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The Case for a Marine Corps Light Attack Platform

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Title: The Case for a Marine Corps Light Attack Platform

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Thesis: There is room in the Marine Corps' inventory for a light attack aircraft that would extend the service life of the F-35 fleet, provide an expeditionary asset capable of distributed operations, and serve as a dedicated Close Air Support (CAS) asset at a fraction of the cost of the F-35.

Discussion: In the past, the Marine Corps has relied on specialized aviation assets tailored to one or more of the functions of Marine aviation. In recent years the Marine Corps has begun to consolidate its offensive air support, antiair warfare, and air reconnaissance aviation assets into a single 5th generation platform, the F-35 Joint Strike Fighter (JSF). At a Weapon System Unit Cost of more than 140 million US dollars each, the F-35 will be the most expensive weapon program to date. The 5th generation capabilities that the F-35 brings to the fight are undeniable but these costly capabilities are not required in all conflicts. Additionally, there are certain risks attached to the dependence on a single fixed-wing asset. This paper will argue that there is room in the Marine Corps' inventory for a light attack aircraft that would extend the service life of the F-35 fleet, provide an expeditionary asset capable of distributed operations, and serve as a dedicated Close Air Support (CAS) asset at a fraction of the cost of the F-35.

Conclusion: The Marine Corps has never relied on a single fighter asset before. Historically a diverse mix of fixed wing platforms has minimized the risk of a single platform in the inventory experiencing maintenance issues or operational issues resulting from changing enemy technology and tactics. Despite the F-35's weaknesses and limitations the Marine Corps is at this point committed to acquiring the F-35. While the program can't be cancelled, its risks can be mitigated by the acquisition of a fixed wing, light attack aircraft.

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.

The air component of the Marine Air Ground Task Force (MAGTF) serves as an integral component of a light infantry force that fights from the sea. The incorporation of aviation into the MAGTF and the single battle concept allows the MAGTF to greatly extend its operational reach and augment its limited, organic ground-based fires and mobility.[1] MAGTF aviation does so by executing the six functions of Marine aviation: offensive air support, antiair warfare, assault support, air reconnaissance, electronic warfare, and control of aircraft and missiles. In the past the Marine Corps has relied on specialized aviation assets tailored to one or more of the functions of Marine aviation. In recent years, the Marine Corps has begun to consolidate its offensive air support, antiair warfare, and air reconnaissance aviation assets into a single 5th generation platform, the F-35 Joint Strike Fighter (JSF). At a Weapon System Unit Cost of more than 140 million US dollars each, the F-35 will be the most expensive weapon program to date.[2] The 5th generation capabilities that the F-35 brings to the fight are undeniable but these costly capabilities are not required in all conflicts. Additionally, there are certain risks attached to the dependence on a single fixed-wing asset. This paper will argue that there is room in the Marine Corps' inventory for a light attack aircraft that would extend the service life of the F-35 fleet, provide an expeditionary asset capable of distributed operations, and serve as a dedicated Close Air Support (CAS) asset at a fraction of the cost of the F-35.

I. Past

To understand the future of CAS it is helpful to look to the past to understand how CAS has developed to where it is today. Marine Corps development of CAS began in the years prior to World War I and continued to be tested and refined for the duration of the war. Unlike the other military services, the Marine Corps focused on the application of air power in support of forces on the ground. This focus backed by extensive development and testing led the Marine

Corps to the view "that a specialized attack aircraft was needed for effective close air support, rather than depending on multi-role fighter and observation aircraft who's dramatically increasing performance made them too fast for proper observation and situational awareness of friendly and enemy positions on the ground."[3]

By the start of the Korean War, communications technology, which had previously limited the effectiveness of CAS, had developed to the point where effective CAS was possible. "Marine aircraft…provided CAS to the Marines stabilizing the Pusan Perimeter, and were critical to the success of that effort. Marine CAS was also critical in the Inchon landings and the campaign that followed."[4] Throughout the duration of the Korean War, the Marine Corps utilized six multirole fighter/attack aircraft and the Douglas AD (A-1) Skyraider which was a dedicated offensive air support aircraft. With greater loiter times than any of the multirole aircraft and an impressive array of weapons the Skyraider was a formidable CAS platform that "was a very popular aircraft with ground Marines."[5] The Skyraider was complemented by the Marine Corps' other multirole platforms and provided a decisive edge that was so effective that after the war "a Chinese General attributed their defeat in no small measure to the deadly effectiveness of the dedicated Marine close air support."[6]

