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14. ABSTRACT

Force Design 2030 challenges the conventional assumptions of secure lines of communication in terms of both logistics and communication. These secure lines are essential for sustainment of aviation capabilities for the stand-in force. Linear programming provides quantitative planning tools such as critical path analysis, queuing theory, and transshipment modeling that supplement both aviation maintenance management and Marine Air Ground Task Force operational planning. These tools can also supplement long term program management of the airframe life cycle.

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MASTER OF MILITARY STUDIES

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Efficacy of the Aviation Maintenance Officer MOS in Future Aviation Paradigms

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OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

Title: Employment Planning of Aviation Support: Efficacy of the Aviation Maintenance Officer MOS in Future Aviation Paradigms.

Author: Major Travis A. Holloway, United States Marine Corps, CSC AY21

Thesis: Reinforcing the focus of the 6002 MOS planning skillset will fill in a critical training and operational gap for Marine Corps aviation. Aviation employment and sustainment in both conventional peer conflict and long-term platform availability can be improved by incorporating a broader scope of deliberate planning techniques that can be applied to both.

Discussion: Efforts to decrease cost while increasing readiness in Marine aviation have resulted in process efficiencies that were well suited to the MAGTF deployment methods and philosophies of the last 20 years. The two fundamental means of achieving these efficiencies bifurcated into two principal approaches on opposite ends of the spectrum. The first was to pursue industrial solutions applicable across Marine Aviation at the service level, constituting top-down controls driven by the Naval Aviation Enterprise (NAE). The second was bottom-up revision of the training methods for aviation maintenance professionals across both enlisted and officer ranks. These efficiencies have since developed into specializations that retain the locus of control in the rear-area, far removed from the forward operating environment. Simultaneously, the community has relied upon foundational assumptions of secured lines of communication and global access to logistical connectors to compensate for this separation.

These two assumptions are directly challenged by the concepts and environments anticipated in the Force Design 2030 and 38th Commandant's Planning Guidance. The acceptance of risk associated with the accepted bridge between national resources and tactical application has resulted in a degradation of the ability to plan for in-theater employment of aviation support and thereby affected the capabilities of the 6002 MOS that are most relevant to the challenges of the expected paradigm. Furthermore, the enterprise's "new" changes implemented in 2005 and 2016 have become established baselines that are reaching the zenith of their novelty and will begin to provide diminishing returns. The Marine Aviation Logistics community must pursue development of the latent set of employment planning skills of the 6002 Officers in order to provide solutions for both near-term forward deployed aircraft availability and long-term platform life cycle management. Doing so under the current service culture acknowledges the new assumptions the current paradigm of peer competition and conflict in the mid-21st century require. This paper proffers a course by which the community can successfully apply the 6002 MOS against the new unknowns.

Conclusion: Aviation sustainment in terms of both military operations and platform lifecycles requires deliberate, cognitive, quantifiable planning processes that are able to be interfaced with both Marine Corps operational planning methods and service level industry. As long as the community continues to deploy company grade 6002 into these planning billets prior to any doctrinal training in operational planning, lack of employment planning will remain a critical gap.

This discourse is intended to provide recommendations for developing skillsets that benefit the billets and responsibilities of company grade officers in the employment paradigm outlined by the Commandant's planning guidance. It also demonstrates how these skillsets complement the current career path developmental requirements for aviation logistics field grade officers.

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Section I: Introduction & Background

Marine Corps Aviation is a single system that is separated, supported, and enabled by numerous agencies, activities, organizations, and concepts. The complexity of aviation sustainment grows apace of the complexity of the platforms it supports. Solutions for ensuring aircraft are usable for their entire lifetime provide one set of constraints at the service level. Methods for maintaining aircraft in a combat ready state constitutes a separate set of constraints at the tactical level. An entire ecosystem of supported and supporting relationships lies between the two. This system requires a high degree of technical and managerial specialization that tends to create silos of efforts and stovepipe organizations.[1] The management, continuity, and authority for these organizations typically resides in stable, established commands in the United States, far removed from the uncertainty and chaos of forward deployed theaters. The capabilities these organizations can bring to bear are considerable, and need to be implemented as far forward in theater as effectively possible. This responsiveness at the point of need is critical for force sustainment as the Marine Corps shifts focus towards a modern paradigm of great-power competition and refocuses on the primacy of the Pacific Theater in its operations. Merely pushing capability, component, or personnel forward does not necessarily mean that it will be effectively managed or employed once there, however.

The effective employment of Marine Aviation is dependent on proper deployment of both the airframes and their supporting components. Maintenance and repair cycles are the critical enabler for the sustainment of aircraft sortie generation. These paradigms should shift from *de*ployment to *em*ployment once in theater. The ability to plan, change, or adapt forward deployed aircraft maintenance is a critical skillset in the modern anti-access/area-denial (A2/AD) environment present on the contemporary battlefield. Forcible entry and expeditionary operations in complex networked environments also require responsive

aviation sustainment and may prohibit access to national level aviation sustainment. 6002 maintenance officers currently do not have an explicit requirement that deliberately addresses the need for this skill set in their training pipeline at the company grade. The current career path does not provide this training until Command and Staff College as a major. While this is appropriate timing to enable majors to become staff planning officers, it is far too late to benefit the company grade 6002 supporting deployed squadrons. This adds further confusion to defining a solution to the critical gap regarding future states of competition and conflict.

The current training provided for the development of junior 6002 Aviation Maintenance Officers focuses on a narrow skillset of management techniques. The current method of maturing these techniques into proactive planning requires a tremendous amount of dedicated on-the-job training that leaves widening gaps as tribal knowledge is propagated. This propagation often crowds out the important by focusing on the immediate. Planning methods involving quantifiable and deliberate cost and consequence analysis are notably absent. Methods of cohesively providing maintenance plans that complement service level operational planning process are also not present until the field grade ranks. This gap can be addressed by specifically scaffolding aviation-relevant, deliberate planning into the training curriculum of 6002 Aviation Maintenance Officers at the company grade level. These processes benefit both employment and holistic, systemic planning, and provide a foundation that will further benefit the 6002 when built upon by later doctrinal military education.

APPROACHES TO PLANNING

Sustainment of Aviation readiness requires short term and long-term planning at both the strategic and tactical level. This planning must be flexible, responsive, complementary, and adaptable at all echelons. Restructuring the 6002 paradigm will cover both the critical training and operational gap while reducing the risk to aviation employment for both

conventional peer conflict while supporting the necessary actions of long-term platform availability. This type of planning is not currently integrated into the company grade Aviation Maintenance Officers (6002) training curriculum. The absence of these types of deliberate planning skills in the introductory level training is directly at odds with the community's accepted cultural norm of assigning company grade officers in direct support of organizational level operational units. It is considered a career advancement requirement for these officers to gain critical military occupational specialty (MOS) experience *from* these assignments well before they have any professional experience or training that allows them to contribute meaningfully *to* those assignments. The burden of compensating for this deficiency is placed squarely on the shoulders of the limited duty officer (LDO; 6004) within the operational units.

Simultaneously, evolutions in quantitative analysis of Marine aviation have focused on national and strategic level methods of maintenance management and planning. This has resulted in elevating quantitative planning to a critical skillset well above the company grade level. Concurrently, and in parallel, the Marine Aviation has invested efforts in developing more effective methods for training logistics professionals in both aviation maintenance and supply chain management. Despite incremental improvements in both aviation maintenance and aviation supply's respective paradigms, neither enterprise level planning nor introductory training has been effective in bridging the gap that is growing between the organizational and service levels of management. Fortunately, intermediate training in concepts such as AIRSpeed have set a firm foundation for effectively addressing this gap and demonstrates a cultural willingness to seek improvements. Convergence and subsequent bridging of the differences between service and organizational sustainment can be achieved by changing the focus of the MOS from maintenance management to employment planning.

Junior Officers in the 6002 community are only provided with minimal institutional training in the skills required to assess, analyze, and complement the Marine Corps planning process deliberate planning methods with respect to aviation maintenance in fluid logistical paradigms. There are critical transitions between decoupling from a ship-based aircraft intermediate maintenance department/division (AIMD) and operating independently as a shore-based air combat element that require intentional coordination. Furthermore, junior 6002 officers receive little or no training in how to conduct assessments, understand transitions between theaters, or the differences in characteristics of support between United States Navy (USN) numbered fleet areas of responsibility (AOR) and Combatant Commander (COCOM) AORs. Disaggregated maritime operations also contain different complexities that must be identified and accommodated for. Experience varies widely among the cadre of 6002s and can lead to false assumptions of capability, both positive and negative, from their supported detachments. Prior maintenance experiences can actually inhibit innovative solutions to new problem sets.

Furthermore, acquisition of this tactical level experience does not necessarily translate into an ability to manage life-cycle conservation, despite the tendency to assume that knowledge of the aircraft at the squadron level implies knowledge of the enterprise at the service level. The service level supervision life-cycle management of airframes and the tactical level management of short-term squadron readiness goals are often perceived as conflicting areas of interest. Additionally, there is not an industry-equivalent steady state for Marine aviation platforms; military platforms exist on a life-cycle continuum whose variables can change drastically year by year, platform by platform, and mission by mission.

Terminology & Context in Marine Aviation Maintenance

Concepts in Marine aviation can be extremely sensitive to context due to overlapping usage of similar terms. This overlap naturally evolved from the hybridization of ground, sea, and air concepts inherent in Marine philosophy. Marine doctrine commonly borrows policy, doctrine, processes, techniques, and procedures from the Army, Air Force, and Navy. Overlapping areas of responsibility and conflicting interests are frequent, with joint doctrine providing some standardization to normalize interoperability at appropriate levels. While joint doctrine is intended to provide cohesion, it does have limitations in providing differentiation when needed. There are several specific terms that need to be clarified. Naval aviation, logistics, echelon hierarchies, types of planning, aviation vs. aircraft, and the semantics of MOSs relative to their corresponding billets all generate inferences that vary significantly according to users' context. Common terminology often disguises technical distinctions between services while similarities between doctrine or tactics can be disguised by habitual acronyms or cultural bias. Marine aviation distinctly interfaces with the other services in specific ways, both directly and indirectly, and context is often assumed to be inferred, which can lead to misunderstanding at the point of execution.

