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The current pilot shortage and operational limitations of the F-35B raise serious concerns about the aircraft's effectiveness in high threat A2AD environments. Technological advancements in expeditionary unmanned systems provide a better solution for the Marine Corps when operating in these environments. A reduction in the number of TACAIR squadrons and an increase in the number of expeditionary UAS squadrons is required in order for the Marine Corps to remain competitive in future conflicts and meet the requirements of Future Force 2030.

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MASTER OF MILITARY STUDIES

F-35B Challenges: Is There a Better Alternative for the Marine Corps' Future Force 2030?

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

Major Kyle A. Bookhout

AY 2020-21

MMS Mentor Team and Oral Defense Committee Member: Dr. Lynn Tesser

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Executive Summary

Title: F-35B Challenges: Is There a Better Alternative for the Marine Corps' Future Force 2030?

Author: Major Kyle Bookhout, United States Marine Corps

Thesis: The Marine Corps must reduce the number of TACAIR squadrons due to the current pilot inventory shortage, pilot production limitations, and F-35 operational limitations; and reinvest resources and manpower into resilient, sustainable, and affordable future UAS capabilities that are better suited to meet the future operating requirements of Future Force 2030.

Discussion: The release of the Commandant's Planning Guidance (CPG) and Future Force 2030 reoriented the focus of the Marine Corps towards great power competition. In order to be better postured for future conflicts the Marine Corps needs to adapt its current construct to operate in contested environments and conduct Expeditionary Advanced Base Operations (EABO). Specifically, the current composition of Marine Aviation is not suited to meet the challenging operating requirements of future conflicts. Operational limitations of the F-35B raise serious questions about the effectiveness of the aircraft when operating in contested environments. The Commandant has called for an external review of the Aviation Plan to determine if the F-35 is the correct platform for the Marine Corps. Additionally, he has also called on the service to explore affordable expeditionary UAS platforms that are better suited to operate in contested environments. The current pilot shortage and pilot production challenges only further strengthen the Commandant's request to increase the UAS footprint in the Marine Corps. This paper aims to clearly outline the operational limitations and pilot production challenges that the F-35 is currently facing and contrast them with the benefits that UAS platforms provide the Marine Corps in future conflicts.

Conclusion: In order to be prepared for the requirements of Future Force 2030 the Marine Corps must divest of F-35 squadrons and increase the number of expeditionary UAS squadrons. Unmanned platforms currently under development, such as the Kratos Valkyrie, provide the Marine Corps a low-cost, expeditionary platform that has a sustainable production pipeline compared to the F-35.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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Preface

My inspiration for this research project came from my three years of aviation manpower experience while working at Manpower & Reserve Affairs (M&RA). I quickly learned that any discussion about the F-35 transition plan can become a passionate and contentious event. I also learned that only a small number of Marines at M&RA, Aviation Hallway, and Training Command fully grasped how dire the state of aviation manpower had become. Fortunately, this small group of Marines were able to successfully communicate the problem to the highest levels of leadership in the Marine Corps and spark a drive for action as outlined in Future Force 2030. I have no doubts that the F-35 will play a crucial role in the future success of Marine Aviation, but the aircraft is not the perfect answer for forthcoming conflicts.

I would like to thank Dr. Tesser for agreeing to be my MMS mentor even though my topic was outside of her expertise. Her outside perspective helped me shape my paper for a broader audience. I would also like to thank LtCol Anthony for agreeing to be my second reader and for providing critical feedback that helped strengthen my argument. Finally, I would like to thank the Marines and civilians I worked with at M&RA, Aviation Hallway, and Training Command that taught me more than I was ever able to teach them.

Introduction

The 2018 National Defense Strategy called upon the Marine Corps to shift its focus from the Middle East to the Indo-Pacific.[1] Long gone are the days of the counterinsurgency (COIN) operations from Iraq and Afghanistan. The Marine Corps is now attempting to transform itself into a relevant force for great power competition. General David H. Berger, 38th Commandant of the Marine Corps, published Force Design 2030 in March 2020. He believes the current construct of the Marine Corps has gone unchanged since the 1950s and is no longer what the country requires of the Marine Corps.[2] Force Design aims to evolve the Marine Corps into a force capable of fighting inside an adversary's long-range precision fire weapons engagement zone (WEZ), away from easily targeted forward bases and fixed infrastructure, and comprised of resilient, sustainable, and affordable platforms and equipment.[3] The Commandant also questions the current design construct of Marine Aviation in meeting the requirements of Future Force 2030 and has called for an external assessment of the Aviation Plan to determine its suitability in meeting the National Defense Strategy.[4] Specifically, the Commandant is not convinced that the F-35 Joint Strike Fighter (JSF) is the correct aircraft for the future Marine Corps and believes that the service needs to develop and expand its unmanned aerial systems (UAS) capability.[5]

The Commandant is justified in questioning the current construct of Marine Aviation given the current aviation manpower shortage and F-35 operational limitations. The Marine Corps is experiencing an aviation manpower crisis while it transitions the entirety of its Tactical Aviation (TACAIR) platforms to the F-35B and F-35C Lighting II JSF and transitions from

[1] General David H. Berger, *Force Design 2030*, Headquarters Marine Corps, March 2020, 2.
[2] Berger, *Force Design 2030*, 2.
[3] Berger, *Force Design 2030*, 5-8.
[4] Berger, *Force Design 2030*, 8.
[5] Berger, *Force Design 2030*, 5-8.

group 3 to group 5 UAS. The Marine Corps is approximately 600 pilots short of target inventory levels for all platforms. Current projections show that the deficit will not be corrected until 2040 due to pilot training limitations. Also, it is important to keep in mind that the JSF program began in 1993, and Lockheed Martin won the contract to produce the JSF in 2001, well before the Marine Corps began exploring expeditionary advanced base operations (EABO) or "stand-in force" concepts to operate in a high threat, contested anti-access/area denial (A2AD) environments. The current operational capabilities of the F-35 raise concerns about the aircraft's ability to operate in these environments. This paper will argue that the Marine Corps needs to reduce the number of TACAIR squadrons due to the current pilot inventory shortage, pilot production limitations, and F-35 operational limitations; and reinvest resources and manpower into resilient, sustainable, and affordable future UAS capabilities that are better suited to meet the future operating requirements of Future Force 2030.

The number of TACAIR squadrons in the Marine Corps must be reduced due to the inability to appropriately staff the current number of squadrons and produce enough replacement pilots to correct the current shortfall of 419 TACAIR pilots.[6] Estimates from Manpower & Reserve Affairs (M&RA), Marine Plans and Policies (MPP) division show that it will take approximately 10 years, assuming that jet training (VT-J) and Fleet Replacement Squadrons (FRS) are staffed to 100% of the manning requirement and pilot attrition remains within historical norms, to produce enough pilots to appropriately staff the fleet squadrons by 2030.[7] It will take another 10 years to produce enough pilots to fill other Necessary B billets, such as forward air controller, primary flight school instructor pilots (IPs), staff billets at the Marine Aircraft Wings (MAW), Marine Air Groups (MAG), Marine Expeditionary Forces (MEF), and

[6] MPP AVN brief.
[7] 2020 MPP inventory estimates.

any officer (8006) billets throughout the Marine Corps. However, there are two main challenges in meeting the estimated timelines.