The Skyraider was the CAS platform of choice until the Vietnam War when it was replaced by another dedicated CAS platform, the Douglas A-4 Skyhawk. Douglas designed the Skyhawk as a dedicated, light-weight, low-cost CAS platform for the Navy and Marine Corps.[7] The Skyhawk was regarded "as the preferred aircraft for destroying targets which required precision attacks" but it was limited to visual attacks.[8] For this reason the Marine Corps in conjunction with the Navy developed the A-6 Intruder. The Intruder ensured "that night and poor weather did not deny ground troops the air support they needed."[9] One other platform that

was newly developed for the Vietnam War was the Rockwell OV-10 Bronco. The Bronco was designed as a Light Armed Reconnaissance platform in support of Counter Insurgency (COIN) operations.[10] It was capable of a diverse set of missions to include visual reconnaissance and surveillance…, helicopter escort, ground attack, airborne tactical air coordination, artillery and naval gunfire spotting, battlefield illumination, and enough cargo and passenger space for liaison and utility use.[11] The Marine Corps' diverse mix of Vietnam War aircraft, targeting technology, and tactics along with "the culture of the Marine air-ground team allowed an innovative and more aggressive employment of CAS with superior results."[12]

Following the Vietnam War, the Boeing AV-8B Harrier was introduced to replace the A-4 Skyhawk and the Boeing F/A-18 Hornet was produced to replace the F-4 Phantom and the A-6 Intruder. Both aircraft were multi-mission capable, but the Harrier maintained the Skyhawk's focus on Offensive Air Support with the added Vertical/Short Takeoff and landing(VSTOL) capability while the Hornet was a true multirole aircraft. In addition to the introduction of the Harrier and Hornet the Gulf War saw the introduction of Precision Guided Munitions (PGM). Media releases touted the capabilities of PGMs but, despite significant advances that had been made in laser guided precision munitions, PGMs only accounted for eight percent of all munitions dropped during the Gulf War.[13] Because of this reality, Broncos with Forward Air Controllers-Airborne (FAC-A) and Hornets with Fast Forward Air Controllers (Fast FAC) played a large role in directing the attacks of the Harriers and Intruders.[14] Intruders continued their Offensive Air Support role in the Gulf War but were reaching the end of their service life and proved vulnerable to Iraqi air-to-air threats which required Hornet escorts to be built into strike packages.[15] Despite the aging technology of several of the Marine Corps' aviation assets utilized in the Gulf War, their combined capabilities fulfilled the required functions of Marine

aviation. In his testimony to Congress regarding the effectiveness of the Gulf War air campaign, Henry Hinton made the following statement:

> The mix of available aircraft types enabled the United States and the coalition to successfully attack or put pressure on a variety of targets and target types; at various times of the day and night; in urban, marine, and desert environments; with various guided and unguided munitions. Even including the platform and munition preferences discussed above, no target category was exclusively struck by a single type of aircraft, and no type of aircraft or munition was exclusively used against a single type of target or target category. Older, less costly, and less technologically advanced aircraft and weapon systems made substantial contributions to the air campaign as did the newer, more technologically advanced systems. No particular weapon system—whether of low or high technology, new or old, single or multirole, high or low cost (or in between on any of these criteria)—clearly proved more effective than another or demonstrated a disproportionate contribution to the objectives of the campaign.[16]

Not long after the end of the Gulf War the Intruder squadrons had all transitioned to the F/A-18. Likewise, the OV-10 was phased out leaving the Hornet and the Harrier as the Marine Corps' only fixed wing offensive air support assets. These two aircraft performed admirably for the next three decades serving through both Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF).

