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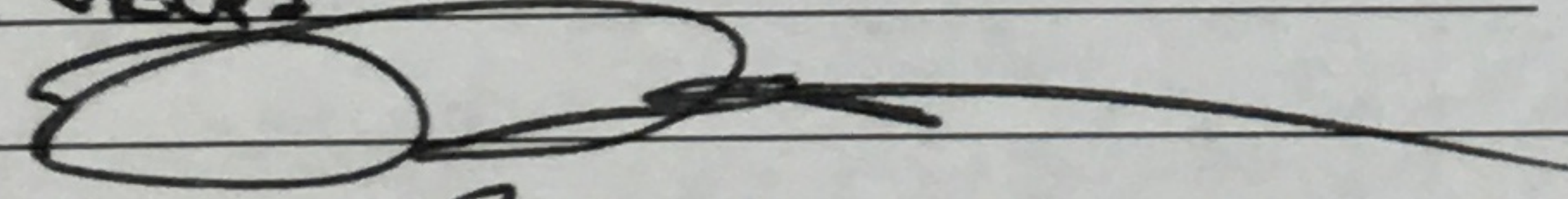
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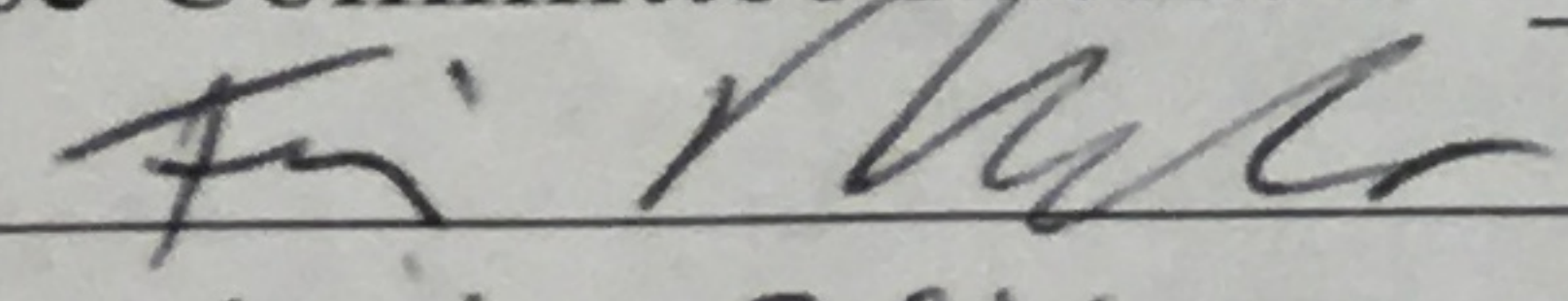
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Executive Summary

Title: Current and Future Marine Attack Aviation Gaps

Author: Major Eric Porter, United States Marine Corps

Thesis: The Marine Corps should acquire a light attack aircraft in order to bridge the gap between the F-35 and attack helicopters and to properly support the Marine Ground Combat Element (GCE) in the future operating environment.

Discussion: Marine Corps Attack aviation currently has some significant capability gaps that will only continue to increase as the F/A-18 and AV-8B Harrier are phased out and replaced with the F-35. The most significant gap in the current Marine Air Combat Element (ACE) is the lack of ability to conduct attached escort for the MV-22. Currently there are no aircraft in the ACE that can do this. There is also a lack in ability to provide persistent ISR and fires. Based on the most likely conflicts that the Marine Corps anticipates fighting, which are low conflict battles in the littoral areas, the Marine Corps needs to acquire a light attack aircraft to accomplish these missions.

Conclusion: The Marine Corps should acquire a light attack aircraft such as the V-280 or the S-97 as soon as possible in order to fill the attack capability gaps that exist in the current Marine Air Ground Task Force.

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Preface

Is the Aviation Combat Element properly equipped to support the Marine Corps in the current and future operating environment? I do not believe that we are. I assert that there is a significant gap in the capabilities of Marine Corps Attack aviation. These gaps exist because of the difference in capabilities of rotary wing attack helicopters and fixed wing attack aircraft. I believe that the Marine Corps needs to acquire a new aircraft to fill these gaps and support the ground forces in future conflicts.

I would like to acknowledge the support of several people in helping me complete this paper. First, Dr. Paul Gelpi, thank you for the mentorship and direction. Additionally, I would like to thank Col Hudson for years of mentorship and providing a direction for this paper. I would also like to thank CDR Boros for a year of mentorship and continued development. Finally, I would also like to thank my mother, father, brother, family, and friends for supporting me in this endeavor. I could not have done it without you all.

Introduction

The Marine Corps has begun to operate in a more fiscally restrictive environment, which has led to increased scrutiny on the equipment that the Marine Corps procures. The restraints of this fiscally restrictive environment make it imperative that the Marine Corps put its resources toward developing capabilities that effectively and efficiently cover the range of military operations anticipated in future conflicts. Historically, the Marine Corps has used what it has to adapt to combat and fill capabilities that it does not possess. One example of this type of creative solution is the use of the KC-130 Harvest Hawk to fill the role of a persistent CAS platform. However, as enemy capabilities increase and Marine Corps resources decrease these creative solutions will become less effective.

