professionals responsible for accomplishing and sustaining operations. As more Marines are exposed to the science, theories, and principles, we observe a change in how thinking, questioning, and knowledge are incorporated into day-to-day mission execution. The strength of this analysis is best revealed when the Marines no longer accept the established status quo and begin to question the "how" and "why" of the current paradigms with a desire to improve maintenance processes and outcomes. In many ways, this thinking has ushered in a renaissance in maintenance execution re-design for distributed operations and how those techniques/methods influence outcomes. (3d MLG, 2022, p. 100)

A key component of CBM+ that is not currently emphasized in the vision is the empowerment of Marines and operational units to seek creative means to solve complex

maintenance problems. 3d MLG identified that for CBM+ to be realized as an effective ground maintenance strategy there needs to be an environment that encourages Marines to try new maintenance processes with a tolerance to change.

CBM+ implementation rests upon three main pillars; people, processes, and technology. There is a tendency to narrowly focus on technology to the detriment of the attention required for people and process changes necessary to support technology once it is available. Combating existing organizational inertia rooted in legacy maintenance strategy mindsets is a required step prior to the fielding of sensors and analytic tools. The heavy focus on technology, legacy maintenance thinking, and gaps in CBM+ policy impede a clear, unified, and widespread understanding of the CBM+ vision and maintenance strategy.

2. Marine Corps Maintenance Policies Conflict

The current vision portrayed through orders, policies, and directives sets CBM+ apart as a distinct and separate program from current maintenance strategies. Distinct maintenance policies that are not mutually supporting lead to a muted vision and place CBM+ on the periphery of Marine Corps maintenance rather than making it an integrated change effort. Orders directing opposing maintenance strategies currently leave an ambiguous vision for change efforts with no prescriptive means for achieving observable gains through integration into current policies and practices.

The tenets identified in MCO 4151.22 for CBM+ closely reflect the Kotter change model but keeps CBM+ as a distinct and separate policy from the overall maintenance strategy of ground equipment. The distinction requires maintainers to continue to follow maintenance strategies from MCO 4790.2, which does not mention CBM+, RCM, or predictive maintenance concepts as part of the Marine Corps overall maintenance strategy. Rather MCO 4790.2 is highly prescriptive in maintenance processes for the Marine Corps and restrictive in innovative changes to established maintenance practices. For example, “Commanders are not authorized to deviate beyond the minimum established schedule(s) for the conduct of PMCS tasks. When tasks are identified that are either redundant and conditions warrant change Commanders will recommend changes to these tasks to the

appropriate program manager via NAVMC 10772 or PQDR" (HQMC, 2016, p. 3-9). The change process is cumbersome and requires coordination for each individual change with I&L and specific PMs.

Prescriptive maintenance policies such as MCO 4790.2 have not been updated and do not align with current ground maintenance strategy documents for CBM+. This misalignment between orders leads Marines to rely on the legacy policies that provide prescriptive actions. A consistent theme among maintenance officers interviewed was that "the [MCO] 4790.2 does not change, and in fact, the [MCO] 4151.22 doesn't necessarily provide processes, so even if you were trying to say, the [MCO] 4151.22 conflicts with the [MCO] 4790.2 … the [MCO] 4790.2 still has a lot of cleaning up to be done" (Maintenance SME, interview, 2022). In 3d MLG's implementation efforts, the conflict between orders led to the requirement for an ETP to allow for changes to processes associated with MCO 4151.22 to supersede applicable portions of MCO 4790.2. However, exceptions and waivers have limited application and usually require units to proactively seek them. Innovations require an open approach to MCO 4790.2 and an integration of the 4151.22 into the overall maintenance strategy. The 3d MLG report addressed this barrier with the following:

> The methodologies of data capture, reporting, and incorporation of executable processes supporting operations need a complete overhaul. (3d MLG, 2022, p. 100)

The MCOs regarding CBM+, MCO 4790.25 and MCO 4151.22, provide definitions for CBM+, but do not present a means for integration into the ground maintenance strategy or a pathway for refinement of existing orders/processes. This lack of means for integration creates an environment where many view CBM+ as a faraway future solution tied to technology acquisitions rather than understanding a shift in maintenance strategy approaches to be executed immediately. Additionally, those that are seeking to move forward with process improvements do not have a clear path to capture process improvements in line with the strategy and disseminate those improvements across the enterprise.

3. FSMAO and Commanding General Inspections Ignore CBM+

Our findings indicate CBM+ is not mentioned in any inspection checklists therefore creating a barrier for CBM+ awareness and execution. Marine Corps organizations put focus on areas that are inspected and the basis for ground maintenance inspections is the FSMAO inspection checklists and the Inspector General Functional Area Checklists used for the Commanding General Inspection Program (CGIP). The questions in these inspection checklists are drawn from policy documents. The current, FY22 FSMAO inspection checklist and CGIP checklist for maintenance reference the MCO 4790.2 as the primary policy document which inspection questions evaluate. The MCO 4151.22, CBM+ Order, was published in 2020 but is not referenced in any inspection checklist. Units are evaluated based on their compliance with the questions in the inspection checklist, therefore units are naturally drawn to prepare and operate in accordance with those requirements. This has shown to be a significant barrier to CBM+ implementation and will continue to prevent units from experimenting with CBM+ processes and practices.

The 3d MLG report observed that, "leaders were concerned with "passing FSMAO" as a reason not to make changes" (3d MLG, 2022). The impacts of inspections on commanders and units were a repeated concern brought forward in interviews with maintenance officers and maintenance chiefs. Commanders and maintenance personnel are currently evaluated against legacy maintenance policies and are required to conduct burdensome administrative actions to ensure compliance. Until there is a mechanism or policy action to lift these inspectable legacy maintenance requirements, the organizational environment will not be conducive for change to a CBM+ maintenance strategy.