The first challenge is staffing the intermediate and advanced jet training pipeline with 61 IPs. Total Force Structure Division (TFSD) has increased the purchased structure for jet training squadrons in the Authorized Strength Report (ASR) to match the Chief of Naval Air Training (CNATRA) production requirement verified by Aviation Manpower and Support (ASM) branch. However, the full complement of IPs is not scheduled to arrive until fiscal year (FY) 2022 due to the limited TACAIR inventory. IPs will be phased into VT-J squadrons during natural move cycles in order to ensure that pilots with the correct qualifications and flight experience are sent to instruct the future aviators of the Marine Corps. The correct level of pilot production cannot be achieved until the training squadrons are manned to 61 IPs and new IPs are fully trained and qualified to instruct new pilots. In a best-case scenario, based on current manpower projections from Manpower Management Officer Affairs (MMOA), the Marine Corps will not reach target production levels at VT-J squadrons until the end of FY23, and the FRSs will not be able to reach target production levels until the end of FY24.

The second challenge to meeting the production estimates is the length of the training syllabus coupled with inherent inability to surge production in the training pipelines. The ability to surge VT-J production is limited by instructor manning, available flight hours, and limited aircraft carrier availability for carrier qualifications. These compounding limitations have caused the jet training pipeline to become the longest training pipeline in the Marine Corps. As of FY20, the average time to train a new pilot from The Basic School (TBS) to the first fleet squadron was approximately 5 years.[8]

[8] CNATRA production data provided to Training Command.

Perhaps a bigger, and often overlooked, challenge to correcting the pilot deficit is the ability of the fleet squadrons to absorb a higher number of new pilots. The number of new pilots required to correct the pilot shortage and appropriately staff the Marine Corps will require fleet squadrons to absorb a higher-than-normal number of pilots that will need to be trained through the T&R syllabus. The historical number of initial accession pilots assigned to each of the TACAIR squadrons was 3-4 per year. This number is calculated based on a tour control factor of 3-4 years for first tour pilots completing the FRS. An easy way to think of this is that every 3-4 years one third to one quarter of the pilots will rotate out of the squadron and need to be replaced by newly trained pilots from the FRS. It just so happens that 3-4 replacement pilots are the number of new pilots a squadron can progress through the T&R syllabus each year in order to reach key qualification milestones, such as section lead and division lead, in a pilots first fleet tour. When a squadron is assigned more than 3-4 pilots in a single year it takes longer to progress through the T&R syllabus due to a limited number of available flight hours. The result of an increased training requirement has the potential to cause an overall decrease in pilot proficiency and qualifications throughout the Marine Corps.

Even with the alarming state of Marine aviation, there are arguments for maintaining the current number of TACAIR squadrons. The first argument against reducing the number of TACAIR squadrons in order to pursue more relevant and resilient UAS platforms is the F-35 program is too big to fail. Currently, the F-35 program is projected to cost $1.5 trillion over the lifetime of the program with initial procurement costs estimated to be $406 billion. [9] This makes the program the most expensive military acquisition program in the history of the United States. The program also relies on 1,500 suppliers and manufactures from nearly all fifty states which

[9] Sebastien Roblin, "The F-35 Program Will Cost $1.5 Trillion. Is It Worth It?, *The National Interest*, June 29, 2020. https://nationalinterest.org/blog/reboot/f-35-program-will-cost-15-trillion-it-worth-it-163721.

puts pressure on Congress to keep the program on track in order to maintain jobs.[10] The Marine Corps is scheduled to procure 353 F-35Bs and 67 F-35Cs for a total of 420 F-35s costing $47.9 billion in just initial purchase costs.[11] The Air Force is scheduled to receive over 1,700 F-35s to replace old F-16s and A-10s, but recent comments made by the Air Force Chief of Staff indicate that the service is looking to reduce the number of F-35s in favor of an inexpensive "fifth-generation-minus" jet.[12] Additionally, the Navy has chosen to maintain the Super Hornet as the primary aircraft in the carrier airwings. The Marine Corps may be forced into a precarious situation if the Navy and Air Force are successful in reducing the number of F-35s they are procuring. Even if the Marine Corps decided to reduce the number of F-35 squadrons in its inventory, Congress and the Department of Defense (DoD) may force the service to maintain 18 squadrons in order to keep the overall procurement numbers from decreasing any further.

The second argument is that the Marine Corps does not know what UAS platform it wants to operate in the future. In early 2020 the Marine Corps decided to abandon its Marine Air Ground Task Force (MAGTF) Unmanned Aerial System Expeditionary (MUX) program due to concerns about the practicality and growing costs associated with developing a multi-mission ship-based group 5 UAS platform.[13] Some critics may point to the MUX program as a perfect case study to illustrate the failure of the acquisition process due to the service's inability to clearly define the requirements. This may very well be true. However, the cancelation of the

[10] Valerie Insinna, "Inside America's Dysfunctional Trillion-Dollar Fighter-Jet Program," *New York Times,*August 21, 2019. https://www.nytimes.com/2019/08/21/magazine/f35-joint-strike-fighter-program.html.
[11] Megan Eckstein, "Marines Won't Cut Planned F-35 Buy Totals for Now, But External Review Could Change That," *USNI News,* April 1, 2020. https://news.usni.org/2020/04/01/marines-wont-cut-planned-f-35-buy-totals-for-now-but-external-review-could-change-that.
[12] David Axe, "The U.S. Air Force Just Admitted The F-35 Stealth Fighter Has Failed," *Forbes,*Feb 23, 2021. https://www.forbes.com/sites/davidaxe/2021/02/23/the-us-air-force-just-admitted-the-f-35-stealth-fighter-has-failed/?sh=305ed2111b16.
[13] Megan Eckstein, "Marines Ditch MUX Ship-Based Drone to Pursue Large Land-Based UAS, Smaller Shipboard Vehicle, *USNI News,* March 10, 2020. https://news.usni.org/2020/03/10/marines-ditch-mux-ship-based-drone-to-pursue-large-land-based-uas-smaller-shipboard-vehicle.

program shows that the Marine Corps now understands what it needs from an expeditionary UAS platform. The Commandant has stated in interviews that the Marine Corps needs a land based, interchangeable payload, expeditionary group 5 UAS capable of being launched and recovered in different locations.[14] He has also stated the need to develop a variant of the Navy's MQ-25A Stingray tanker UAS that could operate from amphibious assault ships and refuel F-35s.[15] Additionally, the commanding general of the Marine Corps Combat Development Command (MCCDC) and Deputy Commandant for Combat Development and Integration (CD&I) recently stated that unmanned systems will be crucial for the services ability to operate inside the WEZ of adversaries and that the Navy and Marine Corps have developed an Unmanned Campaign Plan to stream line the acquisition of new systems.[16] Fortunately, Kratos Defense & Security Solutions is already flight testing an expeditionary UAS named Valkyrie that fits the Commandant's requirements. The Marine Corps now has a clear vision and direction for its UAS program that will streamline the development and procurement process.