Marine Corps aviation needs to be prepared to support Marines going ashore across all six functions of Marine aviation in the future operating environment. Currently, Marine Corps aviation accomplishes this with a variety of aircraft. In particular, the Marine Corps has multiple different platforms to fulfill aviation attack missions. As the Marine Corps transitions to the aviation force of the future, there will only be two attack platforms in the inventory, the H-1 and the F-35. This leaves a significant gap in capabilities between attack helicopters and fifth generation jet aircraft. The Marine Corps should acquire a light attack aircraft in order to bridge the gap between the F-35 and attack helicopters and to properly support the Marine Ground Combat Element (GCE) in the future operating environment. To appreciate best the need for a new light attack platform, a three-fold examination of the issues facing the Aviation Combat Element (ACE) in its support of Marines on the ground is beneficial. First, an examination by the ACE of the future-operating environment for the Marine Air Ground Task Force

(MAGTF); second, a discussion of the attack capabilities of the current and future ACE; and, third, future capability and capacity gaps, as well as potential solutions to these gaps.

The Future Operating Environment

You go to war with the army you have – not the army you might want or wish to have at a later time.
– Donald Rumsfeld¹

Marine Corps aviation has always prided itself on being flexible and supportive of the ground combat element. Whether it is moving Marines and supply around the battlefield or providing close air support (CAS) to Marines in contact, Marine aviation has always been there. As the Marine Corps continues to transition from a land-focused force back to its amphibious roots, it is vital that the aviation element of the MAGTF assess the future operating environment in order to continue to successfully support the GCE. In order to prepare for future conflicts the Marine Corps must understand where they will likely take place, what threats are expected, what missions are required, and what restrictions exist.

The first step in preparing for the future operating environment is to understand where it will take place and what type of conflict is expected. *Expeditionary Force 21 (EF21)*, the future vision document, states that most conflicts are expected to occur in the littorals.² Specifically, *EF21* references the “arc of instability.”³ This area comprises the littoral region from the Middle East, Latin America, South central Asia, and Africa.⁴ These littoral areas are where most of the world’s population lives. Currently, over 80 percent of the world’s population lives within 100 miles of the coast, and as the population continues to grow and more people move toward urban areas, this number will continue to grow.⁵ The littorals are also important because most of the world’s raw materials and goods travel by sea. Over 90 percent of trade occurs on the world’s sea

lines of communication (SLOC).⁶ Because the littorals contain the majority of the population and most of the trade lanes, the littorals remain the most likely area for future conflicts.

In order to accurately prepare for future conflicts, the Marine Corps not only need to know where they will take place but also what kind of conflict will occur. Because of the success of the insurgencies in Iraq and Afghanistan, it is highly unlikely that the Marine Corps will ever be involved in a purely conventional conflict. Although the Marine Corps still needs to prepare to face a near-peer competitor at the high end of the spectrum of conflict, the Corps also needs to prepare for the small-scale conflicts that will most likely occur.

The third element to understanding the future operating environment of the Marine Corps is to understand what threats the Corps will face. The first threat that a MAGTF will face in future operations is gaining area access. The MAGTF will most likely not do this alone but with the help of a joint force. As Anti-Access and Area Denial (A2/AD) systems improve in technology, become less expensive, and proliferate, it will become harder for a MAGTF to gain entry into the operating environment. This threat will drive the Marine Corps to continue to use distributed operations from a combination of sea and shore bases. Once over the operating environment, Marine aviation will have to be prepared to face the air defense threats in the conflict area. These threats will include small arms, rocket propelled grenade (RPG), light anti-aircraft artillery (AAA), and Man-Portable Air Defense System (MANPADS). These threats, particularly the light AAA and MANPADS, continue to improve and represent the most likely threats to aviation in future conflicts.⁷

Although the most likely threat the future MAGTF will face is a small-scale conflict, the Marine Corps must prepare to face a near-peer competitor. In particular, the Chairman of the Joints Chiefs of Staff, General Joseph Dunford, identified the Russian Federation as the greatest threat to U.S. national security.⁸ Russia represents a hybrid threat that fights with both conventional and irregular warfare techniques on the same battlefield. Russia is also equipped with advanced AAA and surface to air missiles (SAM). The Russian army fields weapons such as the SA-22, which is lethal to helicopters and low flying aircraft. The SA-22 is one of the most advanced anti-aircraft weapons in the world. The SA-22 has a battery of up to 12 SAM that can engage targets at a distance of 20km and up to 15,000 ft., as well as two radar-guided, dual 30mm automatic cannons that can engage targets at a distance of 4 km and up to 15,000 ft.⁹ Russia also possesses advanced attack helicopters, such as the Kamov Ka-52. The Ka-52 is a capable air-to-air platform and could pose a threat to U.S. rotary wing assets. Russian leadership has announced its plans to equip some Ka-52 with a tail thruster, giving them an estimated speed of 279 mph.¹⁰ If Russia is successful, this attack helicopter would be faster than any Marine Corps rotary wing aircraft. The hybrid Russian threat with advanced weapons systems represents the high-end of combat that a future MAGTF as part of a joint force would have to face.