Naval aviation is philosophically and technically inclusive of Marine aviation.[2] Marine pilots are technically Naval Aviators and Marine platforms are capable of operating from ships.[3] In the realm of aviation logistics, this term becomes even more inclusive as Marine aviation maintenance follows the US Navy (USN) COMMANDER, Naval Air Forces (CNAF) instruction 4790.2c, colloquially known as the naval aviation maintenance program (COMNAVAIRFORINST 4790.2c, Short title: NAMP).[4] Management of programs of acquisition (or acquisitions programs) for Marine aviation systems are also managed underneath the numbered USN program management, air (PMA) structure.[5] However, not all

Naval PMAs have equivalent application for both Navy and USMC assets, while some support both.[6]

Logistics is another term with multiple inferences resulting from context. Joint doctrine considers the realm of logistics to be inclusive of maintenance as a capability of support. The Army and Marine ground logistics follow this model. Marine aviation typically includes maintenance in logistics, using the terms "supply" and "maintenance" to differentiate when necessary. The U.S. Navy, however, does not include maintenance in its concept of logistics. Logistics to the Navy is a term purely regarding the supply component; i.e. supply chain management, supply (ships stores), and the movement of material in support of ships' missions. These two branches are functionally separate. They are two separate occupational specialties for the officers & enlisted, with separate career progressions.[7] Additionally, the Navy maintains a distinct separation between supply in support of aviation and supply in support of ships.[8]

There are two interrelated echelons applicable to Marine aviation. Their hierarchies have no doctrinal requirement to be synchronized although they naturally lend themselves to some equivalency. While complementary, these two echelons should be considered flexible and adaptable to mission needs.[9] The conventional military command-type operational echelons are tactical, operational, strategic, and national.[10] The conventional maintenance-type support echelons of aviation are organizational, intermediate, and depot (O-I-D) with "contract" as a parallel that exists and supplements at each level.[11] The O-I-D maintenance-type echelons apply to the capability and type of aircraft maintenance and support that an organization is capable of performing.[12] The Marine Corps does not restrict these capabilities to a particular command-type echelon; they are assigned in accordance with mission requirements. For instance, a squadron detachment (typically six aircraft) is considered a tactical level command-type element that may be tasked to support operational level MAGTF

objectives. The detachment may contain organizational maintenance-echelon personnel ("O-Level") by table of organization (TO), but is 'reinforced' with intermediate level maintenance capabilities ("I-Level"). This reinforcement is usually by personnel accompanied by appropriate tooling and equipment. This intermediate level maintenance capability does not inherently change the nature of the detachments mission set capabilities, but *does* inherently change the detachments self-sufficiency in terms of maintenance capabilities. Likewise, an operational level MAGTF may have access to depot level repair capability ("D-Level") within a theater. Access to that capability does not change the command's mission set, but does change its support (repair) capabilities. It should be noted that the US Navy AIMD and the US Air Force maintenance squadron are conceptually different deployment and support philosophies regarding aircraft maintenance, although they use similar concepts and terminology. [13]

Planning is the critical term requiring distinction in this paper and has a specific connotation that corelates differently to the command-echelon and maintenance-echelons relative to application. The Marine Corps planning process (MCPP) is the command-echelon planning concept for operational planning. This doctrinal approach utilizes an established, methodical process to develop missions and provide mission type orders to subordinate units.[14] Maintenance planning is the respective maintenance-echelon concept. It is the deliberate anticipation, organization, and deconfliction of personnel, resources, and processes required to conduct repair actions necessary to generate aircraft sorties in support of aviation missions. It is planning in regard to the maintenance actions themselves; i.e., which aircraft or component undergoes what repair, when, where, and by whom. There are many similarities and correlations between the two but it must be emphasized that *maintenance planning is not the same as the Marine Corps planning process.* These are two distinct paradigms and mechanisms that use different processes to produce different products.[15] Maintenance

planning is based in the present with finite resources and facts at hand, while the Marine Corps planning process is based on the future with desired end-states and unknown variables.

Section II: Present Progress

Readiness: The Metric & the Symptom

Readiness is the byword for the Marine Corps' metric of successful preparation. But what is a "unit of readiness?" How is it quantitatively measured? In Marine aviation this metric is typically quantified by the number of aircraft in a "ready" state. This state for military aircraft is more than merely the ability to simply take off and land, historically referred to as ready basic aircraft (RBA). Military aircraft are intentionally designed to accomplish multiple sets of differing mission types. An aircraft that is able to accomplish all of its mission sets is considered fully mission capable (FMC), while an aircraft that can only accomplish some of its mission sets is referred to as partially mission capable (PMC). An aircraft that cannot execute any mission set is considered non-mission capable (NMC). These are critical concepts to understand when evaluating aviation and in understanding the reports, spreadsheets, and databases used to conduct studies into readiness. These terms are functions of tangible assets, namely the aircraft, aircrafts' equipment, or an end-item component itself (e.g., an engine). Historically, this has been a sufficiently comprehensive metric by which Marine aviation's capacity to support a Commander's task(s) could be quantifiably measured. There are multiple components that contribute to the actual achievement of readiness, however, meaning that "readiness" is not a single variable. Rather, readiness is a function of several other independent and dependent variables, each with their own metrics. The maintenance component of logistics is typically measured by tasks accomplished, personnel trained, and components ready-for-issue (RFI). But if a critical gap does not have a metric,

how can you measure its effects? How do you prove the lack of a third-dimension variable in a two-dimensional model?

The last two decades are replete with analysis, findings, and recommendations for the state of Navy & Marine Corps Aviation in terms of both manpower and assets.[16] Significant emphasis has been given to the War on Terror and its cumulative attritional effects on Marine platforms. The types of issues that the Department of Defense (DoD) services are dealing with are neither new nor unique to modern aviation, but the tempo and duration have exacerbated the historically consistent and strategically persistent challenges in maintaining readiness for military aircraft.[17] The U.S. General Accounting Office (GAO) issued a report to Congressional Requesters in November of 2001 concerning the number of cannibalizations utilized to maintain aircraft in a flyable, mission capable status. [18] The study cited supply system (i.e. spare parts shortages) issues, operational demands, and aging aircraft as the three main causes.[19] While some of the aging aircraft in 2001 are no longer in service, such as the EA-6B and CH-46E, others are only getting longer in the tooth, such as the F/A-18 A through D variants and CH-53E that have since replaced them as the "old platforms."

Illustration 1.
EA-6B Prowler.
1. USNI News, *Marines Sundown Last EA-6B Prowler Squadron.* https://news.usni.org/2019/03/08/marines-sundown-last-ea-6b-prowler-squadron

Illustration 2.
CH-46E Sea Knight.
1. Donal T. Peterson, *VMM-262.* Unk. https://www.marines.mil/Photos/igphoto/2000711216/

Illustration 3.
F/A-18C.
1. Gregory Moore, *VMFA-232 DFT.* 16 May 2013T,yndall AFB. https://www.dvidshub.net/image/935233/vmfa-232-dft

Illustration 4.
CH-53E.
1. Artur Shvartsberg, *CH-53E Tactics.* 1 April 2016,Yuma, AZ, MAWTS-1 https://www.dvidshub.net/image/2497146/ch-53e-tactics

Marine Aircraft supporting operations from ship or from austere locations ashore are especially prone to cannibalization cycles. [20] Cannibalizations are a necessary reality in expeditionary aviation for sustaining sortie generation rates, a.k.a. the desired operational product of "readiness." These maintenance actions are typically a symptom rather than a cause and can be exacerbated as overreliance can disguise critical supply chain shortfalls. In November of 2020, the U.S. Government Accountability Office (GAO) submitted a report to Congress regarding the services' aviation platforms' ability to meet mission goals.[21] This report was the summary of mission capable rates for 46 aircraft types across the Army, Air Force, Navy, and Marine Corps. Twenty-four different aircraft failed to meet their annual mission capable (MC) goals for any year within the nine-year period. The F-35B was the only Marine platform that met its mission capable rate during this period out of the eight Marine platforms. However, it did so only once out of the seven years that it was considered operational, and it did not participate in any combat deployments the first six years until embarked on the 13th Marine Expeditionary Unit (MEU) in 2018.

These factors are actually more critical than the study implies. The mission capable metric used by the GAO was the percentage of total time that an aircraft could fly and perform at least *one* mission set. Every platform operated by the Marine Corps is intended to be a multi-role weapon system, meaning that it is capable of flying multiple mission types.[22] The study's mission capable metric of "at least one" mission set does not indicate how many aircraft were capable of flying their entire mission set. This becomes significant in how much capacity for a capability that the Marine Corps aviation component can provide to a combatant commander (COCOM), Joint, or Marine air ground task force (MAGTF) Commander's mission. "Readiness" must be able to be transitioned into successful, sustained sortie generation in the operational environment.

Both GAO reports cite nearly identical problems, symptoms, and indicators, despite being separated by nearly two decades. Historic studies from the GAO and the Rand Corporation demonstrate that the problems have been endemic for generations of aircraft, and the proposed solutions have been just as generic and ubiquitous.[23] Both reports provide service and enterprise level constraint, restraints, and recommendations regarding planning, management, and utilization of aviation assets. Aviation repair depot throughput and scheduling was commonly referenced in both studies and is a perennial focus. These two reports provide a holistic analysis of the aviation readiness for the Department of Defense presented to Congress and the service and enterprise level recommendations were appropriate for addressing the issues at the macro (service and above) level. The 2001 report may no longer be quantitatively representative of current readiness, but the qualitative cause/effect, results, and necessity and results of cannibalization remain valid and demonstrate how persistent the issue is. The 2020 report is not confined to the Marine Corps and Navy aviation and highlights common trends and provides data that can be shared and parsed appropriately, especially for potential joint ventures. However, most of the recommendations intended to be implemented at the strategic level (the macro), and then are poorly extrapolated down to the tactical/organizational level (the micro).

With the release of the Marine Corps Operating Concept 2025 (MCOC 2025) in 2016, The office of the Deputy Commandant of Aviation directed holistic reviews by the Marine Air Wings (MAW) regarding the ability to generate readiness across the fleet.[24] Specific areas of concern were reports of critical limitations on airframe flight hours for the CH-53E and F/A-18s. Retrograde and retirement of the aging fleet of AV-8Bs were delayed over ten years (and still projected to possibly be delayed further) due to delays in F-35B initial operations capable (IOC) dates. Internal audits and systemic reviews of maintenance culture and capability were conducted in efforts to identify areas where any gains could be found. An

organizational-level independent readiness report (OIRR) produced by Headquarters, Marine Corps (HQMC) Deputy Commandant for Aviation (DCA) identified several aspects of the current readiness issues.[25] These concerns generally fell into three categories. The first is perennial and endemic: the traditional restraint of parts availability in the supply chain. The second is generational and cyclical: the training and development of the enlisted maintenance professionals. The third was situational: maintenance planning.