Comparing F-35 and UAS Platforms: A Review of Existing Research

The goal of this review is to analyze published materials comparing the suitability of F-35 and UAS platforms to meet the future requirements of the Marine Corps' Future Force 2030.[17] Four key focus areas were identified: Navy and Marine Corps directives, pilot and UAS aircrew production, F-35 operational limitations, and UAS advantages when operating in

[14] Megan Eckstein, "Marines Ditch MUX Ship-Based Drone to Pursue Large Land-Based UAS, Smaller Shipboard Vehicle, *USNI News,* March 10, 2020. https://news.usni.org/2020/03/10/marines-ditch-mux-ship-based-drone-to-pursue-large-land-based-uas-smaller-shipboard-vehicle.
Megan Eckstein, "Marines Ditch MUX Ship-Based Drone to Pursue Large Land-Based UAS, Smaller Shipboard Vehicle, *USNI News,* March 10, 2020. https://news.usni.org/2020/03/10/marines-ditch-mux-ship-based-drone-to-pursue-large-land-based-uas-smaller-shipboard-vehicle.[15]
[16] Department of the Navy Press Release, "Navy, Marine Corps Release Unmanned Campaign Plan," March 16, 2021. https://www.navy.mil/Press-Office/Press-Releases/display-pressreleases/Article/2538616/navy-marine-corps-release-unmanned-campaign-plan/.
[17] The information in this section was written by the author as part of a formal literature review. The most relevant information from the literature review is included in this paper.

contested environments. Initial research revealed that there is limited material published regarding F-35 production; however, there are several reports analyzing UAS production. The shortfall of F-35 production and retention material was overcome by analysis of Marine Corps F-35 data published by Training Command and M&RA. Overall, the available information allowed for an in-depth comparison of the suitability of the F-35 and UAS platforms to meet future operational requirements in contested environments.

Future Force 2030 provided the vision for how and why the Marine Corps was going to modernize and adapt in order to meet the National Defense Strategy. In multiple sections of the document, questions are raised about whether the F-35 is the correct aircraft for the Marine Corps in future conflicts.[18] A concern for the future of the F-35 program, alluded to in the document, is the inability to produce and sustain the appropriate level of pilots to man 18 F-35 squadrons. The Commandant also believes that fully integrated, affordable, expeditionary UAS platforms that are capable of reconnaissance, surveillance, and target acquisition (RSTA) and long-range precision kinetic and non-kinetic fires will be required to maintain the tactical and strategic advantage in future conflicts.[19] These requirements are driven by the fact that future forces will be required to operate inside enemy WEZ and will most likely suffer losses by advanced adversary A2AD technologies. Additionally, fixed wing forward bases will be easily targeted by adversary weapon systems.

F-35 and UAS production methods were then analyzed to identify any challenges or efficiencies in the training pipelines. The majority of information comparing F-35 pilot production to UAS operator production for the Marine Corps comes from data produced by M&RA, Manpower Plans (MP) division and Training Command. MP produces future

[18] Gen David H. Berger, *Force Design 2030*, March 2020, 2.
[19] Berger, *Force Design 2030*, 9.

production estimates to reach and maintain a healthy inventory for each aviation and UAS platform in the Marine Corps. Training Command provides historical training output of Naval Aviation Training Centers and FRS for each fiscal year. Comparing the required production to actual production revealed challenges in both the F-35 and UAS communities. The data revealed that it takes on average 5 years for F-35 pilots to reach the fleet after reporting to TBS, while UAS operators consistently reach the fleet in under 2 years. Recent reporting on F-35 manning levels included interviews from the Director of Manpower Management Integration Brach (MMIB). The data provided in the report matches historical manning data from MP and MMOA and emphasized that the F-35B community was only manned at 33 percent of target inventory in 2019.[20]

The Government Accountability Office (GAO) and the RAND Corporation appear to be the leading authorities, outside of the Marine Corps, on the topic of UAS operator production. Much of the GAO and RAND reports were written for the Air Force. These reports are still beneficial in determining future production rates for the Marine Corps, because the Marine Corps currently utilizes the Air Force's UAS training pipeline to produce Marine UAS operators. Research conducted by these authorities found that the Marine Corps has maintained a significant shortfall in UAS operators since 2012 and the target inventory was only at 46% in 2017.[21]

The research objective for F-35 operational limitations was to validate the concerns suggested in Future Force 2030. This topic produced the most amount of published information

[20] Shawn Snow, "Future force in crisis? How Marine shortages threaten the Corps' high-tech war plans,"*Marine Corps Times*, May 21, 2019. https://www.marinecorpstimes.com/news/your-marine-corps/2019/05/23/future-force-in-crisis-how-marine-shortages-threaten-the-corps-high-tech-war-plans/.
[21] Brenda S. Farrell, *Military Personnel: Actions Needed to Better Position the Navy and the Marine Corps to Support Expanding Unmanned System Operations*, GAO-18-162. (Government Accountability Office, 6 Feb 2018), 28-29. https://www.gao.gov/products/GAO-18-162.

from leading authorities. One common theme reported on by multiple sources was that the Navy and Congress are concerned that the limited combat radius of the F-35 may not allow the aircraft to strike enemy targets. The reason the F-35 may be ineffective is due to the necessary standoff distance that aircraft carriers, tanker aircraft, and landing helicopter dock (LHD) amphibious assault ships would need to maintain in order to stay outside the WEZ of anti-ship cruise missiles (ASCM).[22] Published reports also indicated that the Navy and the Air Force were looking to reduce their procurement of the F-35 in favor of developing a 6th generation aircraft due to performance concerns with the F-35. One such report concluded that the Navy has no plans to fully retire its legacy aircraft in favor of procuring more F-35s and is only going to buy 257 F-35Cs while the bulk of their carrier fleet would include over 600 Super Hornets.[23]

The last section of literature explored the advantages that UAS platforms provide over the F-35 in meeting the future requirements of Force Design 2030. The RAND Corporation again emerged as the leading expert in this area of research. A 2010 study asserted that UAS platforms are best suited to perform penetrating strikes, suppression of enemy air defenses (SEAD), and close air support (CAS) missions in high threat areas due to their potential for increased range, stealth capabilities, no danger to aircrews, and low cost.[24] A 2020 study introduced the concept of employing low-cost attritable aircraft technology (L-CAAT). L-CAATs offer multiple advantages over manned aircraft while operating in contested environments because they do not require runways for launch and recovery operations, have the potential to conduct 1,200 sorties per day, and have an expected combat radius of over 1,000

[22] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.
[23] Eric Teglar, "U.S. Navy Just Got Its First New F/A-18 Super Hornets – Here Are The Key Upgrade," *Forbes*, June 22, 2020, https://www.forbes.com/sites/erictegler/2020/06/22/us-navy-just-got-its-first-new-fa-18-super-hornets---here-are-the-key-upgrades/?sh=5f46e42f3d38.
[24] Brian Alkire et al., *Applications or Navy Unmanned Aircraft System* (Santa Monica, CA: RAND Corporation, 2010), xiv.

nautical miles enabling the platform to launch and range targets from outside the WEZ of adversary A2AD weapon systems.[25]

Throughout my research I was not able to find any literature that discussed a solution or provided any recommendations for how the Marine Corps could manage the current F-35 pilot production and operational challenges. My goal is to clearly illustrate the totality of the challenges the Marine Corps is facing with the F-35 and contrast those with the benefits that UAS offer. By doing so, I hope to contribute to this topic a realistic solution to the F-35 challenges that better positions the Marine Corps for future operating environments.