Another key aspect to preparing for the future operating environment is understanding the types of operations that the Marine Corps expects to accomplish. The Marine Corps has two important operation concepts for the MAGTF of the future. The first operational concept is ship to objective maneuver.¹¹ With the increased range of the MV-22 and the slow speed of current surface connectors, the Marine's ship to objective

concept is to bypass the shore and go straight from the ship to the objective. The second operational concept is distributed operations. In particular, the Marine Corps has developed the concept of Distributed Aviation Operations (DAO).¹² These operations are one way that the Marine Corps plans to counter the AD threat. DAO is essentially a forward arming and refueling point (FARP) concept for F-35 Joint Strike Fighters (JSF). In this concept, CH-53 and MV-22 set up mobile forward arming and refueling points (M-FARPS) on roads or other suitable sites inside AD range of a hostile country. This will extend the operational range of the JSF and increase sortie generation without bringing the amphibious assault ships inside the threat ring.¹³ Since Marines can rapidly assemble and move M-FARPs they are more difficult for an enemy to target than conventional airfields.

Aircraft will also need to be able conduct distributed operations in order to support the GCE. Currently, Special Purpose MAGTFs deploy all over the globe and disperse across an area of operation. Once deployed, Marine attack aircraft must be able to support these units by either being able to co-locate in austere conditions with SP-MAGTFs or having the speed to respond in a timely fashion if these units require aviation fires. There are also some specific operational requirements of attack aircraft in the future operating environment. This first requirement is that attack aircraft will have to be able to provide escort to the MV-22. Attack aircraft will also need to be capable of delivering all types of lethal and non-lethal fires.¹⁴

The future operating environment will also have several restrictions. These restrictions will include restricted fiscal environment, reduced naval shipping, and limited collateral effects to civilian population. The restricted fiscal environment in the future

will affect the aviation arm of the MAGTF in many ways. First, it will require the ACE to come up with cost efficient ways to accomplish future missions. The ACE will no longer be given a blank check for flight hours in order to provide support to the GCE. This environment will also affect the Marine Corps' ability to develop new aircraft. The Marine Corps can no longer develop aircraft that are only able to conduct one mission. The Marine Corps needs to ensure that all new aircraft can support missions across the six functions of Marine aviation. The reduced numbers of amphibious shipping will also restrict the ACE in the future operating environment. This reduction in naval shipping will require future aircraft to be capable of supporting the MAGTF from non-traditional ships such as T-AKE class supply ships. It is also important that Marine aviation is capable of supporting the GCE from remote and unprepared surfaces ashore because of this lack of naval shipping and the integration of DSO. These are some of the restrictions that will influence the mission capabilities of aircraft in the future ACE.

Predicting where and what types of conflicts the Marine Corps will fight in the future is extremely difficult, and the Marine Corps will never get this absolutely correct. The current MAGTF that fought in Iraq and Afghanistan was not perfectly equipped for its mission. However, understanding where, and what types of conflicts the Marine Corps anticipates will help it properly equip and task organize the ACE to handle whatever conflict arises. It is true that the Marine Corps must "... go to war with the army that we have."¹⁵ However, it is the Marine Corps responsibility to equip and train that army for the future conflicts that it expects without sacrificing its capability to win in a full-scale conflict.

Current MAGTF Attack Aviation Capabilities

“Instead of providing light support aircraft loaded with technology like the OV-10 Bronco, we spent billions fighting men in mud huts carrying rusty AK-47s with F-16s and F-15s costing tens of thousands an hour to operate. We literally flew the wings off our fighter fleet in the process.”

-Tyler Rogoway (2016)

In order to understand the attack capabilities gap that will occur in the future ACE of 2032, one must first analyze the capabilities and roles of the current ACE of 2016. The ACE currently comprises five fixed wing type/model/series (TMS) and two rotary wing TMS aircraft that conduct attack missions. The Fixed wing aircraft are the AV-8B, EA-6B, F/A-18 A+/C, F/A-18D, and recently the KC-130J. The F-35 has not reached full operation capability and has yet to deploy; therefore, the F-35 is not considered in the current ACE. The rotary wing aircraft include the AH-1W, AH-1Z, and the UH-1Y. This section will discuss the roles of each of these aircraft and how they work together to accomplish all attack requirements across the six functions of Marine Corps aviation.