The majority of available literature regarding military aviation is written with a focus towards audiences at the wing, service, enterprise, or higher level. These studies may include observations and data generated from the lower echelons, but typically provide holistic solutions for the larger institutions. It is easier to identify trends by collating data at higher levels with larger aggregates. Literature studying industry typically reflects similar scope and application. This is to be expected as the cost of these studies must be justified by the savings and efficiencies they are aimed at producing. Studies that are aimed at the deploying squadrons and lower echelon detachments typically focus on supply chain management and theater level logistics; again, solutions provided are aimed at higher echelons that constitute the larger organization. A notable gap in research literature are those studies aimed at validating the assumptions of squadron and detachment level maintenance deployment & employment philosophies. More specifically, most available studies are focused predominantly on the pre-deployment (readiness) and post-deployment phases, as the quantifiable metrics are most easily assessed at these points.

Training: Providing Topsoil for the Root of the Problem

In February, 2017, an aircraft maintenance officer requirement review working group was convened by LtGen Jon M. "DOG" Davis, Deputy Commandant for Aviation.[26] The working group focused on the functions and roles that aviation logistics (AVLOG) provided

in the generation of aviation readiness. One of the most significant gaps the working group identified was the inverse relationship between billets and experience within the aviation maintenance core leadership. Understanding the billets, roles, responsibilities, tasks, experience, and interrelationships between respective areas of responsibility in Marine aviation is not intuitive. There is not a consistent, progressive, linear flow from one billet to another. Career paths may include logistics, fleet readiness centers, acquisitions, PMAs, type-commander (TYCOM) billets, or completely non-MOS related "B-billets."

One of the products of this working group was a revision of the training and readiness (T&R) standards for 6002 Officers.[27] This product contains 783 separate concept areas that a 6002 is expected to become familiar and proficient in prior to promoting to Major (O4). 650 of these tasks are listed as "1000 series" task in the T&R, which denotes them as core skills that are considered fundamental or foundational and are expected to be completed prior to promoting to Captain (O3). The 1000 through 3000 level codes are identical between the 6002 and 6004 MOSs and focus on an extremely diverse range of topics. Additionally, a significant amount of the training and development of a company grade 6002's experience is expected to be provided for "on-the-job" by a 6004 warrant officer (WO) or chief warrant officer (CWO). Furthermore, critical planning experience for pre-deployment and deployment of a detachment is coordinated by the MALS OPSO while coordinating with the AMO, typically through plans of actions and milestones (POA&M). The concentration of planning in these billets precludes valuable experience opportunities for the 6002. Introduction to the operational planning concepts in the MCPP is not provided at any point within the company grade equivalent 6002 training curriculum. Initial formal exposure to this is provided at the captain's level professional military education (PME) curriculum of expeditionary warfare school, provided that the officer in question chooses to enroll or gets selected for conducting the PME in residence. In-depth MCPP PME is not provided until

Command & Staff College at the O4 level as future staff officers. Neither of these training evolutions are guaranteed to be accomplished prior to being assigned to their respective "planning" billets. This results in 6002 officers that are poorly equipped to convey constraints and restraints in meaningful operational context. Inversely, this lack of operational concept or language may result in lack of understanding in how the strategic or tactical situation may hinder aviation sustainment, and vice versa.

Program & Platform Life-Cycle Management

The GAO specifically identified the Marine Corps as having difficulty in managing platform life cycles. This issue is systemic and not isolated to aviation, and is arguably tied to being completely focused on "readiness"; the Marine Corps institutionalizes sacrificing the need for tomorrow's capability to satisfy the want for today's capacity. Two separate reports frame an encompassing view of the depot level maintenance challenges for the Marine Corps. The July 2020 GAO report *Army and Marine Corps Need to Improve Efforts to Address Challenges in Measuring Performance and Planning Maintenance Work* focuses on the Army and Marine Corps depot repair and planning cycle for the majority of the two services programs, but excludes Marine aircraft systems. [28] The June 2020 GAO report *The Navy Needs Improved Planning to Address Persistent Aircraft Maintenance Delays While Air Force Maintenance Has Generally Been Timely* focuses on the Air Force and the Navy, but includes Marine aviation assets as part of naval aviation.[29] Both reports clearly state that the Marine Corps' planning and baselining for air and ground programs are lacking in depot maintenance management, specifically including the Fleet Marine Corps responsibilities in getting platforms sequenced into depot induction. This function is actually a combined responsibility outside of the Marine Corps operational commands for Marine aviation,

however.[30] Furthermore, the June 2020 report identifies how the lack of visibility into lower echelon maintenance inhibits planning efforts that are critical for depot production efforts.

Both reports reflect an inversion of priorities between the depots' metrics (cost and efficiency) against the service's metrics (readiness and availability). The June 2020 report goes further by implying that the lower echelons planning should be suborned to the depots' schedule. This oversimplification precludes the lower echelons priority of providing forces in support of mission. Obvious polarity to either extreme exacerbates the negative effects on the opposite end of the spectrum. Sustained depot throughput is ultimately critical for long-term fleet availability; however, fitness reports are written on readiness achieved in the short-term. The critical requirement is to manage the near-term priorities effectively to enable longer lifecycles. Having to retrieve the June 2020 and July 2020 GAO reports separately also demonstrates an implicit difficulty that must be reconciled by Marine Aviation Maintainers. Professionals in this field must successfully straddle two distinct and separate logistical chains and program management philosophies; ground logistics that are derived from the U.S. Army, and naval logistics that are derived from the U.S. Navy.

Section III: Evaluating Training, Applications, and Culture.

Diminishing Returns due to Normalization

The readiness reviews, RAND studies, and GAO reports have generated significant momentum in holistic revision of Marine Aviation. In 2005, the Naval Aviation Enterprise introduced AIRSpeed to address process inefficiencies across the enterprise. AIRSpeed is the Navy and Marine Corps program that incorporates and combines the industrial concepts of continuous process improvement (CPI), theory of constraints (TOC), and Lean/6σ into a single, holistic program.[31] This program was incorporated into the training requirements for both enlisted and officers throughout Naval Aviation.[32] The AIRSpeed initiative initially

provided dramatic results that have since become baselines. This normalization has resulted in diminishing returns across the enterprise as best practices have been distributed in incorporated into daily operations. The resulting homogenization at lower echelons has resulted in less variety and decreased the sensationalism of change. The AIRSpeed philosophies still retain significant value as a method of teaching process analysis and improvement to personnel who are new to aviation maintenance, as long as its limitations are not positioned to constrain organizational change.[33]

The OIRR study resulted in several significant changes for structuring 6002 training. The adaptation of the previous training curriculum to the training & readiness structure, as recognizable according to the NAVMC 3500 series orders and instructions, was a significant milestone in standardizing and quantifying maintenance training. This enabled a more effective standardization across the different environments for newly minted officers, notably the significant differences between rotary wing and fixed wing deployment. Additional recommendations from the study involved restructuring the 6002 career progression to provide them with multiple opportunities to gain experience with squadron level maintenance management.[34]

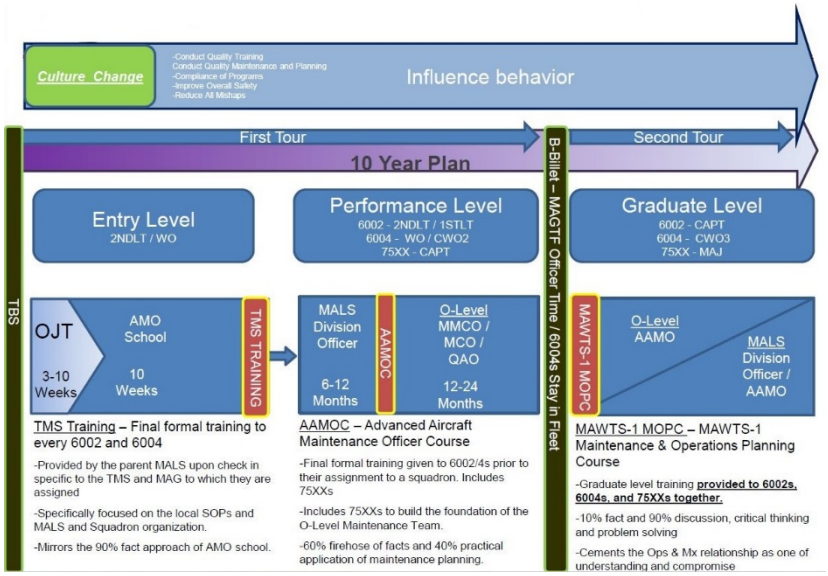

Figure 1.
HQMC, DCA Proposed Restructure to AMO Career Path.
1. DCA, HQMC, *AMO Training and Education Continuum",* (HQMC, Washington, D.C., unk,), slide 26.

The reorganization of the career path timeline was also intended to provide the 6002 Officers with more experience and knowledge prior to being assigned to an operating squadron. The second recommendation was instituting and developing an advanced training curriculum titled advanced aircraft maintenance officer course (AAMOC).[35] This course was incorporated into the weapons and tactics instructors (WTI) school's curriculum. Paralleling WTI's realistic and 'real-time' comprehensive training package for pilots also provided the exposure and training to highly demanding operational sortie generation tempos by incorporating multiple type, model, series (T/M/S) of aircraft in a single environment, simulating supporting the ACE of a MAGTF.

The last twenty years have also seen a shift in acquisition program philosophies in attempts to generate higher institutional readiness levels at lower costs. The V-22 Osprey, KC-130J Hercules, and F-35 Lightning II were all procured under programs designated to be "O-to-D" concepts. Advancements in materials, methods, and technology were intended to remove the need for intermediate level maintenance and its associated "waste" costs by

making these airframes “remove & replace” with the components being sent directly back to the original equipment manufacturers (OEM). These concepts were designed around supply chain management improvements gained by decreasing warehouse storage volume, work-in-process delays, and the additional lash and tolerance required to sustain intermediate repair processes. Notably, both the V-22 and KC-130J have actually regressed from their acquisition model by incorporating more conventional I-level support capability after the platforms were declared fully operational capable (FOC). The F-35 program also proposed cost efficiencies by pioneering a “global-spares-pool” concept for management of material and repair resources distributed across several international economies.

Each of these measures have enabled quantification of readiness metrics in Marine aviation. The metrics captured both significant initial and continuing incremental gains. These improvements are occurring simultaneously on opposite ends of the spectrum. AIRSpeed and other enterprise level independent studies have contributed to quantifying and capturing metrics within processes to enable the identification of constraints, restraints, and chokepoints. These analyses exist within the service level readiness cycle and are effective in steady-state processes such as those in depot level repair flows and certain intermediate level repair processes located in the continental United States (CONUS). A significant ability to quantify the capability and progression of the Officers was established by updating and reformatting the T&R. Establishing the AAMOC provided a valuable secondary tier of experience and training for company grade aviation maintenance professionals. However, the next phase of improvements should not be focused on merely cumulating more incremental changes of the same vein.