Reasons for Current Pilot Shortage and Pilot Production Limitations

In order to fully understand the current state of affairs of Marine Aviation, it is important to detail the cause of the current pilot shortage and pilot production limitations. First, we must quickly dispel any misunderstandings. A common belief held among pilots is that the pilot shortage is due to an increase in pilot separations - or more commonly stated, an increase of pilots separating from service due to the competitive commercial airline industry from 2012 to early 2019. The foundation of this argument is that a higher-than-normal number of pilots opted to separate from the Marine Corps after the completion of their initial service agreement to accept higher paying civilian jobs. However, data from MPP shows that this argument is flawed.[26] Total aviation separations were within historical norms of 6 to 9 percent from 2012-2019.[27] The data does show there was a slight increase in fixed wing pilot separations from 2018-2020. Separations rates during this period increased from 10 percent to 13 percent, but the increase does not account for the total pilot deficit. Secondly, there is a common belief that the

[25] Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), 8-9.
[26] MPP historical separation data.
[27] MPP Attrition data.

reduction in the number of pilots accessed into the Marine Corps from 2012 until 2019 caused the pilot shortage. When you compare the historical accession data to the historical pilot production data it becomes clear that the initial training pipelines were not able to train the number of pilots accessed, even with the reduced training requirements; showing that this also does not account for the total pilot deficit. Therefore, pilot separation rates and reduced accessions from 2012-2019 did not cause the current pilot deficit.

First and foremost, the pilot shortage is a result of a sustained reduction in fixed-wing pilot production that began in 2013.[28] Historical production data provided by Training Command and MPP shows that the Marine Corps has consistently missed the production requirement established in the Training Requirements Letter (TRL). The TRL is the guiding document that is signed by the Marine Corps' Deputy Commandant of Aviation (DCA) and the Navy Air Boss to establish the production requirements at the FRSs and Naval Air Training Command (NATRACOM) squadrons to maintain healthy pilot inventory levels in fleet squadrons. NATRACOM conducts the initial training for all Navy and Marine Corps flight students and includes the VT-J training squadrons. After Naval Aviators complete training at NATRACOM, they advance to a platform specific FRS to learn to the fly their primary fleet aircraft, such as the F-35B or F-35C. If the Navy and Marine Corps fall short of the production requirement for a given fiscal year, the FRS or NATRACOM will be required to fulfill the production shortfall the following FY.

Unfortunately, making up missed production is easier said than done because of the limited production capabilities inherent to the FRS and VT-J squadrons. There are two main causes that have prevented the training squadrons from meeting production requirements. The first cause is the incorrect instructor staffing levels at VT-J squadrons. The Marine Corps,

[28] MPP pilot production data.

through the ASR produced by TFSD, consistently purchased 42 pieces of structure for jet IPs at VT-J squadrons until FY21.[29] The Marine Corps increased the structure for FY21 and beyond to 61 IPs. The catalyst for the structure increase of 20 pilots was ASM's verification of the Navy and Marine Corps IP requirements, established by CNATRA. The IP manning requirement is solely determined by the production requirements published in the TRL and does not account for excess production requirements rolled from previous fiscal years. ASM verified that 61 Marine IPs were required in order to train the minimum number of pilots to sustain healthy inventory levels in 18 fleet squadrons. ASM and MPP also calculated that the minimum requirement to sustain 18 squadrons was a steady state production of at least 80 new jet pilots each year from FRS squadrons.[30]

The second cause of limited production capacity is the limited number of assignable pilots to fill those 61 IP billets at the initial training squadrons and the FRS. As pilot production began to fall in 2013, the number of assignable pilots in the fleet began to decrease. Since FY13, pilot separations has been greater than pilot production.[31] Also, the time to train a new fixed wing pilot from TBS through the FRS is approximately 5 years.[32] Therefore, the available inventory of assignable company grade fixed wing pilots began to decrease in 2015, and has continued to decrease in proportion to the reduced pilot production levels.[33] By November of 2020, the 7509 (AV-8B) company grade inventory was 71 percent, 7518 (F-35) company grade inventory was 24 percent, and 7523 (F/A-18) company grade inventory was 61 percent of target inventory.[34] In order to maintain the operational squadrons at the appropriate staffing levels,

[29] Authorized Strength Reports.
[30] AVN MRA power point.
[31] MPP historical training and attrition data.
[32] CNATRA production brief.
[33] Historical MOS status reports.
[34] November 2020 MOS Status Report.

MMOA was required to utilize inventory shortfall mitigation practices. These practices included extending pilots beyond the normal tour control factor of three years, assigning pilots to successive operational tours instead of filling a Necessary B billet (pilot billet outside of an operational squadron), and billet grade mismatches. A billet grade mismatch is the practice of assigning a field grade officer to fill a company grade officer billet.

A result of these inventory shortfall mitigation practices was a reduction in fixed wing pilots assigned as IPs to the initial training squadrons. Additional field grade officers were required to remain in operational billets at fleet squadrons as the shortage of company grade fixed wing pilots continued to grow each successive FY. By 2017 there were not enough assignable company grade and field grade fixed wing pilots to staff the operational TACAIR squadrons, FRSs, and VT-J squadrons with pilots.[35] As a result, MMOA prioritized A billets (operational fleet billets) over Necessary B billets when making pilot assignments. The IP billets at the initial training squadrons fell into the category of Necessary B billets. The average IP staffing level for the jet training squadrons from 2017-2019 was 39 of 42 pilots. Keep in mind that 42 was already well below the IP requirement of 61 to sustain a healthy inventory. Therefore, a staffing level below 42 IPs only exacerbated the pilot shortfall in the Marine Corps.

Two significant outcomes ultimately resulted from the growing fixed wing pilot shortage. First, was the decision to reduce the pilot staffing level at each of the VMFA and VMFA(AW) fighter attack squadron from 18 pilots to 15 pilots.[36] The Commandant alludes to this staffing reduction in Force Design 2030 when he defines the characteristics of the "Objective Force". The first characteristic for the Air Combat Element is "18 active component fighter attack

[35] Historical MOS status reports.
[36] FY20 Authorized Strength Report.