4. Competing Priorities Consume Capacity

Capacity at commands is a product of resources, manpower, and focus that are competed over by a variety of programs. CBM+ implementation has been challenged by other competing priorities which has slowed down the change process. Monetary and manpower resources for new programs within the Marine Corps, and larger DOD, are finite. Per 3d MLG's CBM+ maintenance approach,

> The scope of this program is to address maintenance processes and is limited to the resources already available at the implementing unit. Additional funding, manpower, or extended work hours is not sustainable and therefore cannot be part of the solution set as a matter of routine. The scope of all our efforts centers on low-cost/no-cost solutions, primarily the process of how maintenance is performed, the effectiveness of the maintenance effort, and what maintenance actions are reported as a matter of value. (3d MLG, 2022, p. 10)

3d MLG's ability to execute CBM+ with low-cost/no-cost solutions means that significant time and attention needs to be applied to consolidate gains from CBM+ related people and process improvements. In the current environment, the focus on the Financial Internal Control and Audit Readiness program (FIAR) and passing the audit crowd out efforts to implement CBM+ by putting a drain on time, focus, and manpower resources. Interviewees described the audit as taking the preponderance of focus from policymakers and executers. CBM+ was described as a lesser priority that did not receive the amount of time necessary to implement maintenance strategy changes. The relationship between the audit and CBM+ was overall perceived to be competing for resources and attention (HQMC, interview, 2022).

The limited capacity of units to address administrative requirements has ramifications for the execution of maintenance strategies. Interviews conducted with policymakers reflected that the audit process reinforces many of the non-value-added tasks in the maintenance process, through inspections, that directly inhibit CBM+ improvements and the overall maintenance process (HQMC, interview, 2022). Legacy maintenance practices impact flexibility and burden maintainers which reduces capacity to make improvements. Maintainers do not have time to seek out potential process improvements without means to capitalize and capture gains from existing resources. The relationship between CBM+ and the audit provides an example of how competing priorities require Marines and leaders to place a hierarchy of importance on new initiatives. There are finite personnel, time, and money available to be applied to various initiatives across the FMF. Capacity available for CBM+ integration needs to be maximized to realize meaningful gains across the FMF.

B. OPPORTUNITIES FOR CHANGE

During the conduct of our interviews, four themes emerged from interviews as potential solutions to gaps in CBM+ implementation. The first theme indicates that leaders within the organization need to drive the CBM+ maintenance strategy implementation process. The second theme emphasizes the benefits of temporary waivers of policies that restrict adoption of CBM+ maintenance practices. The third theme is the opportunity to remove non-value-added tasks within maintenance practices to achieve measurable gains. The final theme is the concept of ownership in the change process and the application of cross-training within operational units.

1. Leadership Buy-In and Advocacy

Commanders must have an awareness of CBM+, understand its benefits, and support the change for unit's to effectively implement CBM+ processes and practices in the organization. The role of leadership in effective implementation echoes Kotter's finding that in successful change stories, change must be driven by leadership (Kotter et al., 2021). During interviews with several maintenance officers, a common theme identified was the weight a commander's support can bring in driving change and creating a sense of urgency (Maintenance SME, interview, 2022). One SME surmised that, "if the Marine Corps wants to fully implement CBM+ and our leadership wants us to do that, we should not have any issues doing it because we write our own policy" (Maintenance SME interview, 2022). Maintenance officers expressed that a commander's interest and advocacy drives urgency more than anything else (Maintenance SME interviews, 2022). Therefore, there is critical importance for commanders throughout the chain of command to understand what CBM+ is and how they can help foster the environment within their units to enable CBM+ success.

3d MLG demonstrated a successful practice in building leadership buy-in and advocacy. Prior to a unit conducting CBM+ implementation, the G-4 staff provided a CBM+ overview brief that equipped commanders and key staff with the understanding of CBM+, the 3d MLG implementation approach, immediate process improvement opportunities, and how to best facilitate successful adoption (3d MLG, 2022). This training

to leaders in the organization created greater buy-in throughout the unit and enabled Marines to execute CBM+ processes (Maintenance SME, interview, 2022).

Urgency for CBM+ must be supported and advocated by commanders and leadership in the chain of command. CBM+ technology is not currently a disruptive technology that forces an organization to change which means changes will be incremental in nature. Maintenance officers reflected that since legacy maintenance practices function to meet mission, a sense of urgency would need to be generated by commanders to implement new maintenance practices (Maintenance SME interviews, 2022). Maintenance officers concluded that leaders need to be presented with the relatively low-risk of CBM+ implementation in contrast to the potential high-rewards (Maintenance SME, interview, 2022). There is not a clear understanding of the low-risk relative to high-rewards that will encourage them to seek policy exceptions and drive policy change. Buy-in by leaders across the FMF will generate urgency necessary to accomplish CBM+ implementation efforts.

2. Exceptions to Policy Enhance CBM+ Implementation

Interviews with 3d MLG maintenance officers highlighted the importance of an interim ETP in the ability to implement CBM+ processes and practices in their daily activities. An ETP enabled them to adjust their processes that were not aligned with non-value-added tasks written in the MCO 4790.2. These units were able to explore new approaches in conducting maintenance that improved efficiency and maintenance production (Maintenance SME interview, 2020). Without an ETP, the unit would be steered to follow the inspection checklists which do not mention CBM+ and mandate the maintenance policy actions in MCO 4790.2.

If units work under an ETP, the valid concern is that they will be able to do whatever they want which could cause things to go awry. To help mitigate this concern, there still need to be guidelines and a planned framework for units to utilize to guide their change efforts and experimentation. 3d MLG's CBM+ Order, playbook, and implementation guide are useful tools to guide units in the implementation efforts. These guidance products can be reproduced and distributed to units throughout the Marine Corps to get momentum in CBM+ implementation. It provides standards units can use to give them focus and direction

throughout the transition while also allowing healthy modification and experimentation to improve processes in specific contexts.

3. Reductions to Non-Value-Added Maintenance Actions

Non-value-added maintenance actions such as administrative or duplicative tasks waste time and resources in maintenance organizations. Feedback from 3d MLG demonstrated that a deliberate reduction in non-value-added actions creates opportunities to improve maintenance processes and conduct training on CBM+ (3d MLG, 2022). The current maintenance production process requirements listed in the MCO 4790.2 Appendix C, are overburdensome and there are not enough work hours to effectively complete those tasks across the fleet of vehicles in a typical unit (Maintenance SME interview, 2022).