The fixed wing component of the ACE is composed of five different TMS with distinct roles to accomplish the ACE Attack mission. The first aircraft is the EA-6B Prowler. The Prowler composes Marine Tactical Electronic Warfare Squadrons (VMAQs) and has the mission of “supporting the MAGTF commander by conducting airborne electronic warfare.”¹⁶ There are currently eighteen EA-6Bs that make up the three VMAQ squadrons.¹⁷ The Prowler is the sole aircraft within the Marine Corps with the primary mission and capability to conduct both sides of electronic warfare, electronic attack, and electronic protection. The Prowler has a cruise speed of approximately 460 mph and a ceiling of 38,000 ft.¹⁸ The Prowler carries up to five electronic counter measure pods and AGM-88 HARM to accomplish its electronic warfare mission.¹⁹

The second fixed wing aircraft in the current ACE is the AV-8B Harrier. The Harrier is a subsonic single seat vertical or short takeoff and landing (V/STOL) aircraft that makes up Marine Attack Squadrons (VMAs). There are six active VMA squadrons with a total of ninety-six aircraft.²⁰ The Harrier has a top speed of 662 mph and a maximum payload of approximately 10,000 lbs.²¹ This payload includes precision guided weapons and a 25mm cannon for air to ground mission. The Harrier also has a limited air to air combat capability. The mission of VMA Squadrons is "... destroying surface targets and escorting friendly aircraft."²² In other words, the primary role of the harrier is to attack ground targets. The Harrier's V/STOL capability also gives it distinct advantages over other FW aircraft. The advantage is that the Harrier is capable of operating off of naval ships that do not have catapults and arresting wire, and it can deploy to unimproved or short landing sites on shore. This V/STOL capability is key to ensuring that MAGTF, in particular Marine Expeditionary Units (MEUs), embarked on naval shipping have inherent fixed wing close air support.

The third type of aircraft that makes up the designated attack aircraft in the current ACE is the F/A-18 Hornet. There are currently two models of F/A-18s in the inventory. There are ninety-six single seat F/A-18A+ and F/A-18C and forty-eight two seat F/A-18Ds.²³ The Hornet is a super sonic aircraft that can reach speeds approaching Mach 1.8 (1190mph) and climb to 50,000 ft.²⁴ The Hornet has a combat radius of 290nm armed with 15,500lbs of munitions.²⁵ These aircraft respectfully compose the eleven active duty Marine Fighter/ Attack Squadrons (VMFA) and Marine All-Weather Fighter/ Attack Squadrons (VMFA-AW).²⁶ The mission of VMFA is to "...destroy surface targets and enemy aircraft, and escort friendly aircraft."²⁷ The VMFA-AW does all the missions of

the VMFA with the additional missions of Multi sensor imagery and supporting arms coordination.²⁸ In addition to serving in an attack role the F-18 is the MAGTF's primary air-to-air platform. The F/A-18 is also hindered by the fact that it cannot deploy from amphibious shipping. This means in order for the MAGTF to employ F/A-18s the ACE must request carrier support from the navy or have a suitable land base within operational range of the objective area.

Another aircraft used to serve in the attack role is the KC-130J Hercules. Originally the KC-130 was not designed to conduct attack missions. The KC-130's primary mission is to "...Provide air to air refueling, aviation delivered ground refueling and assault support airlift."²⁹ However, the Marine Corps recognized that it did not have an aircraft to conduct persistent ISR and deliver fires. Because of the need to fill this mission the Marine Corps quick solution was to purchase six "bolt on/bolt off" Harvest Hawk kits that added a sensor and gave the KC-130 the ability to deliver HELLFIRE, Griffin, and Viper precision munitions.³⁰ Although Harvest HAWK kits provide a persistent fires capability in a low threat environment to the MAGTF, when a KC-130 is providing fires the VMGR squadron's ability to provide refueling capabilities is reduced in two ways. The addition of these kits to the aircraft reduces the capacity of the KC-130 from 60,000lbs of fuel to a max of 42,000.³¹ This is significant based on the already limited amount of fuel KC-130s are capable of giving to other aircraft. The second reason that Harvest HAWK kits affect the refueling capacity of the VMGR is that the aircraft cannot effectively conduct CAS and refueling operations at the same time. Therefore, the ACE must prioritize what mission they want the Harvest HAWK to conduct.

In addition to the fixed wing assets in the MAGTF, the ACE also has two rotary wing helicopters to accomplish attack missions. The first helicopter is the AH-1W/Z Cobra. There are currently 119 AH-1W/Z in the Marine Corps.³² AH-1 Cobra attack helicopters have the mission of “...close air support, strike coordination and reconnaissance, armed reconnaissance, escort, forward air controller airborne, and air interdiction.”³³ Upgraded AH-1Zs are currently replacing older AH-1Ws. The AH-1Z has a combat radius of 131nm and a max speed of 200 kts.³⁴ The AH-1 can carry HELLFIRE laser guided air to ground missiles, Advanced Precision Kill Weapons System (APKWS) rockets, and 20mm cannon rounds. The other half of the Marine Light Attack Helicopter Squadrons (HMLA) is the UH-1Y. The UH-1Y is a utility helicopter that supports the MAGTF across all functions of Marine aviation including offensive air support (OAS). In order to accomplish its OAS role the UH-1Y carries a variety of ordnance including APKWS, .50 cal and 7.62mm. The UH-1 has a top speed of 170kts and a 119nm combat radius.³⁵ AH-1s and UH-1s make up the HMLAs. HMLAs are tasked to support the MAGTF “...by providing offensive air support, utility support, armed escort, and airborne supporting arms coordination.”³⁶