Changes in Paradigms Require Changes in Assumptions

The AIRspeed and AAMOC solutions are reaching the end of their "novelization" as new solutions and most have since become normalized as existing baselines. Additionally, those changes made in 2005, 2012, and 2016 were based on assumptions that are no longer applicable due to the refocus on naval operations in the Pacific as outlined by the Force Design 2030 and 38th Commandant's planning guidance.[36] The assumption that the world provided a single, unchallenged global common for U.S. Department of Defense logistics connectors is fundamentally challenged in the new complex, networked A2/AD environments where low cost stand-off weapons exceed the range of U.S. force projection mechanisms. Industry planning models that the Naval Aviation Enterprise (NAE), and by inclusion Marine Aviation, are applied to provide whole-of-enterprise solutions globally. These processes and solutions do not matriculate well down to individual units that are readily detached and attached to and from various logistical chains. In essence, the whole-of-enterprise paradigms of providing sustainment solutions to Marine Corps Aviation is the antithesis of the decentralized execution philosophy that is central to the employment of Marine Corps Aviation. The assumed correlation between service level solution and organizational level application are not always appropriate. More accurately, they are not always allowed to be applied.

Additionally, the evaluation criteria for Squadron and MAGTF Commanding Officers do not include metrics that reward platform preservation; quite the opposite, in fact. Mission sets are not always equal in terms of allocation. Rotary wing time/distance factors are not on the same scale as fixed wing, much less maritime, platforms. Theaters are not always equivalent in terms of environment or platform utilization. The aggregate data does not always provide specific, relevant operational realities. Data is developed from detachments, or reinforced elements, that do not accurately correlate to non-deployed squadrons.

Conversely in the same manner, solutions are implemented in rear-echelons that do not transfer to forward deployed units. Economies of scale is a common business theory that can provide gross solutions at the service, fleet, or depot level, but does not always have equivalent, complimentary theory at the squadron level. Small scale civilian aviation business models do not transfer well to military aviation. After all, Chevrolet does not sell Tahoes on the same business model that the Hendrick Motorsports team builds racecars, nor does your local mechanic conduct pitstops. Fundamentally, company grade 6002s currently lack the deliberate, institutionalized training that would provide supplementary equivalent or complementary planning methods at organizational maintenance-echelons.

The AAMOC has been training and developing 6002s and other officers for several years now based on the MCOC 2025. Initially designed to supplement the 2025 force design realignment, it provides an interim experiential transition between entry level training and company grade PME. The quantitative changes between the 2025 and 2030 force design plans are mostly a change in force structure numbers regarding the type and number of aircraft the Marine Corps will have. Corresponding changes in the number and location of 6002 billets are essentially basic manpower adjustments. However, it is the qualitative differences between the documents that has the greatest risk of rendering the 6002 MOS obsolete if the gap between maintenance planning and operational employment is not reconciled against the new assumptions. The AAMOC can be instrumental in implementing this change, but is not in itself a cultural change mechanism capable of affecting the cultural shift towards employment planning.

The aviation logistics military occupational specialty career progress study dated 12 January 2010 (colloquially known as the 6002 MOS Roadmap) was a study of the aviation logistics community in efforts to "modernize" the training and development of its officers (6002, 6004, 6302, 6502, 6602, 6604) and various enlisted MOSs.[37] The document has

remained “in review” and “un-official” in perpetuity, but has served as the foundation for career requirement benchmarks for almost a decade. This study codified and defined the purpose of each of the MOSs. Both aviation maintenance officers (6002) and aviation supply officers (6602) are capable of becoming MALS Commanding Officers. Both aviation maintenance officers (6002) and aviation maintenance engineers (6004) are expected to demonstrate mastery of Naval aviation maintenance programs (NAMP) and be capable of scheduling and executing maintenance. In practice, however, the majority of a 6002’s academic training revolves around learning the supply system, while the 6004 is most often holding the billet that actually retains responsibility for scheduling and affecting maintenance relative to the aircraft (MMCO & MALS AMO). Curriculums in the Aircraft Maintenance Officer long course, joint aviation supply maintenance material management course (JASMMM), and the AAMOC dedicate significant portions of their curriculum on the utilization of software and systems as opposed to teaching mechanisms and methods of planning. Additionally, the JASMMM curriculum is almost entirely a Naval Supply primer as the course is written and administered by the Navy. It does introduce 6002s to higher level supply processes within the Navy’s logistical stovepipes, but does not provide any training on *planning*.[38]

The 6002, 6004, and 75xx Officers all undergo nearly identical training courses for their respective qualifications as “aircraft maintenance professionals.” This course is eight weeks long for 6002s, and four weeks long for the 6004s and 75xxs. These three officers have significantly different roles & responsibilities as well as drastically different career paths, backgrounds, and operational/tactical obligations. However, the majority of 6002 career experience and training is expected to be supplemented by on-the-job-training (OJT) from the 6004, which is still heavily replied upon. While OJT is a time-honored concept, its actual implementation has many pitfalls. Its most notable flaw is systemic cultural bias, as

outlined by Diane Walter[39]. Walters' proposal for task analytic training system (TATS) espouses a team-oriented OJT structure to decrease the potential for training gaps. The intent of this structure is already integrated into the training requirements for the enlisted maintainers, albeit unintentionally and passively, through delegated responsibilities outlined and tracked in the aviation skills management (ASM) program/database. However, the "team training" concept that couples the 6002 with a 6004 for OJT still generates a gap in training on how to plan at the organizational level. The OJT instructor can only teach what they know.

Over extended periods this also generates a propensity for systemic propagation of deficiency in skillsets; an unconscious systemic regression that administrative measures cannot fully compensate for. More than a decade's worth of operations in the middle east has resulted in an entire generation of enlisted Marines and Officers that have only operated from established air bases with established interior lines of communication, secure lines of logistics, over land, and under an umbrella of air supremacy. The average 6002 is only at the squadron level for a single tour and for usually less than three years. There is generally only one 6004 in a squadron. Depending on the T/M/S of aircraft, it is entirely likely that the 6004 is a new Warrant, or Chief Warrant, Officer.[40] Similarly, the Aircraft Maintenance Officer at a squadron is a Pilot (75xx MOS), who may or may not have had any previous aircraft maintenance experience. Underwriting this is the fact that the T&R manual for 6002 officers is nearly identical to the 6004 T&R. Notably lacking in the T&R, PME, and school-house initial MOS training is any specific training in *how to plan.* Mandated tasks in the COMNAVAIRFOR 4790.2c dictate what items should be planned *for*, as outlined in requirements for the monthly maintenance plan (MMP) as an example, but no training on methods of *how* to plan what it is requiring to be tracked. AIRSpeed provides the buffer-management tool (BMT) as a situational awareness tool for divisions' workload, allowing the re-prioritization of tasks to reduce certain metrics. Both the MMP and the BMT capture

metrics that display required actions, but do not inherently provide the capability to plan for or deconflict tasks and resources those actions require.

Benefits & Constraints of Civilian Models Applied to Marine Aviation

Most of the service level, RAND, and GAO studies have been written from common frameworks: 1. Aggregate statistical analysis at the service level, 2. Depot and national level solutions, and 3. Assumption of a secure, reliable, global supply chain. The first two characteristics are appropriate considering that the audience is either Congress or the Secretary of Defense. There are limits to the interpolation of that data to lower levels, however. The aggregate statistical analysis suffers from insufficient correlation of which failures are attributable to which operating environment. It is the third assumption, however, that clearly distinguishes the gap of the macro (enterprise solutions) with the gap in the micro (training modernization). It has become a common trend for service level leadership to seek equivalent business models to generate cost-wise readiness at all levels when addressing the macro-level gap of interim readiness and long-term platform availability. Modern civilian aviation invests significant time and resources into analysis and methods to manage maintenance, repair, and overhaul of their aircraft at all levels. US Marine tactical, operational, and organizational maintenance professionals are reflexively quick to cite all of the erroneous assumptions that render civilian business models ineffective in their respective paradigms. There are similarities in application as long as the disparate assumptions are reconciled. Civilian business concepts can be enabled to cross into military aviation at the lower echelons if these assumptions are accommodated. AIRSpeed is a prime example. However, 6002s receive very little exposure to other planning or process analysis methodologies. Careful application of assumptions is key to critically analyzing which models can be applied to a given circumstance. Bazargan demonstrates a method of analysis

for distributing workloads across multiple locations that includes available manpower as a variable.[41] Bazargan's model provides a simple formula to quantify manpower utilization that can be easily applied to any single organizational unit or detachment. Use of this formula can be easily replicated to compare across multiple locations, multiple T/M/S, and multiple sites. Another methodology is presented by Safaei and Jardine. This method uses time-space network (TSN) and connection network (CN) models to prove that aircraft routing can be coordinated in conjunction with maintenance requirements to increase fleet availability.[42] These represent moderately complex models that would be applicable and beneficial at the ACE or component level. These two methods demonstrate that there are civilian methods that include variability and adaptability within their systems that can be applied across the planning spectrum, negating stated limits of applicability of civilian models at the organizational level. Both of these models could be adapted for use by 6002s as formulaic, quantifiable planning mechanisms at the detachment and ACE levels of employment.

Revised training, hybridization of industry efficiency models at the service level, and new acquisition program philosophies appear to be solutions on extreme ends of the problem triangle that are only tenuously linked. However, they are all linked, both figuratively and literally, by the assumption of secure sea lanes of communication that provide the effect of global interior lines.[43] Inherent within this assumption are secure command and control lines of communication as well as access to logistical connectors. These assumptions cannot be guaranteed in modern competition and conflict.

Section IV: Recommendations

Employment Planning & Enterprise Planning Methods: It's the Same Gap

The 6002 MOS should be the linkage between tactical sortie generation sustainment, supply chain actualization, aviation maintenance employment in theater, and service level management interface. These actions do not necessarily occur simultaneously. In fact, it should be the 6002's responsibility to consider the sequencing and prioritization of these issues and deconflict with the supporting and supported organizations where necessary. This should manifest as a distinct type of planner that is able to bridge the difference between aviation logistics and the Marine Corps planning process. This will require two distinct changes; one cultural and one doctrinal. The cultural shift involves the specific spectrum of planning to which the 6002 MOS should be focused on. This planning skill set can be referred to as "aviation maintenance employment planning" to provide distinction that still retains joint doctrine appropriate definitions.[44] *It is this distinction that conveys the summary of the gap between existing means for aviation sustainment and the future state of sustainment in modern theaters against peer adversaries.* The 6602 field remains specialists in supply chain management theories and those skills related to pure supply-type logistics. The 6004 MOS remains the principal agent responsible for the maintenance management actions regarding the aircraft, program management, and supply/support interface; the aforementioned "maintenance planning" that current convention uses. The doctrinal change involves reorienting and refining the training curriculum for the 6002 MOS to include instruction on different methods of planning.