One significant area in which the Marine Corps can reduce non-value-added maintenance actions and get a good return on investment is to modernize preventative maintenance checks and services (PMCS). For motor transport vehicles, a full preventative maintenance (PM) process is required to be conducted annually. According to the technical manual (TM), it will take forty hours to do a PM for one Logistic Vehicle System Replacement (LVSR). It takes twenty hours to complete the PM process for one Medium Tactical Vehicle Replacement (MTVR). These time-consuming processes across the fleet of vehicles within a unit can overwhelm maintenance personnel, negatively impacting their production on other necessary tasks. Annual PMs create significant burden in man-hours, cost, and redundancy across most motor transport platforms (3d MLG, 2022). Additionally, sometimes the PM actions to check serviceability such as disassembly of components on vehicles can cause components to break during the process creating additional corrective maintenance tasks (Maintenance SME interviews, 2022). This is referred to as conducting over-maintenance which causes a greater risk of breakage and increase labor hours.

There are many opportunities for reducing tasks within the various phases of the maintenance process. Figure 3 displays an example of 3d MLG's approach to reduce the acceptance phase from an eighteen- to six-step process through the removal of non-value-added tasks.

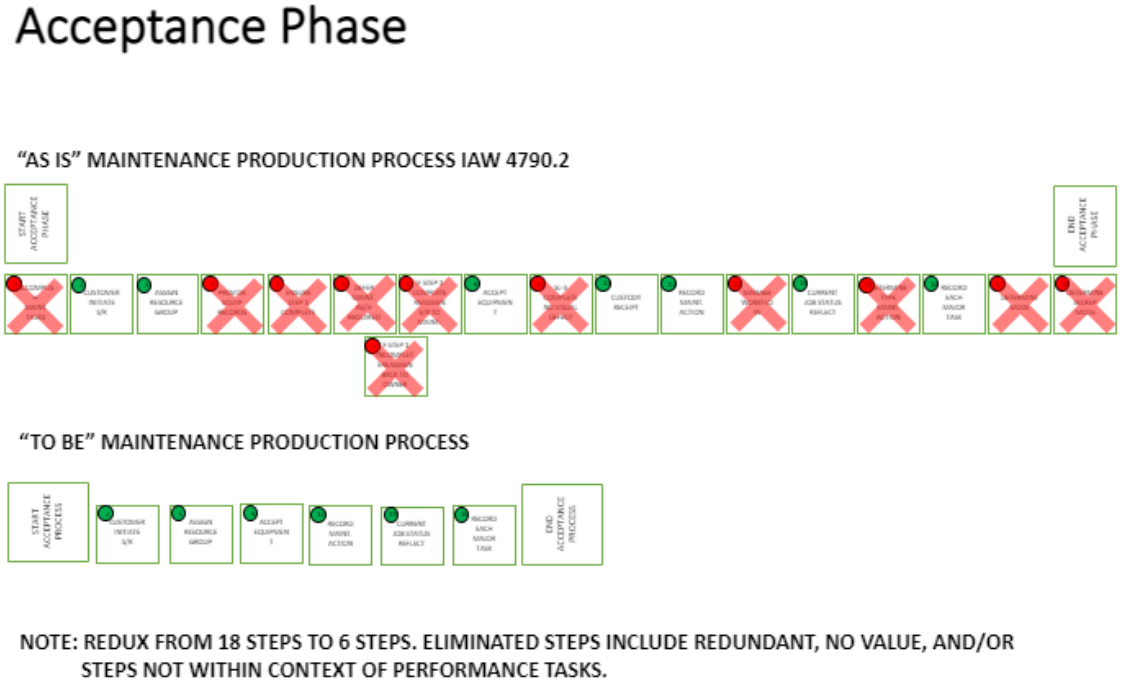

Figure 3. 3d MLG Example Of Maintenance Process Reduction in the Acceptance Phase. Source: 3d MLG (2022).

Reduction of non-value-added tasks has a compounding effect on readiness, cost, and man-hours. Figure 4 highlights the potential gains that can be realized through process changes that eliminate non-value-added maintenance tasks.