These aircraft currently support the MAGTF with all attack capabilities. Of note there are two aircraft with very specific attack roles. The EA-6B is currently the only Marine Corps designated EW platform. The EA-6B is scheduled to phase out of the inventory starting in 2016 and completely out of service by 2019.³⁷ There is no aircraft that is currently being developed to fill this role. However, the Marine Corps plans to replace the EA-6B with the (MAGTF) EW. This concept plans to use technology to place a sensor or EW pod such as ALQ-231 Intrepid tiger on “multiple aviation platforms (unmanned,

fixed wing, and rotary wing assets).”³⁸ Another aircraft with a very specific role is the AV-8B. The Harrier was designed up to be an attack aircraft with a primary mission of destroying ground targets. Having these aircraft with designated roles assures that even in times of competing sorties and limited aircraft that there are still designated aircraft to perform these specific tasks.

Even with the current inventory of attack there exist certain gaps in the ACE’s attack capability. The first gap exists into the ability of Marine Corps aviation to conduct attached escort for the MV-22. Currently rotary attack aircraft such as the AH-1W and Z with a top speed of 160 mph that traditionally serve in this role with the CH-46 do not have the speed to keep up with the MV-22.³⁹ Additionally H-1s do not have the combat radius to support the MV-22 outside of 139NM.⁴⁰ The MV-22 has a combat radius of 325nm.⁴¹ This means that in order for rotary wing attack aircraft to support the MV-22 further than 139NM from the ship or operating base the MAGTF would have to establish a FARP for the helicopters. Having to establish this FARP defeats the benefits of ship to objective maneuver. Also due to the fact the helicopters would have to launch hours ahead to establish a FARP and refuel prior to the MV-22 coming in the objective area the element of surprise could easily be lost. The other aircraft that can conduct escort missions from the amphibious ready group is the AV-8B. However because of the speed difference between the AV-8B and the MV-22 it cannot conduct attached escort leaving the MV-22 vulnerable to enemy attack while en route to the objective area.

Another current gap in the attack capability of the current Marine ACE is the ability to conduct long term ISR and deliver fires. This gap is currently being filled by the KC-130J Harvest HAWK. However, this is not a long-term solution for several reasons. The

first reason is that the Harvest HAWK can only perform its attack mission in a permissive environment. Due to the KC-130's size, relatively slow speed, and low altitude while conducting attack missions it would be an easy target for most ADA and modern MANPADS. Secondly if the KC-130 conducts ISR and attack missions it is not conducting its primary role of refueling. These limitations are the reason that Harvest HAWK is not the best platform to fill this gap.

A third gap that exists is in the ACE's ability to support Joint Terminal Attack Controller (JTAC) and Forward Air Controller (FAC) training. Currently the Marine Corps requires 626 total controllers (FAC and JTAC).⁴² In order to train the 216 new required controllers and maintain the currency of the 626 controllers in the fleet at any given time the Marine Corps must dedicate CAS sorties to their training.⁴³ The Marine Corps also must dedicate CAS sorties to the 142 Forward Air Controller airborne (FAC (A)). The total controls required annually for all of the JTAC, FAC, and FAC (A) in the Marine Corps is 10,441.⁴⁴ This is broken down further into the need for 6587 fixed wing controls and 3,854 rotary wing controls.⁴⁵ The 10,441 controls required annually by Marine Corps controllers "exceed [the Marine Corps] ability to generate the sorties with current organic and contract CAS platforms in order to maintain a T 2.0 readiness level at the present JTAC/FAC manning levels."⁴⁶ This quote illustrates that the Marine Corps knows it currently does not have the capacity to properly train its controllers. This problem will continue to get worse as the AV-8B Harrier, a dedicated attack fix winged aircraft, is phased out and replaced by the F-35, a multirole fighter. In order for the F-35 crew to maintain currency across more mission sets they will have less time to dedicate to CAS. Also, in a fiscally restricted environment it is not prudent to have a 5th generation

fighter conducting a training mission that could be accomplished by a World War II era aircraft with some slight modifications.

As we plan for the future operating environment and transition to the ACE of 2032 the Marine Corps needs to continue to identify current gaps in attack capabilities and look forward to what gaps will still exist in the future ACE. Every effort should be made to find solutions, whether they are material or doctrinal changes, to address the capability gaps that will exist in the future MAGTF. In the next section we will analyze the ACE of 2032 and the attack capabilities that it possesses.