Marine Corps doctrinal publication 1-0 "Marine Corps Operations" outlines six functions that Marine aviation is tasked with accomplishing in support of operations.[45] The nature of these six functions have not changed. However, comparison of the Marine Corps Operating Concept (2025) written in 2016 and the Force Design 2030 written in 2019

demonstrate that there are significant changes in the character of the ACEs deployment and employment.[46,47] The Marine Corps has repeatedly demonstrated proficiency in the ability to readily deploy reinforced aviation detachments in support of both MAGTFs and Joint Operations. Shore-based deployments have become the norm over the last two decades. Ship-based MEUs have been relegated to supplementing shore-based missions. In this cycle, supply networks are established with major hubs existing in either allied or partner nations. Few 6002s are exposed to the process of assessing or evaluating theaters for aviation maintenance support. Large operations are assumed to rely on maritime prepositioning squadron (MPSRON) offloads of entire MALS, with the TAV-B class of ships providing an incremental evolution in this paradigm. Again, the assumption of established, secure communications between supported aviation units and supporting logistical units is a critical weakness.

Aviation maintenance can address this by transitioning to an employment vice deployment paradigm once the ACE is conducting operations in theater. This is an area where company grade 6002s often struggle as the umbilical to the parent MALS is severed. As the Marine Corps reorients on forcible entry and expeditionary operations against peer and near-peer adversaries, enabling and sustaining aviation capabilities will be contested and exponentially more difficult as reach-back will be directly challenged. Complex, in-depth and networked anti-access/area-denial environments deny secure sea-lines of communication and inhibit the interior-lines provided by partner and allied nations. Single-location, comprehensive MALS are both a single point of failure and a critical vulnerability in a single target. Distributed, redundant capability through reinforced (and intermixed) rotary wing and fixed wing capabilities are one way to create resiliency in aviation sustainment.

The current paradigm for 6002s does not proactively provide the skillset required to enable employment planning. This regime of planning is critical to support aviation in

accomplishing operational objectives in forward deployed, contested environments. As force flows generate power in theater, sustainment requirements increase. As lodgments are established and secured, transient air superiority will require the physical component of aviation maintenance (tools, personnel, equipment, and material access) and those components should be expected to transition accordingly. This transition will include regeneration requirements due to attrition. This is not merely the forward arming and refueling point (FARP) concept writ large; it extends beyond merely armaments, ordnance, and bulk fuel. Nor is this shift simply an old forward operating base (FOB) concept reapplied to a new theater. It is a fundamental doctrinal shift between counterinsurgency operations (COIN) and conventional combat against contemporary enemies. It is akin to the cultural and doctrinal shift between World War I & World War II; morphing from merely an additional land army with naval background to becoming a truly amphibious force from the sea. Unfortunately, the Marine Corps is now carrying institutional and cultural memories of past success that create biases, arrogance, and blind spots in our shift of focus.

The current model of sustainment of aviation sortie generation is heavily reliant on direct support and coordination from the parent MALS, Marine Aircraft Group (MAG), and MAW. These supporting agencies are typically located in entirely different theaters under completely different conditions. Once deployed, aviation maintenance capability is incorporated within other planning evolutions of the MAGTF. Several of these capabilities and concepts are already in regular use by other components of the Marine Corps. Maj Kortman's research into a similar constraint on the aviation ground support (AGS) units identified similar gaps.[48] His research was based on developing solutions to the 2025 operating concept. The similarities in the *qualitative* conceptual changes identified by Maj Kortman between the assessments and the current focus shift demonstrates that these types of issues are enduring, and not simply due to the specific *quantitative* changes in the FD2030

structure. The requirements for expeditionary advance base operations (EABO) to be able to support aviation operations in contested environments will require coordination with aviation ground support capabilities. The United Kingdom's Ministry of Defense (UKMOD) published an integrated operating concept for 2025 that expressed a similar paradigm shift facing their deployment and employment concepts.[49] This highlights that this critical platform is not simply a Marine Corps problem and that there are global effects and consequences. The global spares pool concept for the F-35 means that combat losses and stricken assets will foist attrition effects on international partners that may not even have forces in theater thus bringing in a national level political effect.

Some skills are already common and well established within the Marine Corps. Physical network analysis (PNA) is a skillset that Marine logisticians in the non-aviation components are taught. MAGTF staff training program (MSTP) Pamphlet 4-0.2, The Logistics Planner's Guide, includes PNA as part of the variables ground logisticians explore during the Marine Corps planning process (MCPP).[50] PNA forms the basis of the logistic commander's role in the course of action (COA) wargame. Aviation supply conducts similar analysis of supply networks. To clarify; MAGTF Logisticians (4002s) do regularly conduct physical network analysis, supply chain assessments, hub-and-spoke, push-pull wargaming and planning within the staff actions supporting MAGTF and Joint operations.[51] Simultaneously, Aviation Supply Officers (6602s) are also conducting similar assessments regarding aviation supply components of logistics, while 6002s are not. When forward deployed, the senior most 6002 of a MEU is typically a 1st Lieutenant that has had not received any training or education in assessments, physical network analysis, operational planning, or sortie generation metrics. The 6002 lieutenant typically spends the entire deployment learning to mimic the capabilities exercised by the 6004 serving as the

Maintenance and Material Control Officer (MMCO) for the ACE. This trend is reflected in and exacerbated by the mirrored T&Rs for 6002 and 6004.

The net result is that the current roadmap for the 6002 MOS does not provide a *unique* skillset to complement, support, or enable the 6602, 6004, or ACE Commander, but is rather expected to become a little bit of both without either the expectation of mastery or experience of either. The current binary model limits aviation logistics to merely cumulative aggregate results. Synergistic effects can generate a gestalt between the three MOSs by pursuing a distinct regime for company grade 6002s.

Recent modernization of the MOS have been instrumental in adapting to the new philosophies of acquisition programs (5^{th} generation aircraft, O-to-D logistics, composite systems & materials, global logistics, global spares, etc.) at the enterprise, service, and industrial levels, but have neglected equivalent development of the training required for tactical and operational aviation sustainment and adaptability once the officer detached from the parent MALS, i.e. planning or assessment. These initial solutions have been critical in establishing a foundation for the current maintenance paradigm, but continually see application as the "same-old new" and "more of the same change." Service constraints and acquisition program concepts pursued business model cost-efficiencies (economies of scale, lean/6σ, "just-in-time") that were primarily focused on supply chain and production type logistics solutions. This resulted in maintenance planning for forward deployed aviation conforming to regional hub-and-spoke supply concepts that were anchored to large, existing, or established bases of supply. Planning these capabilities has been historically conducted at the Wing or MAGTF level, with specific capability of support being planned and provided by the MAG AMO (6004). This planning is predominantly focused on deployment planning. I.e. whatever is needed to get the capability into theater. Operating out of established hubs reliant upon existing and established procedures has been the norm once in theater. 6002s

traditionally do not deploy into a theater of operations in which there is a requirement to establish a sustainment (i.e. maintenance-support) capability from the ground up.

Additionally, despite the appearance of instantaneous communication, there are significant delays in the actual routine of maintenance communication. Reliance on the Parent MALS/O4 6004 requires days of delay between transmission of a request and approval of support, resulting in decreasing the holistic decision process cycle time (observe, orient, decide, act: OODA loop) of aviation maintenance with matriculating effects on sortie generation. These delays have had relatively minimal impacts in theaters where air supremacy has already been established, but may become crippling in theaters in which air superiority is transient or tentative. Marine Aviation has existed in this paradigm for so long that these assumptions have become inculcated in its planning culture, and has been so for nearly an entire generation. The U.S. Navy even more so.

Application in Future Conflict: Evolution & Adaptation

In a modern, complex, and networked A2/AD environment, logistical supply chains will be threatened well before connectors are in the tactical environment. Acquisitions programs that rely on civilian logistics will find themselves hamstrung when conflicting national policies prohibit contiguous nations from supporting U.S. war material flows into conflict theaters. Active, lethal threats to U.S. naval hulls will increase stand-off distances, creating exponential demands on logistical resources required for connectors. Peer environments capable of jamming and disrupting communications provide the potential for interruption of the management of critical resources and communication of data from CONUS. Attrition of aviation platforms will occur. The ability to sustain aviation sortie generation will require more than a pre-deployment pack-up kit (PUK).

Air superiority should be expected to be temporary and transient, requiring continuous adaptation to real-time operational plans. Military equivalent planning models will need to be run numerous times, often in short sequence and they will not be purely iterative. Application of systems models to military environments will require real-time, effective assessments to generate appropriate assumptions and identify key variables. They will need to be able to be executed as soon as a planning criteria, operational condition, or critical assumption is affected. Most importantly, these models cannot be run with the expectation to provide a single best solution. They must be run to provide *several*, sub-optimal solutions in order to provide supportable, executable options to the Commanding Officer. Aviation maintenance employment planning is the paradigm that must be distinctly developed to enable this. The paradigm of aviation maintenance employment should be expected to be isolated from the existing planning paradigms both figuratively and literally. As such, providing training specific to planning and employment earlier in their career can directly contribute to future relevance of the 6002 in the contemporary modern fight, and should be the unique and distinct capability they provide to complement 6602, 6002, and 4002 skillsets.

Revision of the purpose of the 6002 MOS should be deliberate and can be drawn from existing techniques. Introduction to the fundamental databases and management tools and concepts of maintenance will still be required as they provide a common language for aviation maintenance but they should be taught for introductory familiarity as a foundation, rather than expected mastery as an end-product. Additional employment planning skills should then be built on this foundation.

Several of these skills are already included in the Training & Education Command (TECOM) repertoire, and would require only a small amount of adaptation to supplement aviation maintenance. For example, the ground logistics officers (4002) professional military education program already includes teaching physical network analysis. Physical network

analysis (PNA) is an established process whereby infrastructure and connectors are identified and classified within a battlespace. Capacity and capability are determined and planning considerations are synthesized from this data. The curriculum could be easily condensed and tailored towards aviation maintenance. A 6002 with this skill would be able to supplement the forward deployed MAGTF logistics staff with those criteria that are peculiar to aviation maintenance. The 6002 inclusion to this component of the planning process would also provide reciprocal planning back to the ACE by providing discourse on location, capability, and capacity of aviation maintenance in relation to desired aviation force projection. This also allows the 6002 to provide relevant input into the 6602's PNA for aviation supply. A well-stocked warehouse is useless if the parts cannot be transported to the aircraft.[52] This initially seems obvious and redundant due to our current deployment methods whereby the ACE is operating from either fully established airfields or temporarily extending range via FARPS. The Air Force demonstrated the capability for A-10s to operate from highways in exercise SABER STRIKE 18 to counter this expectation.[53] An established airfield in almost any theater can be assumed to be targeted by a peer adversary in current conflict, and a FARP does not provide maintenance capability. Therefore, an ability to assess existing infrastructure enables the 6002 to provide alternate courses of action.