(VMFA) squadrons, with a reduction in the number of aircraft per squadron to 10."[37] The number of pilot billets purchased by TFSD for fighter attack squadrons is 1.5 pilots per aircraft. Therefore, the new manning level for VMFA squadrons is 15 pilots. However, this decision was forced upon the Commandant because the Marine Corps was only able to staff the VMFAs to 15 pilots due to the shrinking assignable pilot inventory. In reality, by FY19, MMOA was barely able to maintain the squadrons staffing level at 15 pilots due to lack of assignable inventory. The F-35 community was in the worst shape by FY19 with a staffing level only reaching 33% of target inventory.[38]

The second outcome was the early sundown, or Cat 5, of one VMFA and two attack (VMA) squadrons in the Marine Corps due to the inability of MMOA to appropriately staff the squadrons.[39] By FY19, the number of pilots completing initial training was only enough to properly man 11 of the 18 TACAIR squadrons in the Marine Corps.[40] Staffing the VMA squadrons proved equally as challenging at the VMFA squadrons. The appropriate manning level for a VMA squadron is 22 pilots. However, in FY16 the staffing level was capped to 20 pilots per squadrons due to lack of inventory. By the end of FY20 VMA squadrons were consistently staffed below 20 pilots. MAG 13 and 3rd MAW made the decision to accelerate the sundown of the last two VMA squadrons at MAG-13 in the first half of FY21 due to the decreased staffing levels caused by the pilot shortage. Similarly, MAG 31 and 2nd MAW decided to sundown one VMFA squadron in FY20 for the same reason.

[37] General David H. Berger, Force Design 2030, Headquarters Marine Corps, March 2020, 7.
[38] Shawn Snow, "Future force in crisis? How Marine shortages threaten the Corps' high-tech war plans,"*Marine Corps Times*, May 21, 2019. Future force in crisis? How Marine shortages threaten the Corps' high-tech war plans (marinecorpstimes.com).
[39] FY20 AVPLAN.
[40] MPP production forecast data.

F-35 Limitations

It should be clear now that the Marine Corps is facing an uphill battle in correcting the current pilot shortage and appropriately staffing all 18 TACAIR squadrons. The limited number of assignable pilots in conjunction with pilot production challenges plaguing the training pipelines have resulted in an incredibly long estimated recovery timeline. Another argument for decreasing the number of TACAIR squadrons and increasing the number of UAS squadrons is the current operational limitations of the F-35 when operating in a contested environment such as the Indo-Pacific Command (INDOPACOM) area of responsibility (AOR).

The main operational concern regarding the F-35B and F-35C is the limited range of the aircraft. The design process of the complex aircraft has taken over 20 years to complete. An argument can be made that the aircraft was not designed to operate in the current threat environment of high-speed anti-ship cruise missiles employed by near peer adversaries. The Project on Government Oversight believes that the complexity of F-35 program has caused the program to fall behind emerging threats.[41] China has developed the DF-21D anti-ship ballistic missile with a range of 780 nautical miles and the CSS-5 anti-ship cruise missile with a range of 930 nautical miles.[42] Russia has developed the Kinzhal hypersonic missile with a reported range of over 1,000 nautical miles.[43] The proliferation of anti-ship ballistic, cruise, and hypersonic missiles has completely changed the battle space that the Navy and Marine Corps' F-35s will be operating in.

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[41] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.
[42] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.
[43] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.

In order to survive the threat of anti-ship missiles, the Navy will be forced to operate their aircraft carriers and LHDs outside of the WEZ of these missiles. A standoff range approaching 1,000 nautical miles from adversary missile systems will be required. The current unrefueled combat radius of the F-35C is approximately 670 nautical miles and the combat radius of the F-35B is 450 nautical miles.[44] To combat the standoff problem, F-35s will require tanker support to refuel in flight. However, DoD currently does not have an operational stealth tanker to compliment the stealth capabilities of the F-35. Air to air refueling operations can potentially nullify the stealth advantages the F-35 enjoys if the tanker aircraft are identified by enemy radar. Navy aircraft carriers could choose to operate within the WEZ of anti-ship missiles and rely on their advanced self-defense capabilities; however, senior military officials and government leaders will most likely be weary to put the $13 billion ships, with 6,000 sailors on board, into a high threat area.[45]

The limited operational range also poses challenges for operating from fixed bases within the INDOPACOM AOR. For example, the Marine F-35Bs stationed at Iwakuni, Japan will also require tanker support in order to conduct combat missions to any location other than the Korean Peninsula. A simple Google Earth measurement shows that the F-35s will only be able to range extremely limited sections of Chinese and Russian coastlines. The same risks associated with utilizing tanker aircraft from aircraft carriers will hold true in operations conducted from fixed bases. Also, a conservative assumption can be made that any fixed U.S. military base in the AO will be targeted at the onset of any major conflict which could threaten the combat viability of aircraft forward stationed at those bases. A 2020 RAND report commented regarding the

[44] Lockheed Martin. "About the F-35", https://www.f35.com/f35/about.html.
[45] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.

enemies use of accurate ballistic and cruise missiles that "fixed land bases…are increasingly vulnerable to attack by these weapons, large salvos of which can overwhelm currently available active defenses."[46]

There are also likely challenges in maintaining aircraft operating from expeditionary advance base (EAB) locations in contested environments due to the strained supply system employed by Lockheed Martin and the DoD. The supply chain for the F-35 includes more than 1,500 suppliers located in almost every state of the U.S. and globally.[47] The complex supply chain has caused readiness issues in F-35 squadrons across the DoD. For instance, in 2017 and 2018 approximately 50 percent of the F-35s in the Air Force were operational at any given time.[48] In April 2019 the GAO found that "the Pentagon had a repair backlog approaching 4,300 parts, wasn't managing its inventory properly and often lacked data on the cost and current location of its F-35 components."[49] These supply issues are for squadrons operating out of established air bases with every means of commercial and government transportation at their disposal to ship parts. Now imagine trying to ship one of those 4,300 parts to an aircraft operating out of an EAB during a conflict, let alone actually performing required maintenance with a minimal manpower footprint.

Faced with the reality of the current state of Marine TACAIR Aviation, it is difficult to make an argument to invest resources and manpower into fixing the TACAIR inventory shortage to sustain 18 F-35 squadrons when there are more capable and sustainable options being developed that better fit the need for Future Force 2030. In 2018, the House Armed Services

[46] Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), 1.
[47] Valerie Insinna, "Inside America's Dysfunctional Trillion-Dollar Fighter-Jet Program," *The New York Times Magazine,* August 21, 2019, https://www.nytimes.com/2019/08/21/magazine/f35-joint-strike-fighter-program.html.
[48] Valerie Insinna, "Inside America's Dysfunctional Trillion-Dollar Fighter-Jet Program," *The New York Times Magazine,* August 21, 2019, https://www.nytimes.com/2019/08/21/magazine/f35-joint-strike-fighter-program.html
[49] Valerie Insinna, "Inside America's Dysfunctional Trillion-Dollar Fighter-Jet Program," *The New York Times Magazine,* August 21, 2019, https://www.nytimes.com/2019/08/21/magazine/f35-joint-strike-fighter-program.html

Committee directed the Secretary of the Navy to brief the Armed Services panels on options, including manned and unmanned aircraft that would "expand the strike range of a carrier air wing in a contested environment."[50] These options could include a stealth tanker capability, improved engine technology or to develop a strike capability that is purposely built to strike at increased range.[51] Congress is clearly concerned about the viability of the F-35 in a future fight in a contested environment.