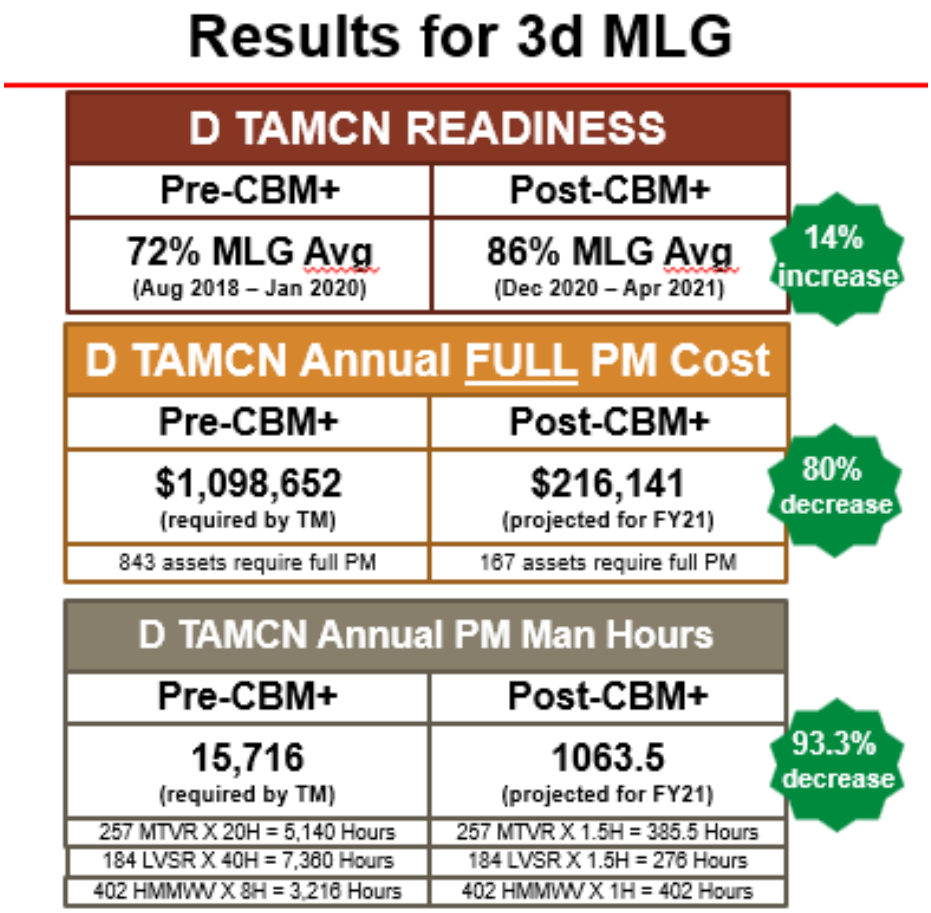

Figure 4. 3d MLG CBM+ D TAMCN Readiness, PM Cost, and PM Man-Hours Analysis. Source: 3d MLG (2022).

There is potential to scale these observed benefits from 3d MLG D TAMCN CBM+ process improvements. Figure 5 provides an estimate of the cost and man-hours savings for a MEF with the implementation of CBM+ processes that seek to reduce non-value-added maintenance tasks.

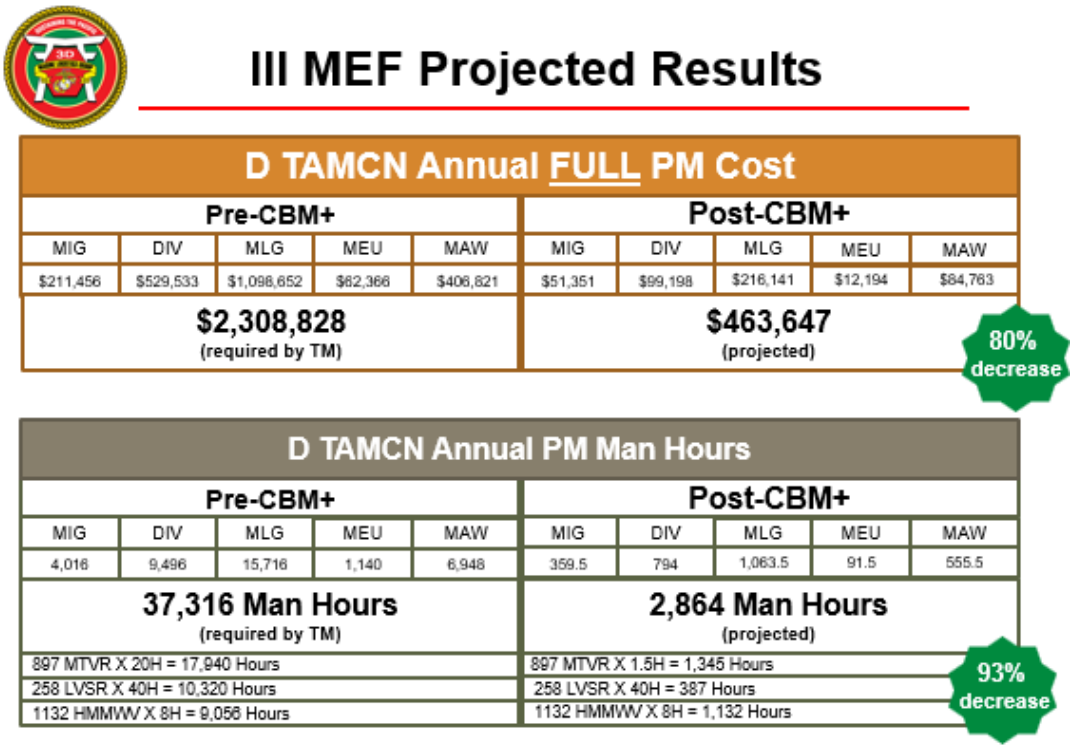

Figure 5. 3d MLG Projection Analysis of III MEF PM Cost and Man-Hours with CBM+. Source: 3d MLG (2022).

3d MLG revealed how much time was saved by adjusting the PM process and discovered there is a reduction in man-hours by 50–60% by eliminating redundant annual PM actions that were already covered in beginning, during, after (BDA) and monthly zonal PM checks (3d MLG, 2022). Due to this modification, there was a positive impact on morale for the mechanics. Additional time could be dedicated toward corrective maintenance repairs to improve readiness and operational availability.

These are relatively immediate results that can be realized across the Marine Corps with this one modification in the approach to maintenance with the focus on the true condition of the assets and eliminating redundant actions within the current maintenance process. Readiness can increase, millions of dollars and thousands of labors hours can be saved and applied to higher priority tasks across the force.

4. Cross-Training Operators and Mechanics

The CBM+ focus on identifying the true condition of the weapon system puts a greater importance on operators becoming more proficient at detecting faults or irregularities in the weapon systems. The "mecherator" (mechanic-operator) concept was developed in 3d MLG which aims to train operators to become more proficient with maintenance actions and train mechanics to better understand operator considerations (3d MLG, 2022). The key benefit of this cross-training is it reduces the amount of time between discovering a fault and getting it repaired. Operators are the first sensors that can detect a problem and identify the condition of a vehicle, so being equipped with basic operator-level maintenance skills can be a force multiplier to make repairs as required while reducing the burden on trained mechanics. Operators possessing the responsibility and maintenance skills to conduct operator-level maintenance such as lights, fuses, door handles, and other degraded actions, can free mechanics to focus time and effort on conducting restorative deadlining actions that only they are authorized and trained to execute.

This concept directly supports the Marine Corps concepts of stand-in forces, expeditionary advanced based operations (EABO), and distributed operations. To operate effectively under those operating concepts, the Marine Corps will need more versatile Marines that are equipped with more skill sets to increase survivability, maintainability, and lethality. CBM+ encourages this cross training in daily operations which will build a more flexible Marine and overall unit that can solve maintenance problems forward with greater confidence.