II. Present

For more than fourteen years Marine Corps Harriers and Hornets have trained for and deployed overseas in support of OEF, OIF, and overseas contingency operations. This represents the longest period of conflict that the United States has been part of. This lengthy period of conflict has taken a toll on the readiness of Marine Corps aviation, particularly the Hornet fleet. "The readiness challenges are being driven by high operating tempos and related maintenance backlogs; insufficient procurement of new aircraft; and delays in the F-35 Joint Strike Fighter coming online."[17] A large percentage of the Marine Corps' Hornet fleet has reached its service life and is now scheduled to be replaced by the F-35 Joint Strike Fighter (JSF). The transition to

the JSF was planned for Marine Corps Harriers before Hornets but now that the Hornet fleet is in a readiness death spiral the Marine Corps has opted to transition its Hornets first. According to the Government Accountability Office (GAO) JSF full rate production is not anticipated until 2019, seven years behind schedule.[18] Likewise, Initial Operational Capability (IOC) has been delayed more than 5 years.[19] Procurement of JSFs for all three services is behind to the point that "since 2002, the total quantity through 2017 has been reduced by three-fourths, from 1,591 to 365."[20] Along with these significant schedule delays, JSF procurement costs have risen significantly from a 2001 unit cost estimate of $81 million to a 2015 unit cost estimate of over $154 million.[21]

Figure 1: Annual Procurements of F-35 Aircraft

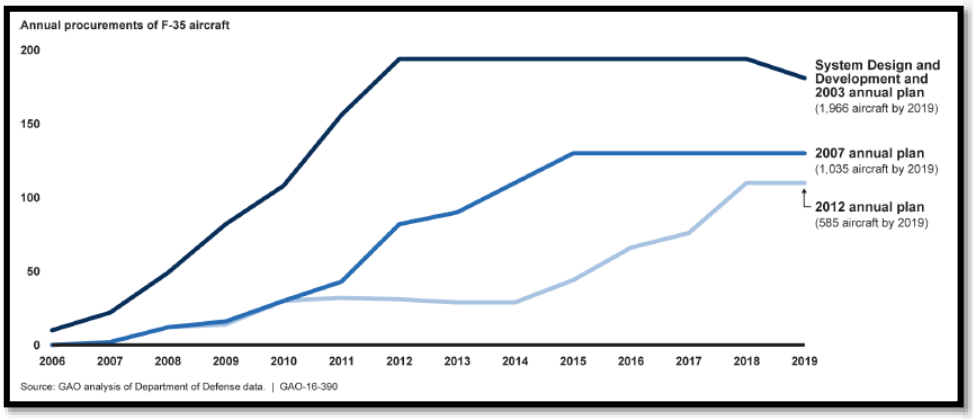
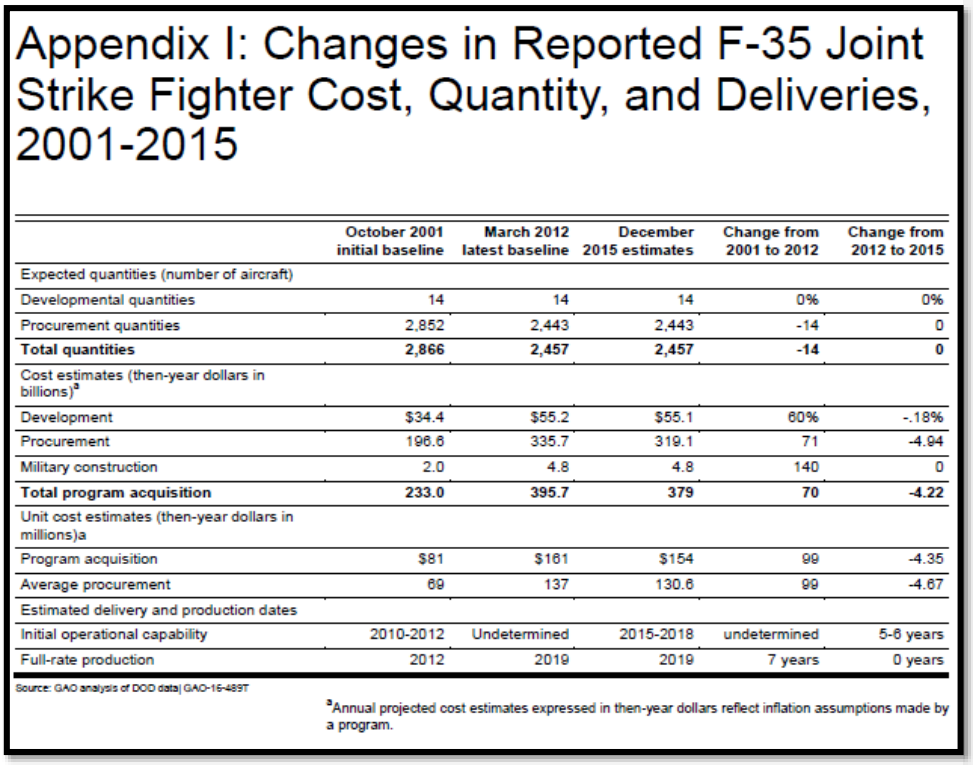