The Navy and the Air Force are also concerned about the operational limitations of the F-35 and have joined efforts to develop a 6th generation aircraft that will be operational in the 2030s. [52] Navy and Air Force planners envision that the aircraft will be designed for both manned and unmanned missions.[53] As a result, both services are also looking to limit the number of F-35s that they procure. Recent reports indicate that the Navy is only going to buy 257 F-35Cs while the bulk of their carrier fleet would include over 600 Super Hornets.[54] The February 2020 Defense Budget Overview published by the Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer shows that the Air Force reduced the number of F-35As they were acquiring from 98 in FY20 to 79 in FY21. Just like the Navy and Air Force, the Marine Corps should be equally concerned about the limited operational capability of the F-35

[50] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.
[51] John M. Donnelly, "The Navy's F-35 Flight Range Is Dangerously Low, Congressional Report Says," *Task and Purpose*, May 22, 2018, https://taskandpurpose.com/military-tech/navys-f-35-strike-radars-already-date-new-report-says/.
[52] Kris Osborn, "F-35s Are Dead: The Sixth Generation of Fighter Aircraft Is On Its Way," *The National Interest*, January 19, 2020, https://nationalinterest.org/blog/buzz/f-35s-are-dead-sixth-generation-fighter-aircraft-its-way-114901.
[53] Kris Osborn, "F-35s Are Dead: The Sixth Generation of Fighter Aircraft Is On Its Way," *The National Interest*, January 19, 2020, https://nationalinterest.org/blog/buzz/f-35s-are-dead-sixth-generation-fighter-aircraft-its-way-114901.
[54] Eric Teglar, "U.S. Navy Just Got Its First New F/A-18 Super Hornets – Here Are The Key Upgrade," *Forbes*, June 22, 2020, https://www.forbes.com/sites/erictegler/2020/06/22/us-navy-just-got-its-first-new-fa-18-super-hornets---here-are-the-key-upgrades/?sh=5f46e42f3d38.

and begin to invest in platforms that have a more efficient training pipeline and capabilities better suited to operating in the contested environments of future conflicts.

UAS Advantages

UAS platforms provide two main advantages over the F-35B and F-35C when operating in a contested environment. The first advantage is the increased operational range of unmanned systems. A 2010 RAND report concluded that the long-range and increased endurance attributes give these platforms an advantage over the F-35 in the applications of penetrating strike, electronic intelligence (ELINT) collection, SEAD, and CAS when operating within contested environments.[55] A second RAND study published in 2020 highlighted the increased operational range that L-CAAT platforms could offer over conventional aircraft. The report states that L-CAATs have a maximum cruise range of 5,055 nm and can conduct operational missions out to 1,000 nm of the operating area.[56]

The second advantage unmanned platforms have over the F-35 is the potential to easily operate from EABs in contested environments. The Air Force, in conjunction with Kratos Defense & Security Solutions, has developed the XQ-58 Valkyrie. The Valkyrie is "a multi-mission, run-way independent UAS capable of long-range flights…and a variety of applications."[57] By the beginning of 2020 the system had conducted two successful test flights demonstrating the capability to be launched without a runway. In fact, the Valkyrie is designed to be operated from a deployable launch container that is the same dimensions as a standard

[55] Brian Alkire et al., *Applications or Navy Unmanned Aircraft System* (Santa Monica, CA: RAND Corporation, 2010), xviii.
[56] Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), 8-9.
[57] Kratos press release, "Kratos XQ-58A Valkyrie Continues Series of Successful Flights," June 17, 2019. https://ir.kratosdefense.com/news-releases/news-release-details/kratos-xq-58a-valkyrie-continues-series-successful-flights.

commercial shipping container.[58] The ability to launch and recover L-CAAT platforms without the use of any airfield infrastructure greatly increases the number of potential operational base locations for the military.

RAND Project AIR FORCE, a division of the RAND Corporation has developed operational concepts for L-CAATs. These concepts highlight the advantages when operating in an expeditionary environment. Fifteen L-CAAT platforms with 20 personnel can conduct flight operations from an open field approximately the size of 12-15 football fields.[59] The field layout contains 4 launching sites, marshalling area, and a large recovery area that takes up most of the open field. The size of the deployment area can be significantly reduced if the vehicle does not need to be recovered at the point of launch. Additionally, these sites would be difficult to locate for airborne ISR platforms, and "even if the site could be located, there is little at the site that would justify the expenditure of a long-range weapon. If the site were attacked, it could easily be abandoned, with surviving personnel and equipment moving to another, similar site, perhaps a few hundred meters away."[60] This operational concept certainly meets the Commandant's vision of building a resilient force capable of absorbing losses and continuing to operate decisively against a peer adversary.[61]

Another key advantage UAS platforms have over the F-35 is a streamlined training pipeline. As stated previously, it takes approximately 5 years for a new F-35 pilot to reach an operational squadron after reporting to TBS. However, a new UAS operator reaches his or her first fleet squadron in approximately 1.5-2 years. The UAS training pipeline is more efficient

[58] Joseph Trevithick, "This Containerized Launcher For the XQ-58A Valkyrie Combat Drone Could Be A Game Changer," *The War Zone*, October 16,2019. https://www.thedrive.com/the-war-zone/30474/this-containerized-launcher-for-the-xq-58a-valkyrie-combat-drone-could-be-a-game-changer.
[59] Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), 19.
[60] Thomas Hamilton and David Ochmanek, *Operating Low-Cost, Reusable Unmanned Aerial Vehicles in Contested Environments* (Santa Monica, CA: RAND Corporation, 2020), 20.
[61] General David H. Berger, Force Design 2030, Headquarters Marine Corps, March 2020, 5.

because it is not limited by the number of available aircraft and weather. Most of the training syllabus is conducted with the use of simulators. The Air Force recently updated their Remotely Piloted Aircraft (RPA) training syllabus, RPA Training Next (RNT), in 2020 to maximize advancements in technology-based training systems such as artificial intelligence (AI).[62] Students going through the new RNT syllabus are projected to complete undergraduate training and Formal Training Unit (FTU) training in one year. [63] The RNT syllabus also provides seamless transitions between training phases unlike the antiquated pilot training pipelines. This means that RPA students will have no breaks in training between the undergraduate and FTU phases of training. Naval aviators, on the other hand, may experience delays lasting months between different phases of flight training.

The Air Force MQ-9 training pipeline offers an excellent example to showcase the efficiencies in unmanned operator production. To be clear, this paper is not arguing that the MQ-9 provides the operational capabilities that the Marine Corps requires for Future Force 2030 but is simply highlighting the production efficiencies the platform has over manned aviation. The UAS training pipeline permits higher student throughput with a lower instructor requirement than manned aviation. In 2019 the Air Force was able to train 310 MQ-9 operators. In comparison, this would be approximately 75 percent of the total annual Marine Corps pilot production requirement across all aviation platforms.[64] In 2019 the instructor to student ratio at

[62] Dan Hawkins, "RPA Training Next transforms pipeline to competency-based construct," U.S. Air Force, June 03, 2020. https://www.af.mil/News/Article-Display/Article/2207074/rpa-training-next-transforms-pipeline-to-competency-based-construct/.
[63] Dan Hawkins, "RPA Training Next transforms pipeline to competency-based construct", U.S. Air Force, June 03, 2020. https://www.af.mil/News/Article-Display/Article/2207074/rpa-training-next-transforms-pipeline-to-competency-based-construct/.
[64] David Roza, "That place is a dumpster fire – Inside the Air Force's dilapidated Reaper school, which won't be fixed anytime soon," *Task & Purpose*, May 08, 2020. https://taskandpurpose.com/news/air-force-drone-school-falling-apart/.

the MQ-9 FTU at Holloman Air Force Base, New Mexico was approximately 1 to 3. [65] The average instructor to student ratio at Marine TACAIR FRSs was approximately 1 to 1 in 2019.[66] This simple comparison shows an efficiency increase of 66 percent at the MQ-9 FTU over Marine Corps FRSs.