MAGTF Attack Aviation Capabilities of 2032

Today's approach of loitering multi-million dollar aircraft...is not the most effective use of aviation fires in this irregular fight. A Light Attack Armed Reconnaissance (LAAR) aircraft capability has the potential to shift air support from a reactive threat response, to a more proactive approach

– General James Mattis about LAAR (2010)

The ACE of 2032 will attempt to cover the same attack aviation roles as the current ACE including the addition of non lethal fires with one fixed wing aircraft, the F-35 and two rotary wing aircraft the AH-1Z and the UH-1Y. These aircraft are at opposite ends of the cost and performance ladder. Attack helicopters are relatively inexpensive; however, they have limited range and speed. The F-35 is a very expensive fifth generation fighter that can carry limited ordnance. Despite the advanced capabilities of these aircraft there are still several missions that the ACE of 2032 will have difficulty accomplishing.

The key change in capabilities between the current ACE and the Future ACE is with the fixed wing aircraft. There is no major change to the rotary wing aircraft with the exception of the remaining AH-1W transitioning to a more capable AH-1Z. However the fixed wing community will go through major changes. Currently the AV-8B will be out

of the inventory by 2026 and will be replaced by the F-35.⁴⁷ All models of the F/A-18 will also be phased out of the inventory and replaced by the JSF. The last F/A-18 is scheduled to be decommissioned in 2030.⁴⁸ This means that according to the current Marine Corps aviation plan that after 2030 there will only be two fixed wing aircraft capable of conducting attack missions, the KC-130J and the F-35. Additionally the EA-6B will be retired from service in 2019 and some of its roles will also be assumed by the F-35. As mentioned before the KC-130J is very limited in its ability to conduct attack missions and has other roles to fill for the ACE so the F-35 will be required to accomplish all fixed wing missions for the future ACE.

The F-35 is a fifth generation stealth strike fighter.⁴⁹ There are two models of the F-35: the F-35B and the F-35C. The main difference between these aircraft is that the F-35B is a STOVL aircraft and the F-35C is a conventional, land- or carrier-based aircraft. The Marine Corps plans to acquire a total of 234 F-35s for active duty squadrons.⁵⁰ The F-35 was designed to be

the next generation strike weapons system designed to meet an advanced threat, while improving lethality, survivability, and supportability. It will be the cornerstone of a multi-mission joint force possessing improved mission flexibility and unprecedented effectiveness to engage and destroy both air and ground threats.⁵¹

The Marine Corps will replace all of its VMAQ, VMA, VMFA, and VMFA-AW squadrons with 18 F-35 VMFA active duty squadrons, two F-35 VMFA reserve squadrons, and two F-35 training squadrons. The F-35 will be an extremely capable aircraft. Its stealth features allow it to penetrate enemy air defenses undetected; however, this stealth technology also limits the ordnance that the F-35 can carry. In order for the F-35 to maintain a low signature the F-35 must store its ordnance internally. This limits the

F-35B to two 1000lb bombs and the F-35C to two 2000lb bombs.⁵²

Despite the advanced capabilities of the F-35 there are still several gaps in attack capabilities of the future ACE. The first gap that exists is the ability to provide attached escort that was discussed in the previous section. With only H-1s and F-35s to complete the escort mission the same gap exists in the future MAGTF that exists today. This gap in attached escort will become more prevalent with the advancements and increased proliferation of ADA and MANPADS, which will further increase the threat to rotary wing aircraft. Also the increase in A2/AD weapons systems will increase the need to conduct ship to objective maneuver and distributed operations. These two factors combined will increase the distances that MV-22 will have to fly to conduct their missions and increase the threat to the aircraft during this transit.

Another gap that exists will be a capacity gap. This gap could become apparent if the Marine Corps enters a full-scale conflict with a near peer competitor. For example if all the JSF sorties were needed to conduct air-to-air missions, EW, and long range strike missions there would be little to no sorties left to conduct FW CAS. Additionally if the JSF is required to use its stealth capability it cannot have any external stores severely reducing the ordnance capacity of the aircraft. Currently having a designated attack aircraft the AV-8B solves this problem. As a designated attack aircraft the AV-8B has the primary role of striking ground targets and until recently did not even carry an air-to-air weapon other than short-range AIM-9 sidewinder missiles. Therefore, even if all F/A-18 sorties had to be dedicated to air to air missions and long range strike, AV-8Bs would still be available to provide FW CAS to ground troops. By having only one fixed wing aircraft to conduct a multitude of missions across the 6 functions of Marine aviation, it is

more likely that the F-35 will be pulled to do missions other than CAS for the infantry, limiting them to rotary wing support. As discussed rotary wing aircraft are limited in their ability to conduct ship to objective maneuver by their operational range. Rotary wing aircraft are also limited in what ordnance they bring to the fight. An AH-1's largest ordnance is a 104 lbs HELLFIRE missile, which was designed originally for destroying tanks and has limited blast and fragmentation effects depending on the model. FW aircraft are capable of carrying multiple bombs ranging from 250 – 2000 lbs. This lack of FW CAS would severely restrict the MAGTF commander's ability to prosecute targets.