Figure 2: Changes in Reported F-35 Joint Strike Fighter Cost, Quantity, and Deliveries



Appendix I: Changes in Reported F-35 Joint Strike Fighter Cost, Quantity, and Deliveries, 2001-2015

	October 2001 initial baseline	March 2012 latest baseline	December 2015 estimates	Change from 2001 to 2012	Change from 2012 to 2015
Expected quantities (number of aircraft)					
Developmental quantities	14	14	14	0%	0%
Procurement quantities	2,852	2,443	2,443	-14	0
Total quantities	**2,866**	**2,457**	**2,457**	**-14**	**0**
Cost estimates (then-year dollars in billions)[a]					
Development	$34.4	$55.2	$55.1	60%	-.18%
Procurement	196.6	335.7	319.1	71	-4.94
Military construction	2.0	4.8	4.8	140	0
Total program acquisition	**233.0**	**395.7**	**379**	**70**	**-4.22**
Unit cost estimates (then-year dollars in millions)a					
Program acquisition	$81	$161	$154	99	-4.35
Average procurement	69	137	130.6	99	-4.67
Estimated delivery and production dates					
Initial operational capability	2010-2012	Undetermined	2015-2018	undetermined	5-6 years
Full-rate production	2012	2019	2019	7 years	0 years

Source: GAO analysis of DOD data| GAO-16-489T

[a]Annual projected cost estimates expressed in then-year dollars reflect inflation assumptions made by a program.

With soaring costs and schedule delays the GAO published the following conclusion in its 2016 JSF report:

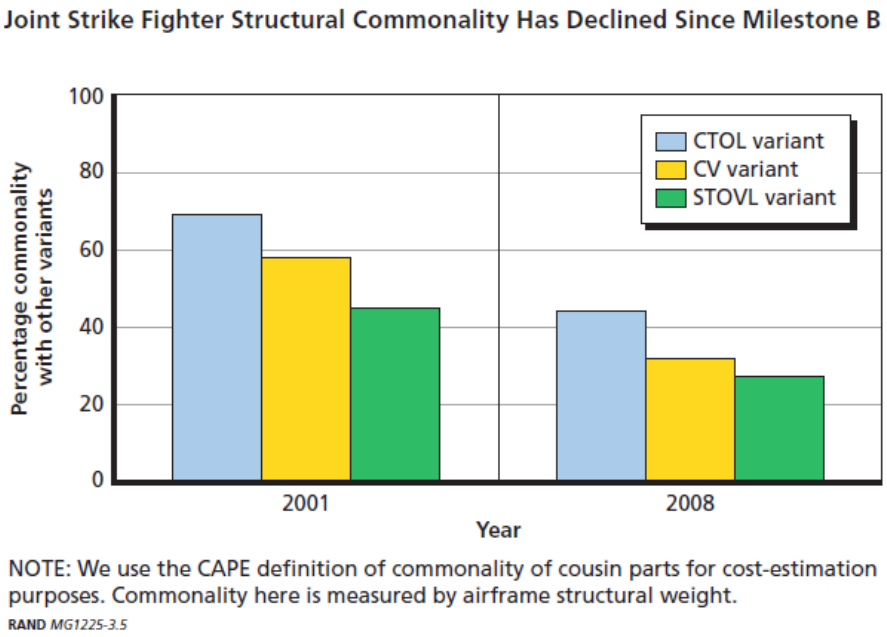
> Our preliminary results indicate that, although the F-35 development program is nearing completion, the program is not without risks. The remaining significant and complex 3F mission systems software developmental testing, continuing issues with ALIS, and new issues with the ejection seat and F-35C wing structures pose ongoing risks. Going forward, the program will likely continue to experience affordability and oversight challenges. DOD expects that beginning in 2022 it will need more than $14 billion a year on average for a decade to procure aircraft. **It is unlikely that the program will be able to receive and sustain such a high level of funding over this extended period**,