The Air Force has demonstrated how much more efficient an established unmanned training pipeline can be over a manned pipeline. However, the Marine Corps is still developing its own initial training pipeline and has experienced some challenges growing the UAS community. Relying on the Air Force for all entry level UAS training means that student throughput is limited by the seat allocations that the Air Force determines to be appropriate for Marine students. Any requests for an increase in the allocated training quota is met with resistance because Air Force students will lose their class seats to Marines. By 2017 the total inventory of Marine UAS operators was only 46 percent of the target inventory. [67] By 2019 the UAS inventory had improved to 53 percent and was projected to keep improving in large part due to the redesignation of naval flight officer and naval aviator students into the UAS community.[68] In 2019, student naval aviators and naval flight officers who were unable to complete flight training were allowed to redesignate to the UAS community. Many of these Marines qualified for an abbreviated UAS syllabus that bypassed the initial training at Randolph Air Force Base due to their previous flight experience. These students enabled all three Marine Unmanned Aerial Vehicle Squadrons (VMU) to be staffed above staffing goal by the end of

[65] Government Accountability Office, "Unmanned Aerial Systems: Air Force Should Take Additional Steps to Improve Aircrew Staffing and Support," June 2020, 28.
[66] This number was derived from 2019 ASR staffing levels and student production numbers at Marine Corps FRSs.
[67] Brenda S. Farrell, *Military Personnel: Actions Needed to Better Position the Navy and the Marine Corps to Support Expanding Unmanned System Operations*, GAO-18-162. (Government Accountability Office, 6 Feb 2018), 28-29. https://www.gao.gov/products/GAO-18-162.
[68] Shawn Snow, "Future force in crisis? How Marine shortages threaten the Corps' high-tech war plans,"*Marine Corps Times*, May 21, 2019. https://www.marinecorpstimes.com/news/your-marine-corps/2019/05/23/future-force-in-crisis-how-marine-shortages-threaten-the-corps-high-tech-war-plans/.

2020. In addition to the redesignation initiative, M&RA extended the UAS service agreement from 4 years at the start of training at TBS to 6 years commencing at the completion of training at the UAS fleet readiness detachment (FRD). This step will ensure that a healthy inventory of company grade operators remain in the Marine Corps.

Even though UAS platforms offer many advantages over the F-35 there are some disadvantages such as the reliance on a robust communication network. In order to operate the UAS platforms a communication network comprised of a ground control center and satellite communication constellation are required. The data uplinks and down links required for command and control of the system may be vulnerable to attack. Satellite communication is particularly vulnerable to noise jamming and kinetic threats.[69] When current UAS platforms experience broken data links, they either orbit in place or return to base, effectively making them combat ineffective. Also, the platforms will require high data rates to transmit ISR imagery to offboard crews. The emissions created by transferring this data may make the platforms easier to detect and ultimately be attacked.[70] Key advancements in areas of data-compression techniques, automatic target classification, and resilient communication networks are being developed in order to mitigate this risk.[71] The Department of the Navy has also begun to develop a digital infrastructure by investing in networks, control systems, AI, and data bandwidth to successfully operate unmanned systems in contested environments.[72]

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[69] Brian Alkire et al., *Applications for Navy Unmanned Aircraft System* (Santa Monica, CA: RAND Corporation, 2010), xv-xvi.
[70]Brian Alkire et al., *Applications for Navy Unmanned Aircraft System* (Santa Monica, CA: RAND Corporation, 2010), xv-xvi.
[71] Brian Alkire et al., *Applications for Navy Unmanned Aircraft System* (Santa Monica, CA: RAND Corporation, 2010), xv-xvi.
[72] Department of the Navy, Press Release, "Navy, Marine Corps Release Unmanned Campaign Plan," 16 March, 2021. https://www.navy.mil/Press-Office/Press-Releases/display-pressreleases/Article/2538616/navy-marine-corps-release-unmanned-campaign-plan/.

Recommended Way Forward

The Marine Corps needs to implement a near-term and long-term strategy in order to successfully convert a larger portion of the fleet to unmanned systems. During the near-term strategy, the Marine Corps will continue to transition legacy squadrons to the F-35 while the Unmanned Campaign Framework is developed and implemented with the Navy. The framework will focus on developing the critical digital infrastructure that will be required to operate a high number of unmanned systems and streamline the design and acquisition process of future systems. Moving away from a platform-centric to a capability-centric design process will ensure future unmanned systems can be integrated across the same infrastructure while performing different missions.[73] Once the framework is established, the Marine Corps will be able to begin the rapid design and procurement of expeditionary UAS that can be integrated with the capabilities of the F-35 and other unmanned platforms throughout the Navy.

Continuing to transition legacy aircraft to the F-35, during the near-term strategy, is an essential step to modernizing Marine Aviation as a whole. The Marine Corps chose not to make incremental improvements to their TACAIR aircraft inventory and instead opted to extend the service life of the existing aircraft. Unfortunately, delays in the F-35 design process have resulted in the legacy aircraft flying well beyond their intended service life. This has resulted in low readiness, reduced flight hours, and a longer time to train new pilots when they reach the fleet. Transitioning legacy platforms is an important step in maintaining pace with our peer adversaries. The question is how many squadrons of manned and unmanned platforms best meets the requirements of future conflicts. It is too early to determine the exact mix of manned

[73] Department of the Navy, "Unmanned Campaign Plan," 16 March 2021. 24. https://www.navy.mil/Portals/1/Strategic/20210315%20Unmanned%20Campaign_Final_LowRes.pdf?ver=LtCZ-BPlWki6vCBTdgtDMA%3d%3d.

and unmanned platforms, but the Commandant has stated that no one should be surprised if half of the aviation assets in the Marine Corps are unmanned in the future.[74]

The long-term strategy can commence when the service has established the necessary infrastructure and is ready to start procuring unmanned systems. A timeline for this phase is difficult to predict due to the ongoing research and development of systems coupled with the required development of infrastructure for command and control, communication, and force integration. If the infrastructure is in place prior to FY27 the last four TACAIR squadrons slated to transition to the F-35 could be stood up as UAS squadrons. However, a more time-consuming transition process will be required if there are delays beyond FY27 as the final TACAIR squadrons are scheduled to receive F-35s in FY28. The service would need to identify established F-35 squadrons to sundown and transition to the selected UAS platform if procurement is delayed past FY27. Global Force Management (GFM) obligations and geographic location would drive this decision. Obviously, the earlier a platform is identified, and infrastructure established the better.