A third gap exists because of the fiscally restrictive environment that we currently operate in and will continue to operate in the future. It is not responsible to send a JSF with an estimated operating cost of \$32,000 dollars per hour to complete a mission that could be done with an aircraft such as the A-10 that costs \$11,500 dollars per hour to operate.⁵³ For example, in order to complete the 5207 fixed wing controls that are required annually by the Marine Corps (assuming 3 controls can be conducted an hour) it will cost \$55.5 million if done by the F-35. For comparison it costs roughly one third of this to conduct the same sorties with an A-10. This gap between the cost of using a highly capable fifth generation fighter to conduct a mission that can be completed in an irregular battlefield by a much less expensive aircraft is exemplified by General Mattis' comment that, "today's approach of loitering multi-million dollar aircraft... is not the most effective use of aviation fires in this irregular fight. A Light Attack Armed Reconnaissance (LAAR) aircraft capability has the potential to shift air support from a reactive threat response, to a more proactive approach."⁵⁴ This shows that even during the Corps most

recent conflicts that the Corps leadership recognized that the ACE has capability gaps that could be solved with different solutions.

The Marine Corps needs to come up with a solution to this capability gap and cannot rely on the joint force for several reasons. First, due to the nature of amphibious operations, there may be missions that are not feasible for the other services to support because of location. The advantages of having a MEU that is self-sufficient are negated if the MEU needs to wait for other land-based forces to provide attack aviation capabilities.

Potential Solutions

In other words, HQMC is responsible for manning, training and equipping the force, for the readiness to fight and win our nation's battles.

- USMC Aviation Plan 2015

There are several potential solutions to the capability gap that exist in the current ACE of 2016 and will continue to get larger in the ACE of 2032. This section of the paper will compare and contrast some leading solutions that can address the gap that will exist in the future MAGTF. Some of these solutions are aircraft that are currently flying and would be relatively easy to adapt into the USMC aviation fleet and other aircraft are still in the research and development phase and would take years to be introduced into the fleet.

The first option is a low cost armed turbo prop aircraft such as the AT-6 or the A-29 Super Tucano. These aircraft are both two-seat and propeller driven aircraft that are designed to operate in a low threat environment carrying rockets, guns, precision guided munitions and bombs up to 500lbs. The Super Tucano is not manufactured in the United States, because of this in order for the Marine Corps to procure it, a factory would have to

be built in the U.S. This would add to the cost and delay the production of the aircraft. Therefore, the AT-6 is the leading propeller driven fixed wing alternative. The AT-6 has a top speed of 363 mph.⁵⁵ The AT-6 also has the advantage of being 85 percent the same as the T-6, the aircraft that all Navy and Marine Corps aviators train on in primary flight school.⁵⁶ This means that all current Marine Corps aviators would be qualified to fly the AT-6 after a short refresher course. It would also be an advantage to field the aircraft because the supply parts chain currently exists within DOD. The key advantage to acquiring an aircraft such as the AT-6 is that because the aircraft is currently flying and the supply chain exist this aircraft could be operational in the fleet very quickly. Also the T-6 currently has an operating cost of \$2,235 per flight hour.⁵⁷ However the AT-6 has one severe limitation. The AT-6 could only be land based because it has no arresting gear or STOVL capability and it requires more runway than the 820 ft that is available on a LHA.⁵⁸ This would limit the ability of this aircraft to support Marines embarked on naval shipping.

The second option is a relatively inexpensive jet attack aircraft such as the Textron Scorpion. The Scorpion is designed to be a high subsonic attack jet filling a role much like an A-10 or an AV-8B.⁵⁹ Production for this jet is scheduled to begin in 2016.⁶⁰ Textron is designing the aircraft without a current customer. They believe that the final price will be approximately 20 million.⁶¹ Although this sounds expensive it is much cheaper than the approximate 100 million per F-35.⁶² This aircraft will be able to fill multiple missions including CAS and ISR with up to five hours time on station.⁶³ Additionally, the cost per flight hour for this jet is expected to be around \$3,000. This is much less than the current \$18,000 per hour of an F/A-18 or the potential \$32,000

of an F-35.⁶⁴ This jet is also hindered just like the AT-6 in that it cannot be ship based. In a future operating environment that focuses on distributed operation is austere environments and ship to objective maneuver this is a important disadvantage. However, because of the top speed of 517 mph this jet it has a distinct advantage in survivability over the AT-6.⁶⁵

The next two aircraft that could fill the gap in capabilities of the ACE are both vertical take off and landing aircraft. The first aircraft is the S-97 Raider. The S-97 uses X2 technology, which is a twin coaxial rotor system with a tail mounted pusher propeller in order to achieve cruise speeds of 276 mph while maintaining a vertical take off and landing capability.⁶⁶ The S-97 is expected to have an operating cost of about \$3000 per flight hour.⁶⁷ One of the most impressive features about the X2 technology used in the S-97 is that Sikorsky says that it is scalable. They envision that this technology could be used in aircraft like the S-97 that is UH-60 sized or it could be adapted to a smaller dedicated attack sized aircraft. This scalable concept is very promising; a current HMLA could be replaced by two versions of future helicopters using X2 technology. This would allow the HMLA to maintain their communality like the H-1s of today while still having a designated attack platform and a utility platform as well. Because the S-97 has a vertical take off capability and can reach 276 mph it is capable of launching from the ship or other austere locations and providing attached escort for MV-22. This is a key difference from the other two options previously listed.