The 3d MLG report proposed the consolidation of certain military occupational specialties (MOS) that align within maintenance performance roles (3d MLG, 2022). Though there is potential for MOS realignment and changes to training, the key takeaway is the benefit that cross-training provides as a capability multiplier in austere environments. Restrictions on the type of maintenance conducted by certain MOSs and echelons by level should be reviewed and lifted where possible. This will assist in a key finding from the 3d MLG report that, "increased responsibility for the owners/operators provided stewardship at the tactical level improved the material condition of the assets, thereby increasing

operational availability" (3d MLG, 2022, p. 21). The FMF putting greater emphasis on operator-mechanic cross-training provides numerous advantages for the Marine Corps and better prepares the people and process for CBM+ implementation.

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V. RECOMMENDATIONS

Change is difficult and often comes up against a lot of resistance. Effective change requires a multi-pronged approach that leverages existing and new resources to make change happen. These recommendations are based on that understanding and consider the numerous lines of efforts and areas of opportunity that can be leveraged to facilitate CBM+ implementation in the Marine Corps. To build sufficient momentum to change maintenance strategies, various organizational entities and initiatives are required to act in alignment with the CBM+ vision. Organizational change is a dynamic and continuous process therefore these recommendations provide only a portion of the overall change effort. This chapter provides some key recommendations that the Marine Corps should explore in the implementation of CBM+ throughout the enterprise.

A. ALIGN CBM+ WITH *FORCE DESIGN 2030* AND *TALENT MANAGEMENT 2030*

A sense of urgency should be built for CBM+ implementation by communicating to the FMF how it supports the current CMC priority initiatives. Since 2019, the Marine Corps' highest priority has been force design to meet the current and future threats (CMC, 2019). In March 2020, the CMC published *Force Design 2030* (FD2030) which provided an argument for change, vision, and expectations of the force design effort. Significant innovation and experimentation have occurred to meet the FD2030 requirements, and there will continue to be adjustments over the next several years (CMC, 2022). As FD2030 has gained momentum, the Commandant has placed equal emphasis on the priority of *Talent Management 2030* (TM2030) which supports the objectives of FD2030 (CMC, 2021). Included in this document, along with CPG 2019, is the importance of talent retention. The CMC's Planning Guidance states, "Retention of the most talented individuals within the institution is critical" (CMC, 2019). Talent retention is essential to the maintenance community to maintain high levels of readiness.

Shifting from executing maintenance utilizing the MCO 4790.2 that includes many time-consuming and non-value-added maintenance actions toward CBM+ that seeks to

reduce non-value-added tasks and improve operational readiness can directly impact maintenance workforce behaviors, attitudes, and retention. The maintenance community has historically been known to work long hours consistently and still trying to keep up with the demand while seeking to adhere to time-consuming policy requirements (Maintenance SME, interview, 2022). Excessive policy requirements that are difficult to achieve on top of a heavy workload causes added stress and frustration at the mechanic and mid-level manager positions. These are Marines that the Marine Corps needs to retain to mature the force and maintain high talent Marines. The longer the Marine Corps executes legacy maintenance practices, the harder it will be to retain talented Marines in the maintenance community.

A CBM+ implementation initiative across the FMF can instead leverage the young maintenance Marines to help improve maintenance processes in alignment with CBM+ practices which will help gain their buy-in as well as reduce labor hours in the long run. 3d MLG CBM+ implementation efforts have sparked innovation, ideas, and a renewed energy in the junior enlisted workforce (3d MLG, 2022). The junior enlisted maintainers are seeing increased results in maintenance production, equipment operational availability, with reduced labor-hours and redundant tasks. Leaders will have a greater ability to retain Marines that are experiencing these positive impacts than Marines that are operating in an inefficient maintenance process environment. CBM+ implementation can help retain critical Marines and experienced maintainers with the ability to innovate which will enhance CBM+ application. The emphasis on CBM+ benefits to FD2030 and TM2030 objectives should be communicated throughout the FMF to build a greater sense of urgency to change maintenance strategies.

B. ESTABLISH A CBM+ GUIDING COALITION

The purpose of a CBM+ guiding coalition is to, as a team, guide, coordinate, and communicate CBM+ implementation throughout the Marine Corps. Creating a guiding coalition is the second stage of Kotter's change process (Kotter, 2012). A CBM+ guiding coalition should consist of Marines and civilians throughout various levels of the Marine Corps organization. This includes representatives from the battalion-level to the MEF-

level, key supporting establishments, and headquarters elements such as I&L, CD&I, and MCSC.

The guiding coalition should be directed and led from the owners of the Marine Corps maintenance policy and strategies to have the sufficient level of authority and responsibility to initiate and approve enterprise policy change. In the Marine Corps' context that would reside in LPM, Materiel Readiness and Management Branch, in I&L. The members of this guiding coalition need to possess the knowledge, competence, credibility, commitment, will, and drive to get CBM+ maintenance strategy executed throughout the Marine Corps. The deliberate development of this coalition will be critical to the speed, efficiency, and effectiveness in which CBM+ is implemented. This guiding coalition will be a key strategic communication tool to empower broad-based action as well as be a role model for the attitudes and behaviors that are necessary for CBM+ execution. If individuals in this guiding coalition are not fully bought into CBM+, it will create added friction, barriers, and slow down the implementation process. On the other hand, if the guiding coalition consists of highly talented and well-respected individuals from the youngest Marine to senior-level Marines and civilians, then there is potential for accelerated momentum during implementation. There are four key characteristics that Kotter deems to be essential to effective guiding coalitions which are position power, expertise, credibility, and leadership (Kotter, 2012). These four characteristics within the coalition will help give it enough power that is necessary to combat the forces of inertia.