Once detached from the parent MALS structure, the maintenance capability for a sea-based, shipborne ACE is in a high state of flux regarding logistical support infrastructure and demand. Estimates and assessments (E&A) are another existing, complementary ground logistic skillset that could easily be tailored to the particulars of planning that should concern a deployed 6002. Logistics estimates provides the critical questions for framing the problems 6002 should be focused on. Transitioning between numbered Fleet AORs corresponds to a change in capability and support paradigms from both the Navy and the Marine Corps supply chain that requires an adjustment assessing maintenance capability and capacity.

Furthermore, the increased potential for disaggregated operations creates complex dynamics for sustainment of the ACE that is predominantly dependent on the LHA or LHD AIMD's capability for sortie generation sustainment. The capability to estimate and assess the distinct aviation sustainment characteristics of a theater enables the 6002 to provide recommendations to the ACE or detachment commander based on cognitive, deliberate processes rather than intuition. The purpose being to enable the provision of *options* to the Commander so that they may chose the risks they are willing to accept. Again, two decades in the Middle East has done a disservice to intuition. By definition, a MEU/ARG can be disaggregated in 5th FLEET while only being separated by approximately 100 miles but be operating in completely different logistics paradigms between EUCOM/6th FLEET, CENTCOM/5th FLEET, and PACOM/7th FLEET; inversely, thousands of miles can separate a MEU/ARG in PACOM/7th FLEET without them meeting the definition of "disaggregated".[54] A doctrinal estimates & assessments processes would enable a 6002 to proactively seek options to support possible concepts of operations.

Physical network analysis (PNA) and estimates & assessments (E&A) should be considered critical skills. Operational E&A is a completely disparate concept from naval aviation planning and estimates. However, PNA and E&A are only half of the 6002's course of action framework for employment planning. PNA and E&A enable the 6002 to interface with the 6602 and 4002 in the logistics environment external to the maintenance process. 6002s must also be able to interface with the 6004 to provide for the environment internal to the maintenance process. Application of appropriate civilian methodologies and equivalent processes can be applied at the tactical/organizational level to provide recommendations of future states of maintenance that facilitate the 6004s maintenance planning. This is better illustrated by the use of an example:

In the development of a proposed course of actions, Future Operations cell proposes an ideal operational objective that includes the seizure of a civilian airfield from which upcoming flight operations can be conducted. The ACE's area of operation contains several airfields which meet the requirements for the aircraft intended to operate from the field, with no clear benefit to any particular one. The Current Operations cell is simultaneously planning on how to both generate sorties to seize the airfield and transition current flight operations from the in-use airfield to the proposed seized airfield. A 6002 with aviation maintenance experience *and* PNA and E&A training can participate in all of the relevant phases of the operational planning and understands the particular needs of aviation maintenance and can infer how current readiness impacts future operations. In assessing two of the airfields, the 6002 recognizes that one airfield contains an enclosed hanger rated for heavy aircraft maintenance containing a gantry crane, while another airfield contains covering parking facilities for aircraft. The 6002 has been proactively engaged with the 6004 and understands that one V-22 needs to have the prop-rotor hub removed, while several of the F-35s need low-observable restoration completed. With this information, the 6002 can meaningly contribute to the Operation's Cells planning by notifying them of how each airfield benefits the type of maintenance needed, as well as the effects on whether or not the ACE needs personnel lift, thereby prioritizing the airfield with the heavy maintenance hangar for the V-22, or if it needs to suppress enemy air defenses, thereby prioritizing the covered parking for the F-35s. Coordination with the 6004 and 4002 in conduction the PNA also enables the 6002 to provide how this information with shape the logistics network to ensure that the right parts are prioritized to the right location in sufficient time to be on hand when maintenance begins.

Linear programming methods such as transshipment problems, critical path analysis, network models, project management modeling, and queuing theory are all adaptable, scalable techniques that can provide *quantifiable* data for COA development. Incorporation

of these mechanisms into the 6002 skillset also provides responsive metrics and controls at lower levels to complement service level aggregate analysis. These models can be easily set up for planning purposes and are visual, easily iterated, and relatively simple to execute at organizational levels. They are responsive to inputs and can be easily coupled with both PNA and E&A to provide sound recommendations in the support of aviation sortie generation. Linear programming is generally a method of solving a model by which a quantity, constraint, or restraint can be maximized, minimized, or limiting, allowing for the development of consequences and alternatives.[55] In MCPP parlance: small scale COA development. Transshipment network modeling complements PNA by providing a method for solving transportation and transshipment analysis, both inter-theater and intra-theater.[56] Figure 3 demonstrates an inter-theater model for an ARG with an embarked MEU transiting through one theater to reach an area of operations.

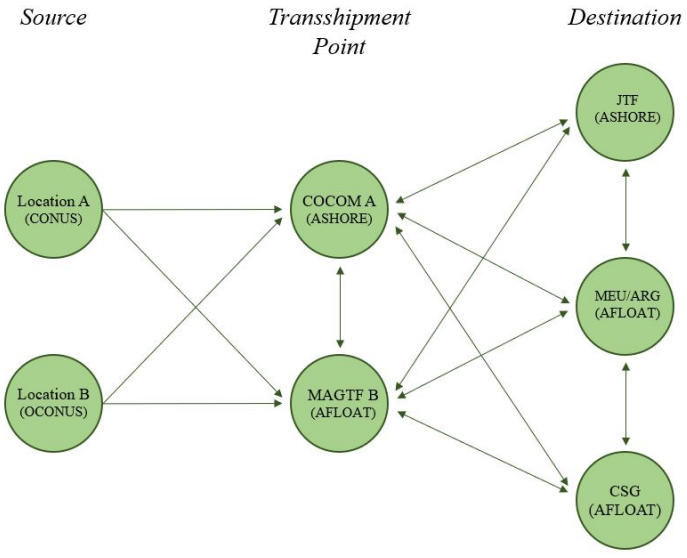

Figure 2.
Inter-theater Transshipment Model

Transshipment solutions can be instrumental in determining time-space-distance consequences for the internal movement of resources within the aviation maintenance organization itself. Figure 4 represents the movement of engines between a suitable repair facility and the aircraft installation location that may not have either site collocated with the repair facility for the ground support equipment needed to move the engines.

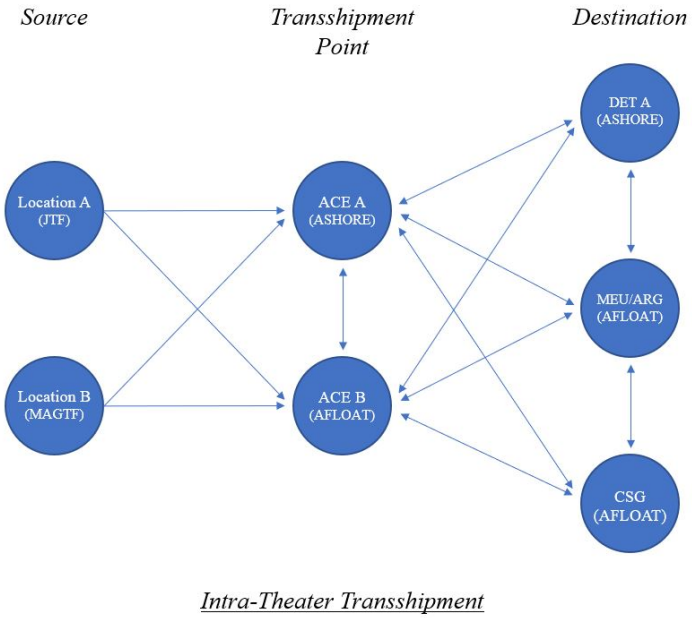

Figure 3.
Intra-theater Transshipment Model

Project management models provide techniques for analytically sequencing complex problems. This technique is effective in managing time and cost. Critical path analysis models are another tool (figure 5).

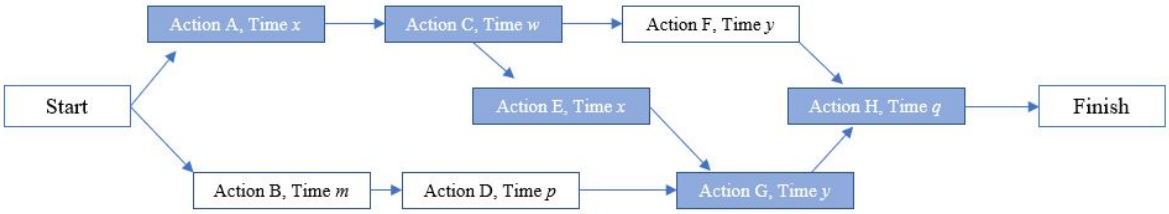

Figure 4.
Critical Path Analysis Model

Simultaneous management of aircraft maintenance using this method can provide logical and deliberate quantitative, comparative decisions to help reduce reactive cannibalization, enabling more efficient utilization of maintenance manhours. In non-tactical environments, this tool can be used to supplement depot level planning for better cost-to-readiness decisions for aircraft on the flight line.

Finally, queuing theory (figure 6) can be used to analyze waiting times and manpower resource allocation to reduce down-time (aircraft not being worked on or personnel not in work). Queuing theory generates organizational efficiencies when coupled with project management by aligning project tasks with available manpower. Queuing theory can also be used to complement theory of constraints analysis to align personnel with scarce resources in terms of either infrastructure or tooling; e.g., a single test bench or test cell with only a few qualified operators in theater.