The most important step in the long-term strategy is the actual stand up of the FRD and new UAS squadrons once a platform is chosen. The most efficient way to transition to the new UAS platform is to fully establish the FRD and then transition legacy UAS squadrons. Important lessons were learned during the F-35 transition that must be applied to this transition. The F-35 FRS was never fully manned at the beginning of the F-35 transition which has resulted in constant production challenges. A fully manned and equipped FRD is essential to a successful transition. Legacy UAS operators will serve as the initial instructor cadre at the FRD and as instructors in fleet squadrons. Legacy UAS squadrons should transition first because the

[74] Department of the Navy, "Unmanned Campaign Plan," 16 March 2021. 3. https://www.navy.mil/Portals/1/Strategic/20210315%20Unmanned%20Campaign_Final_LowRes.pdf?ver=LtCZ-BPlWki6vCBTdgtDMA%3d%3d.

operators will require the shortest transition syllabus and result in the quickest standup of new squadrons. F-35 pilots can begin to transition once the designated legacy UAS squadrons have transitioned and FRD seats become available. Marine Corps Air Station Cherry Point is an ideal location to establish the new FRD because the RQ-21 FRD could serve as a host squadron and four F-35 squadrons are scheduled to be operational there by FY28 and would facilitate integrated flight operations.[75] The last step is selecting the appropriate platform.

Fortunately, there are multiple systems currently under development that the Marine Corps could adopt for different roles in Future Force 2030. The Navy is testing the MQ-25A Stingray which can perform aerial refueling and ISR from carriers. The Navy is also testing VBAT vertical take-off and landing (VTOL) systems capable of performing ISR missions.[76] The Marine Corps is currently standing up the first MQ-9A Reaper squadron which will be capable of conducting persistent ISR and eventually air to ground strikes.[77] However, the platform that is best suited to replace the F-35 is the Valkyrie. The Valkyrie is a truly expeditionary, low-cost, stealthy unmanned combat vehicle that is capable of long range, high-speed, and fighter-like maneuverability. The system also has an internal bomb bay, wing stations, and can employ multiple lethal weapons.[78] The system has already conducted successful formation flights with a F-35 and F-22. The true expeditionary nature of the platform, low cost compared to the F-35, and performance characteristics make the Valkyrie the front runner for Future Force 2030.

[75] 2020 TACAIR transition plan from AVPLAN.
[76] Department of the Navy, "Unmanned Campaign Plan," 16 March 2021. 32. https://www.navy.mil/Portals/1/Strategic/20210315%20Unmanned%20Campaign_Final_LowRes.pdf?ver=LtCZ-BPlWki6vCBTdgtDMA%3d%3d.
[77] Department of the Navy, "Unmanned Campaign Plan," 16 March 2021. 32. https://www.navy.mil/Portals/1/Strategic/20210315%20Unmanned%20Campaign_Final_LowRes.pdf?ver=LtCZ-BPlWki6vCBTdgtDMA%3d%3d.

[78] Kratos, "Tactical UAVs", https://www.kratosdefense.com/systems-and-platforms/unmanned-systems/aerial/tactical-uavs.

Conclusion

It should be evident that the Marine Corps needs to reduce the number of TACAIR squadrons due to current pilot production challenges and F-35 operational limitations, and reinvest resources and manpower into resilient, sustainable, and affordable group 5 UAS platforms that are better suited to meet the future operating requirements of Future Force 2030. The current pilot shortage in the Marine Corps may be an insurmountable obstacle to overcome in a timely manner given the limited pilot inventory coupled with the inherent limitations of the TACAIR training pipelines. The projected timeline for producing enough pilots to sustain 18 TACAIR squadrons, at approximately 15 pilots in each squadron, is 10 years once the correct production levels are met. These estimates assume a steady state production level of over 80 TACAIR pilots a year, sustained TACAIR IP manning of 61 pilots, and no readiness issues with the training aircraft. The question the Marine Corps must ask is whether the investment of manpower and resources into correcting and maintaining 18 squadrons is worth it when the F-35 may not even be effective when operating in future conflicts.

There is no question that the F-35 is an upgrade to the current generation of TACAIR aircraft currently utilized by the Marine Corps. However, the F-35 was designed to operate in a different environment and against different threats than the Marine Corps currently predicts it will be fighting in. The advancement and proliferation of A2AD weapon systems by near peer and non-peer adversaries has altered the future operating environment for naval forces. Aircraft Carriers and LHDs will operate further from targets and objective areas in order to stay out of the WEZ of advanced anti-ship missiles. Current estimates show that the F-35 will require aerial refueling in order to operate from these increased ranges potentially reducing their combat effectiveness. Even if the F-35Bs were flown off the LHDs and placed on EABs they would still

require a large logistical footprint to operate from these sites potentially becoming easy targets. Having a vertical short takeoff and landing (VSTOL) capability, counter to some opinions, does not automatically equate to expeditionary. The true expeditionary ability of a 5th generation aircraft like the F-35 is questionable when it requires sophisticated maintenance, robust supply chains, large amounts of fuel, ordnance storage, and some sort of improved short runway or VSTOL pad to operate.

Alternatively, UAS platforms provide multiple advantages over the F-35. Expanding UAS operations in the Marine Corps would provide a more efficient and resilient training pipeline resulting in a sustainable inventory of operators. The Air Force can train their RPA pilots in one year with an instructor to pilot ratio of 1 to 3. If the Marine Corps replicates this process, UAS operators could reach operational squadrons in 1.5-2 years after beginning training at TBS. This would cut the current TACAIR pilot time to train by 3 years. Additionally, the UAS training timeline is not dependent on aircraft availability rates and good weather which streamlines the entire process and prevents delays between training phases. The Marine Corps will be able to fashion their UAS training model after the RNT system in order to maximize training efficiencies and ensure a stable inventory of operators ready to face the challenging operating environments of the future. The Marine Corps and Navy will be able to better integrate with the joint force by mirroring current joint training methods.

Current and future UAS designs also provide operational advantages over the F-35. Platforms such as the Valkyrie and other L-CAATS currently being tested by the Air Force can operate outside the WEZ of current A2AD weapon systems with an operational range exceeding 1,000 nautical miles. These platforms are also designed to be launched and recovered from expeditionary operating bases and do not require the use of a runway. In addition, the Valkyrie

is projected to only cost 2-3 million dollars per unit which places them in a single use item category. These expeditionary UAS platforms could be launched with no intent to recover them given the low cost per unit. To put that in perspective, the Marine Corps could purchase 50 L-CAAT variant UAS for every F-35.

Based on the requirements for Future Force 2030 the Commandant is certainly justified in questioning whether the F-35 is the right the platform for the Marine Corps. The current pilot shortage, uphill battle to fix inventory levels, and F-35 operational limitations has forced the Marine Corps to look for a different option. Expeditionary UAS platforms offer solutions for all the challenges currently facing the Marine Corps as it attempts to transition to the F-35. The Marine Corps will be better situated for a future conflict by reducing the number of F-35 squadrons and increasing the number of expeditionary UAS squadrons.

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