There is potential to use existing tools within the Marine Corps policy refinement process, such as the Total Life Cycle Management Cross Functional Team Model, for a CBM+ guiding coalition. MCO 4000.57A, *Marine Corps Total Life Cycle Management (TLCM) of Ground Weapon Systems, Equipment and Materiel*, established a cross-functional governance structure to support the direction and execution of the total life cycle management strategic framework (HQMC, 2009). This governance structure consists of an executive board, a corporate board, cross functional teams (CFTs), and integrated project teams (IPTs). The CBM+ CFT would be chartered to provide oversight for policy improvements, provide metrics for implementation efforts, and communicate overall Marine Corps ground maintenance strategies as a permanent entity.

When this CBM+ CFT is formed, led by I&L LPM, integrated planning teams (IPTs) can be scheduled quarterly, semi-annually, or annually to help shape the initial CBM+ maintenance vision and strategy across the enterprise. Kotter supports this sequence of creating a guiding coalition with power and expertise to lead change, then getting them together to work as a team to create a vision and develop executable strategies to achieve that vision. A CBM+ vision is already written, but it will need to be refined and shaped with the contribution of a guiding coalition to create buy-in and communicate it in a more effective way to the enterprise (Kotter, 2012). Each commodity manager will likely have different planned actions and milestone timelines based on the complexity, variety, and understanding of CBM+ application on specific systems. These IPTs can be a tool to help shape the correct vision and an executable strategy to achieve that vision.

During the early stages of the CBM+ guiding coalition, there should be a higher frequency of IPTs to build the necessary understanding, communication, and momentum to develop a sound strategy and achieve early gains. Additionally, members of the CBM+ CFT can capitalize on the annual commodity symposiums, conferences, or operational advisory groups (OAGs) to discuss and advance CBM+ maintenance strategy in each of the commodities and throughout the enterprise. Establishing a guiding coalition is needed to sustain the change process and will bring the right players to the table to ensure policy and orders are updated to reflect the intent of CBM+ implementation.

C. REFINE AND COMMUNICATE CBM+ VISION

We recommend the CBM+ CFT provide an updated CBM+ vision that associates with FD2030 and empowers units to seek out improved maintenance practices and provide bottom-up refinement to the CBM+ CFT. A directed review and update effort of the MCO 4790.2 should integrate CBM+ strategies and provide commanders guidance on latitude to implement innovative concepts. While MCO 4151.22 provides the overarching narrative for CBM+, the order needs to be incorporated as a part of MCO 4790.2 to reflect that CBM+ is a key component of the Marine Corps maintenance strategy moving forward.

A necessary component of communicating a compelling vision is ensuring that the vision, as presented, is achievable with measurable and observable gains. Kotter's sixth

stage, generating short term wins, emphasizes planning for observable improvement in performance (Kotter, 2012). The *3d MLG CBM+ Implementation Report*, endorsed 14 October 2022, demonstrates the success of policy as measured by CM days deadline, PM Cost, PM Man-Hours, and DRIS to SR close (3d MLG, 2022). This can be translated into improved readiness, cost effectiveness, improved use of manpower, and reduced administrative burdens. Measurable improvements in MCT, cost effectiveness, and man-hours provides CBM+ advocates with compelling evidence for presenting CBM+ to leaders across the FMF.

Technology, the "+" in CBM+, is a long-term enabler for the predictive aspect of CBM that will be contingent on the acquisition process, updates to current equipment sets, and will likely be piecemeal. Many of the short term wins available for changing the way that the Marine Corps conducts maintenance exist in maintenance processes and behavior changes. Intermittent updates to policy, technical manuals, and inspectable criteria will enable capturing and disseminating lessons learned in a meaningful manner to encourage future change actions. This leads into the consolidation of gains and production of more change that Kotter emphasizes in stage seven of *Leading Change* (Kotter, 2012).

A strategic communication plan needs to be developed to promulgate the vision of a CBM+ maintenance strategy as well as build the knowledge and education of the force on CBM+ practices, processes, and benefits. Kotter observed in studying organizations going through change that, "without sufficient communication of a rational and emotionally compelling case for change, it was nearly impossible to achieve buy-in that inspired and mobilized the action required to drive and sustain difficult change" (Kotter et al., 2021). Existing strategic communications capabilities need to be leveraged to push CBM+ vision and narrative throughout the force for CBM+ change efforts to take root in the organization. MCSC has an Office of Public Affairs and Communication (OPAC) which can be used to broadcast actions the different program offices are doing with CBM+ and RCM. Every MEF has a Strategic Communications and Operations (COMMSTRAT) company that can support CBM+ implementation through strategic communication. OPAC can provide MEF COMMSTRAT with messaging and narratives related to CBM+. Additionally, units within the MEFs having success or discovering effective CBM+

processes and practices can feed COMMSTRAT ideas to broadcast throughout the force. Deliberate and frequent broadcasting will build greater awareness of CBM+ which can lead to educating the force faster and generation of more innovative ideas. A CBM+ strategic communication plan will expedite the exposure of CBM+ maintenance strategy throughout the force helping to advance implementation at a faster rate.

D. RESOLVE CONFLICTS BETWEEN MAINTENANCE POLICIES

The military's standard top-down pushing of policy and change is not the most effective way of creating change in this generation and cultural context. It is still necessary to have the high levels or policy approvers of the organization to establish an initial policy direction and outline a strategy, but that can be enhanced over time from bottom-up refinement when there is a new initiative introduced to the organization like a CBM+ maintenance strategy. There is an opportunity with CBM+ implementation to drive change within the Marine Corps in a different way that aligns with many of our goals and initiatives for FD2030 and use a method that has been proven successful in private sector organizations. The Marine Corps has an opportunity to capitalize on and leverage the knowledge and skills throughout the organization to build buy-in and shape the policy from up and down the chain of command.

To enable change to the Marine Corps maintenance strategy and adoption of CBM+, operational units need to be empowered to seek out process improvements and opportunities to apply CBM+ practices. The restrictive nature of present orders and constraints placed by required non-value-added maintenance actions present obstacles to Marines seeking to update processes to incorporate CBM+ principles. We recommend creating an environment that fosters short-term wins through ETPs and enhancing gains through consolidation of maintenance orders in a single volumized policy document.