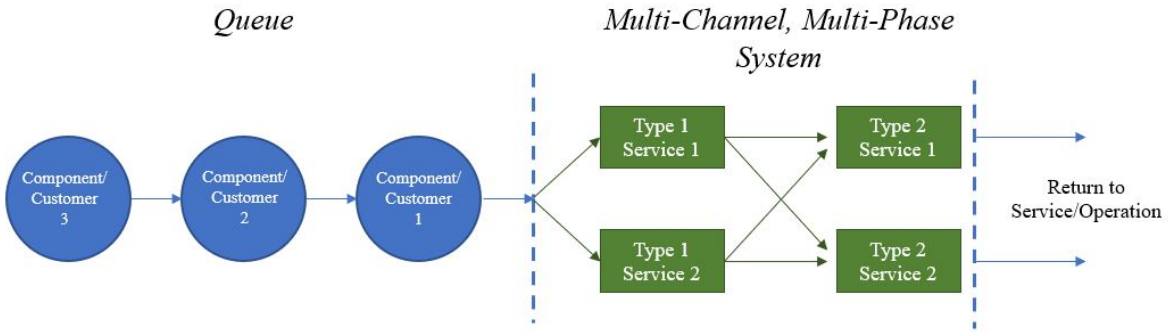

Figure 5.
Queuing Theory Model

In essence, linear programming, network modeling, project management, and queuing theory are teachable techniques that can provide a 6002 with *how* to plan. To use MCPP parlance again, expanding these skills into the 6002 curriculum enables the 6002 to perform as an aviation maintenance equivalent of Future Operations (FOPs) to complement the 6004 as an aviation maintenance equivalent of Current Operations (COPs).

Section V: Conclusions

Aviation maintenance is a complex system of systems that exists simultaneously within ground, aviation, and naval logistics. Each component contains independent variables comprised of finite resources in terms of assets, platforms, material, time, and personnel. Further specific studies should be conducted to develop which types of models should be used, and how best to incorporate them into the instructional curriculum. These methods can easily be structured to provide additional applicability at each level of professional development by either introducing more complex models or more inclusive scope. The 6002 is ideally situated to provide the interface between external infrastructure and internal processes. However, the current training regime for 6002 does not include methods to proactively analyze and quantitatively synthesize variables and then generate tailorable options for the employment of aviation maintenance support. This is an absolutely critical skillset for forward deployment in complex A2/AD environments, expeditionary advanced base operations, and combined/joint forceable entry operations against modern contemporary adversaries where C2 and SLOC cannot be assumed inviolate. These techniques should be taught deliberately as specific skills in order to provide a deployment ready 6002 capable of supporting the planning and employment of aviation maintenance to the Fleet Marine Corps.

Appendix A

Military Occupational Specialties & Relative Billets

Military Occupational Specialty Codes:

4002	Logistics Officers (Ground, unrestricted)
6002	Aviation Maintenance Officer (unrestricted)
6004	Aircraft Maintenance Engineering Officer (restricted; WO, CWO, & LDO)
6602	Aviation Supply Officer
75xx	Pilot/Naval Flight Officer (unrestricted; any T/M/S)

Billets relative to MOS:

The Marine Corps uses similar titles for occupational specialties and their respective billets in logistical fields. These conventions are not distinguishable when using acronyms and their differences are usually garnered through context. Marine aviation contains a technicality in the difference between "aircraft" and "aviation" in the contexts of billet and MOS that is lost in using the acronyms. Both Aviation Supply Officers (6602) and Aviation Maintenance Officers (6002) can hold the billets of Operations Officer, Executive Officer, or Commanding Officer of a MALS.

AMO (MOS):

-An *Aviation* Maintenance Officer (AMO), MOS of 6002, does not hold the billet of *Aircraft* Maintenance Officer (AMO) within a MALS or Squadron.

AMO (Billet):

An Aircraft Maintenance Officer (AMO) in the MALS/MAG is an Aviation Maintenance Engineer (AME) that is a Limited Duty Officer (LDO), MOS of 6004, The Aircraft Maintenance Officer (AMO) of a squadron is a pilot, MOS of 75xx.

Supply vs. Logistics:

-An Aviation Supply Officer (ASO), MOS of 6602, can hold the billet of Aircraft Supply Officer (ASO) within the MALS.

-A ground Logistics Officer, MOS of 4002, may occasionally hold the billet of Supply Officer or Maintenance Officer in non-aviation fields (i.e. motor transportation, artillery, etc.), but does not hold those billets in an aviation command. Logistics Officers (4002) hold the Ground Logistics Officer billet in aviation commands.[57]

Appendix B

Acronyms & Abbreviations

A2/AD	Anti-Access/ Area Denial
AAMOC	Advanced Aircraft Maintenance Officer Course
ACE	Air Combat Element
AGS	Aviation Ground Support
AIMD	Aircraft Intermediate Maintenance Department/Division/Detachment
AMO	Aircraft Maintenance Officer (Billet)
AMO	Aviation Maintenance Officer (MOS)
AOR	Area of Responsibility
ARG	Amphibious Readiness Group
ASM	Aviation Skills Management
AVLOG	Aviation Logistics
BMT	Buffer Management Tool
CENTCOM	Central Combatant Command
CN	Connection Network
CNAF	COMMANDER, Naval Air Forces
CNATRA	COMMANDER, Naval Aviation Training Command
CSC	Command & Staff College
CO	Commanding Officer
COA	Course of Action
COCOM	Combatant Commander (Title 10)
COIN	Counter-Insurgency
CONUS	Continental United States
COPS	Current Operations
CPI	Continuous Process Improvement
CWO	Chief Warrant Officer
DoD	Department of Defense (United States)
EABO	Expeditionary Advanced Base Operations
EUCOM	European Combatant Command
E&A	Estimates & Assessments
FARP	Forward Arming & Refueling Point
FD	Force Design 2030
FMC	Fully Mission Capable
FOB	Forward Operating Base
FOC	Full Operations Capable
FOPS	Future Operations
FRC	Fleet Readiness Center
GAO	Government Accountability Office (formerly Government ...
IOC	Initial Operations Capable
JASMMM	Joint Aviation Supply Maintenance Material Management Course
MAG	Marine Aircraft Group
MAGTF	Marine Air-Ground Task Force
MALS	Marine Aviation Logistics Squadron
MAW	Marine Aircraft Wing (United States)
MEU	Marine Expeditionary Unit (United States)
MC	Mission Capable
MCOC	Marine Corps Operating Concept (United States)

MCDP	Marine Corps Doctrinal Publication
MCWP	Marine Corps Warfighting Publication
MCPP	Marine Corps Planning Process
MMCO	Maintenance/Material Control Officer
MMP	Monthly Maintenance Plan
MOS	Military Occupational Specialty
MPSRON	Maritime Pre-Positioning Squadron
MSTP	MAGTF Staff Training Program
N41	US Navy Supply Department numerical designator
N42	US Navy Maintenance Department numerical designator
NAE	Naval Aviation Enterprise
NAMP	Naval Aviation Maintenance Program (CNAFINST 4790.2C)
NAVMC	Navy and Marine Corps
NMC	Non-Mission Capable
OEM	Original Equipment Manufacturer
OID (O-I-D)	Organizational-Intermediate-Depot
OIRR	Organizational-level Independent Readiness Report
OJT	On-the-Job Training
OODA	Observe, Orient, Decide, Act
PACOM	Pacific Combatant Command
PMA	Program Management, Air
PMC	Partially Mission Capable
PME	Professional Military Education
PNA	Physical Network Analysis
POA&M	Plan of Action & Milestones
PUK	Pack-up Kit
RBA	Ready, Basic Aircraft
RFI	Ready for Issue/Issuance
T&R	Training & Readiness
TATS	Task Analytic Training System
TECOM	Training & Education Command
T/M/S	Type/Model/Series
TO	Table of Organization
TOC	Theory of Constraints
TSN	Time-Space Network
TYCOM	Type Commander
UKMOD	United Kingdom Ministry of Defence (British Spelling)
USMC	United States Marine Corps
USN	United States Navy
WTI	Weapons & Tactics Instructors
WO	Warrant Officer

Endnotes

[1] For example, the Defense Logistics Agency (DLA) and Naval Supply Systems Command (NAVSUP), Program Management, Air (PMA) all provide specific types of material, logistical, and program support.
[2] In this paper, the term "naval aviation" is inclusive of Marine aviation except where specific service differences require distinction, and clarification will be provided. For further breakdown of the specific relationships between USMC aviation and USN aviation maintenance, see Chapters 1 & 2, COMNAVAIRFORINST 4790.2c (CNAFINST, Short title: NAMP).
[3] USMC Pilots attend and are graduated from Naval Flight School, under the authority of COMMANDER, Naval Aviation Training Command (CNATRA), a USN Three-Star Admiral. https://www.cnatra.navy.mil/cnatra.asp
[4] Appendix A, CNAFINST 4790.2c. COMMANDER, Naval Air Forces. *Naval Aviation Maintenance Program.* COMNAVAIRFORINST 4790.2C. 2017. https://www.navair.navy.mil/documents?name=&field_document_description_value=NAMP.
[5] A list of numbered PMAs can be accessed via the NAVAIR website, and fall under PEO(T), PEO(U&W), and PEO(JSF). Link: https://www.navair.navy.mil/
[6] For instance, USN PMA 257 is in support of the AV-8B aircraft, of which there are none in the Navy inventory. PMA 260 manages aviation ground support equipment for all USN and USMC aircraft.
[7] "Occupational specialties" is a Marine term regarding the specific field of the job-set. The military occupational specialty (MOS) is a four-digit number. The Army uses the same term for specific individual job sets, while using the term "branches" to signify major fields; i.e. logistics, infantry, artillery. USN uses the term "rating", also a four-digit number. The Air Force uses the term air force specialty code (AFSC).
[8] The distinction between aviation supply & ship supply is typically opaque, with very little interface. However, there are cultural distinctions that are not obvious that create complex problems for Marine aviation/MAGTF in particular. US Navy Carriers (CVNs) are actually owned (funded, operated, and tasked) by CNAF. The relationship between aviation and ship is unified. US Amphibious ships are owned (funded, operated, and tasked) by US Navy Surface Forces Pacific or Atlantic (COMNAVSURFPAC & COMNAVSURFLANT), and there is a distinct cultural divide between USN surface and USN air forces. When Marine aviation is embarked onboard COMPHIBRON ships, there is a different relationship than when Marine aviation is embarked onboard Navy Carriers.
[9] A MALS is manned and equipped to support Marine Aircraft Group (MAG) deployment paradigms. Marine Squadrons are typically comprised of 16 aircraft, with manning & structure allocated to allow them to separate into two detachments of 5 aircraft and one of 6. Any numbered combination is technically possible as long as appropriate support is coordinated. USN Squadrons fixed wing squadrons are typically 10 aircraft, but tactical, rotary, and maritime deployment philosophies vary widely according to mission and location.
[10] The typical military structure is usually tactical, operational, and strategic. Due to the inclusion, in modern acquisition programs, of civilian contract support to military aviation and aviation logistics, especially in terms of explicitly joint programs, the national level is included here.
[11] For specific details of the organizational, intermediate, and depot levels, see Chapter 3, COMNAVAIRFORINST 4790.2c. The OID concept closely resembles the maintenance, repair, and overhaul (MRO) model in civilian aviation
[12] A non-ship unit or command that provides a support capability is often referred to as an "activity" in USN publications. E.G. FRC Southwest is an activity. MALS-13 is also considered an activity.
[13] While the Navy AIMD concept closely resembles the Marine MALS, a Navy AIMD is not inherently a scalable, deployable capability; it resides in a fixed location, either ashore onboard an installation or on ship as a department. Also, the Navy has transitioned to "Centers of Excellence" concepts CONUS, which combine intermediate and depot level maintenance. However, OCONUS, the Navy currently separates Intermediate & Depot levels (COMFAIRWESTPAC and COMFRCWESTPAC, respectively). Note that the U.S. Air Force uses a maintenance squadron concept in which *aircraft* in a maintenance state are transferred, as opposed to the Marine Corps model that transfers *personnel* or *tasks*.
[14] Chapter 1, Page 1. MCWP 5-0 "Marine Corps Planning Process." Headquarters US Marine Corps. *Marine Corps Planning Process*. MCDP 5-0. Washington, DC: Headquarters US Marine Corps. September, 2020.
[15] The term 'operational' planning is used at the tactical, operational, and strategic levels, and should not be considered to be options, decisions, or risks that only applicable at the operational level.
[16] See RAND studies on aviation, GAO studies on readiness and program management, and internal HQMC, DCA studies and Marine Corps Center for Lessons Learned (MCCLL).