> especially given DOD's competing resources such as the long range strike bomber and KC-46A tanker.[22]

This conclusion highlights the possibility that the Marine Corps will not receive its planned allotment of JSFs due to competing high cost programs.

Given the current readiness death spiral of the Marine Corps' Hornet fleet, the delays and potential reduction in total JSF procurement, and the inevitable strain that will be placed on the Harrier fleet and those few Hornets that are operational it would serve the Marine Corps well to look to the past to plan the future of Marine aviation. The Marine Corps has always had multiple fixed-wing aviation assets with generally one specialized in Offensive Air Support. With the current transition to the JSF, for the first time the Marine Corps will be reliant on a single fixed-wing multi-mission asset. The Rand Corporation evaluated the possibility of a single aircraft fleet wide stand down and determined that "there is a 2.2-percent probability that the entire fleet will be directed to stand down at any given point in time. However, if there are two fighter types in the inventory, the probability declines to 0.05 percent."[23] "In addition to the benefit of a lower probability of fleet-wide stand-downs, there are also historical examples of a diversity of fighter types across services that provided warfighters with greater flexibility to respond either to unforeseen problems or design flaws in U.S. forces or to the introduction of unanticipated new enemy capabilities."[24] Putting all of the Marine Corps' eggs in one basket incurs significant operational risk in the case of a fleet wide stand down, the introduction of new enemy capabilities, or the more immediate risk posed by the developmental delays experienced by the F-35 program. In addition to the operational risk of operating a single fighter across the Marine Corps, the cost savings which were supposed to be realized through the commonality of design between the three different F-35 models never occurred (Figure 3).

Figure 3: Joint Strike Fighter Structural Commonality



The Marine Corps incurred significant risk when the decision was made to declare IOC prior to Initial Operational Testing and Evaluation (IOT&E). "The Marine Corps directed the lab to truncate the planned testing of the Block 2B mission data so that an immature version could be fielded in mid-2015 to 'support' Marine Corps IOC."[25] In his testimony to the Senate Armed Services Committee, the Director, Operational Test and Evaluation testified "the risks of operating with these mission data are not understood, and will not be characterized until the full set of planned testing, including operational test flights with the mission data, are conducted."[26] Known risks that the Marine Corps has opted to accept include significant operational limitations, sustainment issues, reliability issues, structural issues, and survival systems issues.

"As of the end of March 2016, the program had 1,165 open, documented deficiencies, 151 of which were Category 1, defined as deficiencies which may cause death, severe injury, or severe illness; may cause loss of or major damage to a weapon system; critically restricts the combat readiness capabilities of the using organization; or result in a production line stoppage."[27]

Several of the operational limitations that the Director, Operational Test and Evaluation, Michael Gilmore, highlighted in his testimony regarding the F-35 program are significant and present a reduction in capability from older 4th generation assets. The F-35 operating with Block 2B software is limited to two bombs, two missiles, and no gun. This alone is a significant reduction in capability from prior fighter assets. Marrying this with the fact that the F-35 burns fuel at a higher rate and lacks the Time on Station of previous fighter assets makes the reduction in capability only worse. Unfortunately, the F-35s woes don't end there. Both the Air Force and the Marine Corps have conducted simulated deployment assessments of the F-35 to mixed results. During the Air Force's simulated deployment of six F-35As, the aircraft experienced significant issues with launching alert fighters due to software instability which required multiple startup sequences to reboot and reset malfunctioning systems. During an attempt at launching all six alert aircraft, only one actually took off. The Marine Corps experienced issues of its own during a simulated deployment to Twenty-Nine Palms. While operating from an expeditionary airfield of aluminum matting, two of the Marine Corps' eight participating F-35Bs received Foreign Object Debris (FOD) damage to their engines. Both aircraft were down for the duration of the simulated deployment and the ensuing repairs required contractor support.