1. Institute Exception to Policy During the Transition to CBM+

A Marine Corps-wide interim ETP specific to maintenance practices that inhibit the implementation of CBM+ should be published. This ETP will enable units across the Marine Corps to test CBM+ and discover more efficient ways of conducting maintenance

that will better prepare them for technology integration. Marine Corps units need to be given time to improve their processes and procedures under a CBM+ maintenance approach prior to the integration of technology to truly maximize its impact. An ETP allows units across the Marine Corps to build momentum for CBM+ which will also provide the force evidence of best practices that can help influence and shape CBM+ future policy. An ETP helps remove some barriers to change and it also provides an opportunity to capitalize on the ideas and creativity of Marines and units across the force. This helps create empowerment at the lowest levels and there will be a sense of ownership within each unit to drive toward CBM+ using initiative, innovation, and problem-solving. They will need to be given right and left lateral limits within the ETP, but there needs to be some freedom of experimentation to discover the best processes and practices the Marine Corps can use.

A Corps-wide ETP will reduce the friction of a Marine going from one unit under the ETP to another unit that is still operating under the MCO 4790.2 maintenance practices. An interim ETP will reduce potential friction in CBM+ implementation and mitigate frustration within the maintenance community while policy updates incorporate CBM+ strategies.

A large concern for many regarding changing maintenance practices is the potential risks in using an ETP and transitioning to CBM+. The Marine Corps often views risk through two lenses: risk to force and risk to mission. Risk to force ties into the safety of the Marines. During the interviews with experienced maintenance officers, there was a unified agreement that there is low risk in terms of safety and mission with the implementation of CBM+ practices and processes. Due to the low safety risk and risk to mission, a CBM+ organizational change effort is an initiative worth executing across the force to gain speed, progress, and improve the adaptation proficiency of the Marine Corps.

CBM+ implementation can be used as a change model/example/standard for future changes the Marine Corps will need to perform. There will be lessons learned and some failures along the way during this change effort, but the Marine Corps will be further along in performing more modern and effective maintenance practices and the organization will grow from the adaptation that it required. An ETP during CBM+ implementation will enable a more agile ground maintenance strategy and innovative environment for the FMF.

2. Conduct Volumized Maintenance Order Rewrites and Dynamic Updates

We recommend a volumized rewrite of maintenance orders such as MCO 4790.2, MCO 4790.25, and MCO 4151.22 into a central document that defines a holistic maintenance strategy for the Marine Corps. A consolidated order for ground maintenance strategy will assist in presenting a concise vision of Marine Corps ground maintenance that is inclusive of CBM+. A volumized approach will allow for individual volume updates to capture process improvements over an extended period. Additionally, the structure enables updating individual process and procedural segments while combining multiple references into a single source document. A deliberate rewrite of orders will also provide measurable targets for implementation by the CBM+ CFT and working groups.

Creating a volumized MCO that clarifies, simplifies, and removes duplicative orders for TLCM and ground equipment maintenance will help solidify the change initiatives into the future. Kotter's eighth stage, *anchoring new approaches in the culture*, identifies the need to codify improved processes and articulate lessons learned (Kotter, 2012). A volumized MCO can be shaped and developed through frequent feedback throughout CBM+ implementation from the FMF in venues such as annual commodity conferences, operational advisory groups (OAG), or integrated planning team (IPT) meetings. To have maintainers' buy-in to CBM+ as the new maintenance strategy, Marines need to see the adoption of innovations through codifying policy changes and incentivizing positive contributions for reducing maintenance downtime. Feedback directly from the maintenance community in the form of innovation challenges will communicate the new view towards maintenance strategy, encourage participation in process improvements, and invest Marines in the implementation of CBM+. The consolidation of feedback into a volumized MCO can help ensure the maintenance strategy best practices and lessons learned during implementation are anchored in the culture through informed and actionable policy.

E. DEVELOP CBM+ EDUCATION FOR COMMANDERS

We recommend incorporating CBM+ and maintenance concepts central to Marine Corps maintenance strategy into training and logistics seminars for leaders. Our interviews make clear that not all commanders are aware or have a good understanding of CBM+. CBM+ education to commanders is a line of effort that needs to be expanded to create a greater sense of awareness and urgency throughout the Marine Corps to implement a CBM+ maintenance strategy. Commanders have a significant number of responsibilities and information that they are required to absorb prior to and upon assuming command therefore there needs to be an iterative and balanced recurrent approach to educating commanders.

All commanders are required to attend a two-week course designed for O-5 and O-6 command-selected leaders called Cornerstone: The Commandant's Combined Commandership Course. This course is offered twice a year, tentatively in October and April, to help equip commanders for the responsibilities and duties of command. This venue is an opportunity to educate commanders on CBM+ and its benefits before they command. Promulgating a CBM+ information paper is an effective tool to provide commanders and FMF CBM+ awareness and education in an expedient manner. An information paper provides easily digestible content that can be leveraged by unit commanders and staff throughout the FMF to improve CBM+ education and implementation efforts.

After commanders assume command, CBM+ education can be reinforced by the MEF or MSC G-4 materiel readiness symposiums which are typically conducted on a quarterly or semi-annual basis. Additionally, individual unit commanders should receive a more in-depth education on CBM+ maintenance strategy from the MSC CBM+ training personnel to help build greater understanding and be able to get unit-specific feedback on the barriers and opportunities of CBM+ implementation efforts. This individual unit commander education touch point has shown to be a best practice that has created positive momentum in 3d MLG's implementation of CBM+.

Additionally, we recommend integrating CBM+ in the Commander's Materiel Readiness Handbook to improve leaders' familiarity and provide a quick reference to principal components of the Marine Corps maintenance strategy. Feedback from SMEs reinforced that for change to happen within the military, commanders must be invested and willing to adopt changes to the overall maintenance strategy. Limited exposure to maintenance practices or available strategies prior to assuming command reinforces a focus on maintenance to meet inspection or reporting requirements rather than a CBM+ approach. The underlying strategies and implementation of CBM+ as the Marine Corps a ground maintenance strategy should be presented to commanders in a maintenance handbook for commanders. This provides commanders with reference material that will give them the basis for exploring these concepts in their respective commands and encouraging innovation by their Marine maintainers.