[17] Government Accountability Office records contain reports regarding depot level maintenance, planning and utilization as far back as 1977. RAND reports concerning aircraft maintenance and readiness cycles date back to 1966.
[18] The U.S. General Accounting Office and the U.S. Government Accountability Office are the same institution. The institution underwent a formal name revision in 2004, thus all articles produced prior to 2004 will cite the former title.
[19] Curtin, Neal P. *Services Need Strategies to Reduce Cannibalizations.* GAO Report to Congressional Requesters GAO-02-86. Washington DC, General Accounting Office, November 2001. https://www.gao.gov/products/GAO-02-86
[20] Of note, care should be taken when applying studies regarding Naval aviation to Marine Corps aviation. While the two paradigms share a great deal of administrative similarities, their theory of employment & deployment result in drastically different cultures. Small organizational and command & control differences result in significantly different interpretations of the naval aviation maintenance program (NAMP) instruction, OPNAV 4790c. Further complication arises when discussing program acquisitions for Marine aviation as they are run under the Navy; COMMANDER, Naval Air Forces (CNAF) publishes safety requirements and operational guidelines for ship board operations, and administrates supporting programs through the program management activities (PMA).
[21] Maurer, Diana. *Weapon System Sustainment: Aircraft Mission Capability Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems*. GAO Report to Congressional Requester GAO-21-101SP. Washington DC, Government Accountability Office, November 2020. https://www.gao.gov/products/GAO-21-101SP
[22] Platforms mission sets are defined by their mission essential task lists (METL), which are grossly subdivided into the six functions of Marine Air: anti-air warfare, assault support, electronic warfare, offensive air support, air reconnaissance, and control of aircraft & missiles. See MCDP 1-0 Operations.
[23] Navy purchases contractor services in order to maintain C-12 Aircraft. Stolarow, J. H. *Review of Navy's Requirements to Buy Contractor Services to Maintain, Support, and Test the C-12 Aircraft.* GAO Report to Secretary of Defense B-196096. Washington DC, General Accounting Office, October 1979.
[24] Neller, Robert B. General, USMC. *Marine Corps Operating Concept: How an Expeditionary Force Operates in the 21st Century*. Washington DC, United States Marine Corp, September 2016.
[25] Hulse, S. *2d MAW AMO Perspective*. OIRR. (Unknown).
[26] Spratlin, Colonel, USMC, Blauw, Colonel, USMC. *Aircraft Maintenance Officer Requirements Review Working Group*. PowerPoint presentation. NAS Whiting Field, FL, March 2017.
[27] The 6002 T&R is a task list generated from the aviation skills management (ASM) database. This database is used to track and document maintenance training, proficiencies, and authorities in accordance with COMNAVAIRINST 4790.2c. The T&R program itself falls under the NAVMC 3500 series of orders. The Aviation T&R is the NAVMC 3500.14E; there is no 3500 series order specifically for aviation logistics, as those are contained in ASM as a task list.
[28] Maurer, Diana; Khan, Asif. *Army and Marine Corps Need to Improve Efforts to Address Challenges in Measuring Performance and Planning Maintenance Work.* GAO Report to Congressional Requesters GAO-20-401. Washington, DC, Government Accountability Office, July 2020. https://www.gao.gov/products/GAO-20-401
[29] Maurer, Diana; Khan, Asif. *The Navy Needs Improved Planning to Address Persistent Aircraft Maintenance Delays While Air Force Maintenance Has Generally Been Timely.* GAO Report to Congressional Requesters GAO-20-390. Washington, DC, Government Accountability Office, June 2020. https://www.gao.gov/products/GAO-20-390.
[30] Sequencing depot-level induction of Marine Aircraft is a Type Commander (TYCOM) function for the respective type, model, series. Management of throughput in the depots is the responsibility of the regional Fleet Readiness Centers, under the purview of Commander, FLEET READINESS CENTERS (COMFRC). See ch.12 of the COMNAVAIRFORINST 4790.2C (NAMP).
[31] For details on the NAE AIRSpeed program, see Ch3.2.2.26 in the COMNAVAIRFORINST 4790.2C (NAMP) or https://www.public.navy.mil/airfor/nae/pages/navairairspeed.aspx.
[32] A separate comparative study should be conducted on the correlation between service cultures and the acceptance of AIRspeed. The Navy more readily implements AIRSpeed at upper echelons, while its lower echelons eschew it. Conversely, the Marine Corps gives the passing nod to AIRSpeed at higher levels, while effectively inculcating it at the organizational level.
[33] Lean/6σ/TOC, the foundation of AIRSpeed, are essentially focused on *production* process efficiencies. Below OEM and Depot levels, the majority of aviation maintenance is repair, replace, and rework, which are considered waste in the civilian production models.

[34] 6002 Optimal Career Path revision and Figure 2 can be found on slide 26 of the Aircraft Maintenance Officer Requirements Review Working Group brief, 2 March 2017. Headquarters US Marine Corps, Aviation Logistics Support Branch. *Aircraft Maintenance Officer Requirements Review Working Group*. (2017).
[35] Unknown, AAMOC & 3MC Power Point. Unknown.
[36] Headquarters US Marine Corps. *Force Design 2030.* (2020).
[37] Valour, LLC. *Aviation Logistics Military Occupational Specialty Career Progression Study.* Headquarters, USMC, Quantico, VA. Unknown.
[38] Joint Aviation Supply Maintenance Material Management course. Course number CIN A-8B-0020. Navy Supply Corps School, Newport Rhode Island.
[39] Walter, Diane. "Competency-based On-The-Job Training for Aviation Maintenance and Inspection-a Human Factors Approach." *International Journal of Industrial Ergonomics 26.* (2000).
[40] This Warrant officer will be expected to train up a junior 6002 without receiving any specific education in *how to train*, further contributing to uncontrolled deviation as the training is inconsistent, resulting in more systemic regression.
[41] Bazargan, Massoud. *Airline Hangars Balanced Manpower Utilization: an Optimization Approach*. International Journal of Aviation Systems, Operations, and Training, vol 3, issue 2. July-December 2016.
[42] Safaei, Nima, and Jardine, Andrew K.S. *Aircraft Routing with Generalized Maintenance Constraints*. Omega: International Journal of Management Science 80. 2017
[43] Page I-5; Joint Publication 3-18. *Joint Forceable Entry Operations (2018).*
[44] JP 3-35 defines "deployment" as the activities required to plan, prepare, and move forces and material from home station to a destination. JP 5-0 defines "employment" as the strategic, operation, or tactical use of forces [to accomplish an objective or complete a mission].
[45] Headquarters US Marine Corps. *Marine Corps Operations*. MCDP 1-0. Washington, DC: Headquarters US Marine Corps. September, 2001
[46] Headquarters US Marine Corps. *Force Design 2030.* (2020) & Headquarters US Marine Corps. *Marine Corps Operating Concept (2025).* (2016).
[47] The joint publication (JP) series provides distinction between deployment & employment. JP 3-35 defines deployment as the rotation of forces into and out of an operational area. JP 5-0 explains that employment is the strategic, operation, or tactical use of forces.
[48] Kortman Jr., D. H. "Marine Aviation: Enabling the Implementation of Marine Corps Operating Concept (MOC) 2025." Master's Thesis, Marine Corps University, 2018.
[49] United Kingdom Ministry of Defence Crown publication. *Integrated Operating Concept 2025*. https://www.gov.uk/government/publications/the-integrated-operating-concept-2025/the-integrated-operating-concept-2025-accessible-version#:~:text=The%20Integrated%20Operating%20Concept%202025%20sets%20out%20a%20new%20approach,military%20thought%20in%20several%20generations.
[50] Headquarter US Marine Corps. *A Logistics Planner's Guide*. MSTP Pamphlet 4-0.2. Washington, DC: Headquarters US Marine Corps. June 2011.
[51] The Marine Corps contains a specifically designated Field Grade Officer MAGTF Planner MOS (0502 & 0505). The intent of providing these skillsets to the 6002 training at the Company grade is to enable them to better integrate with the planning process prior to Command & Staff College at the field grade ranks.
[52] The USMC & USN current concept of operations in Bahrain in support of SPMGTF and CENTCOM is an ideal case study regarding supply/maintenance, theater access, and maintenance costs of over-the-horizon tasking and allocation of air support.
[53] "This is why A-10s Have Been Training to Land on Highways Near Russia." https://www.airforcetimes.com/news/2018/06/14/this-is-why-a-10s-have-been-training-to-land-on-highways-near-russia/
[54] Aggregated: MEU/ARG operating under single geographic combatant commander (GCC) with OPCON/TACON of ARG/MEU. Disaggregated: MEU/ARG divided to support multiple GCCs. Distributed: Separation of OPCON and TACON between GCCs for a specific duration or mission. See Joint Publication 3-32, *Command & Control of Joint Maritime Operations.*
[55] Chapter 7, Render et al. *"Quantitative Analysis for Management."*
[56] Chapter 9, Render et al. *"Quantitative Analysis for Management".*
[57] Technically, Marine Wing Support Squadron (MWSS) and Low altitude air defense (LAAD) are "aviation commands" as they fall under the MAW structure, and may contain 4002's in those billets. These type of "ground-aviation" units are outside the context of "aviation commands" in this paper.

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