The last option is the V-280 Valor. The V-280 is a tilt rotor aircraft. It is about the size of a UH-60 with a cruise speed of 322 mph and a combat radius of 900 nm.⁶⁸ One advantage of the V-280 is that it uses proven technology unlike the S-97 that is the first

of its kind. The military has logged over 300,000 flight hours in tilt rotor aircraft.⁶⁹ Like the S-97 the V-280 is also capable of vertical take off and landing and has the required speed to and range to escort a MV-22. Another advantage of the V-280 is the cockpit size. The empty area behind the pilots could be used to hold more ammunition so that the aircraft could rearm. The empty space could also be used for future weapons systems such as cyber weapons.

The two fixed wing options bring certain advantages to the future battlefield. The first advantage they bring is speed. The AT-6 is the slower of the two options and it has a top speed of 363 mph.⁷⁰ This speed advantage equates to a survivability advantage in combat. The faster an aircraft is the quicker it can get into the target area complete the mission and return to base. Additionally this speed advantage is important in evading threats and air to air combat. Despite the speed advantage that Scorpion and AT-6 have they are still not a capable air-to-air platform compared to modern fighters. In a conflict where the enemy has a credible fixed wing air threat these aircraft would rely on F-18s or F-35s to provide combat air patrols. The second advantage that the fixed wing alternatives bring is service ceiling. Both of these aircraft have pressurized cockpits and are capable of flying at altitudes in excess of 25,000 ft.⁷¹ in a low threat environment this allows the aircraft to climb out of the threat envelope from small arms and MANPADS. However these aircraft would have a low survivability in a combat zone against a peer competitor such as Russia that employs advanced surface to air weapons. Fixed wing aircraft have greater range capability than the other alternatives. The final advantage to the two fixed wing options is that they are both currently flying and could rapidly be integrated into the ACE.

The S-97 and V-280 both also have several advantages and disadvantages compared to the fixed wing options. The first advantage is that these two aircraft are capable of flying like helicopters. This means that they can conduct terrain flight (TERF). Terrain flight is when helicopters fly as low as 10ft and use the terrain to hide them from radars and other enemy threats. The ability to fly below enemy radars and mask their signature makes these aircraft more survivable than some fix wing aircraft in high threat environments. The final and most compelling advantage of the S-97 and the V280 are their ability to vertically take off and land. This allows them to operate from amphibious ships and unprepared landing zones making them uniquely qualified for a service that is sea based. This vertical take off and landing capability along with a speed comparable to the MV-22 allows these aircraft to conduct attached escort from take off to insertion point in any environment. Fixed wing aircraft are not capable of conducting this mission.

One disadvantage of both of these aircraft is that in their current configurations they are not designated attack aircraft. Therefore the temptation could exist to task them with other missions such as assault support. This additional tasking would take sorties away from attack missions. Because of the advantages of the S-97 and V-280 in a high threat environment and their ability to vertically take off and land vertically they are the best options to fill the gap in attack aviation capabilities. Another potential disadvantage is the range of the V-280 and the S-97. The V-280 advertised combat range is up to 800 nm however the S-97 is only capable of going approximately 320 nm.^{72 73} The MV-22 is has a combat range of 515 nm and because of its ability to air-to-air refuel that range can be greatly extended. In order to fully support the MV-22 these two aircraft must also be equipped with air-to-air refueling capabilities.

However, despite the disadvantages of the V-280 and the S-97 they are the only aircraft that will fill all the capability gaps in the MAGTF. The main reason the Marine Corps should acquire this type of aircraft is because of its vertical lift capability. This vertical lift capability is important for various reasons. Mainly it allows the V-280 and S-97 to escort the MV-22 during all phases of flight. Additionally, it allows the V-280 and S-97 to operate from amphibious shipping further increasing the capabilities of an amphibious MAGTF.

Conclusion

In order for the ACE to continue to effectively support the GCE in the future operating environment the Marine Corps should immediately begin pursuing a light attack aircraft to fill “[the] significant mismatch between existing capabilities within the U.S. arsenal for light air support and those capabilities demanded by our national strategies in Afghanistan and across the globe.”⁷⁴ The vertical take off and landing capabilities of the S-97 and the V-280 make them uniquely qualified to fill this roll for the Marine Corps. These gaps in attack capabilities, attached escort, and EW will only increase as the AV-8B and the EA-6B are retired and replaced by the JSF. This aircraft must be able to excel in the low intensity conflict that the Marine Corps will most likely fight in. However, It must also be able to fight in a high intensity conflict with a near peer competitor. The aircraft acquired must also be able to fit into the Marine Corps operational tenants of DAO and ship to objective maneuver. In the fiscally restrictive environment that we currently face and will continue to operate in during future conflicts a cost efficient attack platform capable of operating from the ship to the objective is required to counter current and future threats.

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