F. UTILIZE FSMAO TO SUPPORT CBM+ INTEGRATION

FSMAO is an organization that acts on behalf of HQMC to inspect and analyze units on compliance to orders, policies, and directives. Their mission as indicated in MCO 4400.160 is, "FSMAO conducts comprehensive analyses of logistics functional areas in order to assess compliance with orders and directives and improve overall Marine Corps equipment accountability and readiness" (HQMC, 2013, p.1). The order also states, "The desired end state of a FSMAO analysis is enhanced unit readiness, increased operational availability of equipment, and a comprehensive review of equipment accountability, readiness and reporting, maintenance management…" (HQMC, 2013, p.2).

There are three FSMAO teams in the Marine Corps, FSMAO East, FSMAO West, and FSMAO WestPac. FSMAO teams consist of hand-selected SMEs in the fields of maintenance and supply chain management. FSMAO has the unique opportunity to analyze and inspect every organization in the Marine Corps, which no other entity can do. This unique organization can be leveraged to help facilitate CBM+ implementation throughout the Marine Corps and be a source of feedback for best practices.

FSMAO can be utilized as a key contributor in communicating the CBM+ vision for Marine Corps maintenance through evaluating, training, and consolidating best

practices of CBM+ processes. For 3d MLG to capitalize on CBM+, change gains made to maintenance processes, inspections conducted by 3d MLG of subordinate units and checklists were updated to incorporate CBM+. This enabled goal alignment with implementation of CBM+ as a maintenance strategy with individual unit performance indicators. The 3d MLG report described how inspections enabled CBM+ implementation.

> 3d MLG G-4 provides an inspector to review CBM+ centric processes. This checklist differs from other inspections as it is a knowledge/skills assessment (KSA), meaning key billet holders must be able to show/explain the answer to the question to demonstrate compliance. To be successful, the individual will need to be trained and have incorporated CBM+ into their daily procedural documents. Unit maintenance management sections must include CBM+ type assessments in the internal inspection programs. 3d MLG G-4 also reviews this requirement. (3d MLG, 2022)

Inspections are an enabling force in the maintenance community that reinforce maintenance strategy and processes. Inspection teams assess proficiency and understanding of concepts while providing training and guidance towards corrective actions. These benefits need to be leveraged to solidify CBM+ implementation and maintenance strategy changes.

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VI. CONCLUSION

It is a matter of time before the Marine Corps and the other services fully implement CBM+, the only difference will be the speed and effectiveness with which it happens. There continues to be increased pressure from Congress and the DOD for the services to implement CBM+ and predictive maintenance. Reactive and time-based maintenance as the primary maintenance strategy does not support the future force. Therefore, now is the time to gain momentum by establishing the right foundations to enable CBM+ future success as a ground maintenance strategy.

The foundation to an effective CBM+ maintenance strategy is people executing the right behaviors and processes that will improve maintenance capacity. Making necessary adjustments to get the people and processes working efficiently will facilitate effective technology integration. Technology that is integrated into inefficient processes with people executing poor behaviors will add limited to no value.

The Marine Corps has an excellent opportunity to achieve quick and early gains in the implementation of CBM+ as a ground maintenance strategy by making changes to the people and process aspects that will not require additional resources and funding. 3d MLG's CBM+ implementation efforts has proven to significantly increase operational availability, reduce cost, and reduce man-hours. Gains in the maintenance process were achieved without additional resources and funding. During 3d MLG's implementation, they developed a CBM+ playbook, with the focus on people and process changes, that can be scaled and utilized across the FMF as an enterprise-wide template.

Marines are not empowered within legacy maintenance processes, outlined in MCO 4790.2, to execute CBM+ practices. The maintenance production process outlined in MCO 4790.2 enforces redundant and non-value-added tasks that are negatively impacting the operational availability of equipment, increasing cost, and increasing man-hours. This legacy maintenance strategy does not align with the Commandant's priorities for FD2030/ TM2030. The Marine Corps will have a harder challenge encouraging quality maintenance Marines to re-enlist if they continue executing non-value-added tasks mandated in the

legacy maintenance strategy. Leaders can also increase Marines' motivation to reenlist by improving efficiency and effectiveness of maintenance practices and allowing young Marines to contribute to change solutions that improve the Marine Corps. The Marine Corps has an opportunity in transitioning to a CBM+ ground maintenance strategy by tapping into the ideas, innovations, and creative problem-solving capabilities of Marines to better the organization at relatively low risk. Any movement or forward progress in CBM+ implementation is good for the Marines and the organization.

Our recommendations emphasize areas of opportunity for the Marine Corps to generate urgency, empower broad-based action, and solidify CBM+ as a ground maintenance strategy. An effective communication strategy that reinforces the CBM+ vision needs to be presented to Marines that encourages a proactive approach. The management of the CBM+ vision and implementation efforts should be under the supervision of a CBM+ cross-functional team that would serve as the permanent guiding coalition. Organizational change requires a guiding coalition to put forth a consistent vision and sustain a sense of urgency in the organization. Our recommendations are not final solutions for CBM+ implementation, rather they point to available organizational tools within the Marine Corps and organizational change approaches. Our recommendations provide options for leaders and policymakers to drive CBM+ implementation.

This paper is primarily focused on the early wins the Marine Corps can achieve in implementing CBM+ as a ground maintenance strategy with respect to people and processes. People and process are foundational to maintenance strategy and there are immediate actions the Marine Corps can take without additional resources and funding to advance CBM+ implementation. Capitalizing on these opportunities and generating early wins has the potential to create the necessary momentum and maintenance practice foundation for technology integration. CBM+ cannot be treated as just another program; it needs to be holistically integrated into the ground maintenance strategy. Enterprise-wide integration of CBM+ as a ground maintenance strategy plays an important role in enabling logistics as the pacing function for the Marine Corps and supports FD2030/TM2030 objectives.

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