In addition to the operational limitations that have already been identified, the F-35 has concerning reliability and sustainment issues. "The FMC rate for the F-35 fleet has declined steadily since December 2014. Data from February 2016…show a fleet-wide FMC rate of 30

percent and an F-35B FMC rate of less than 14 percent."[28] Of equal concern to the low readiness rate is the high amount of contractor support that is required to maintain it. In addition to the obvious operational impact of such a low readiness rate "the Marine Corps has recently described difficulties in completing pilot training requirements due to low aircraft availability with full functionality."[29] All of these issues serve to compound the already observed program delays and further delay IOT&E during which it is likely that more issues will be brought to light.

Lastly, several F-35 structural issues have been identified as well as an issue with the ejection seat impacting pilot survivability. These issues do not immediately affect the program but will require addressing. All three models have experienced cracks in their titanium bulkheads which will result in reduced service life if not addressed. Another structural issue was found to be caused by "overloads that are occurring while carrying external AIM-9X missiles that may require a structural modification to the wings."[30] In addition to flying an aircraft with known structural issues "the F-35's pilot escape system is immature; it requires modifications and additional testing if the Services are to be reasonably confident the system is safe for their intended pilot populations."[31]

These few issues that were highlighted represent only a fraction of the issues that have been identified in the F-35 program. Additionally, since the program has not completed IOT&E, or started it for that matter, there will likely by more issues found which will cause further program delays and reliability issues. The current procurement plan projects the transition to the JSF to be complete by Fiscal Year (FY) 2032 but as previously discussed funding and schedule delays may impact this.[32] The projected service life per JSF is 32 years and the program is planned to last until FY 2070.[33] Current program issues and future funding doubts leave the

matter of program completion up in the air. The Marine Corps should look to low cost Offensive Air Support alternatives which will help preserve the JSFs that it does acquire and provide better support to Marines on the ground.

III. Future

In the first week of Operation WOLVERINE, 3d Marine Expeditionary Brigade (MEB) secured an Expeditionary Advanced Base (EAB) which allowed III Marine Expeditionary Force (MEF) to begin flowing follow-on forces into the battlespace. F-35Bs from 1st Marine Aircraft Wing (MAW) maintained air superiority around the EAB which they then began to extend into the enemy area of operations. As air superiority was expanded, 1st MAW AT-6C Wolverines began flowing into the EAB. Initially 1st MAW used strike packages of F-35Bs and AT-6Cs operating from the EAB. The F-35Bs conducting Deep Air Support (DAS) eliminated radar and air-to-air threats to establish local air superiority. With the local airspace secured the F-35Bs used their organic Electronic Warfare capabilities to detect and track targets, jam and attack enemy networks and communications, and provide early warning of any surface-to-air threats. The F-35Bs operational picture distributed over the Multifunctional Information Distribution System (MIDS) fed target and threat information to III MEF ground forces allowing them to designate priority targets for ground and aviation based fires. Under the cover of local air superiority provided by F-35Bs, the AT-6Cs conducted Offensive Air Support operations in support of III MEF forces on the ground. Their mix of high and low altitude tactics granted them excellent responsiveness and allowed them to maximize effects on the enemy.

Due to the threat of enemy Chemical, Biological, Radiological, and Nuclear (CBRN) attack, Mobile-Forward Arming and Refueling Points (M-FARP) were established which easily

met the relatively small fuel and ordnance requirements of the AT-6C Wolverines. 1st MAW F-35Bs continued to operate out of the EAB with air-to-air refueling support from 1st MAW KC-130Js due to their large fuel requirements that the M-FARPs would have been unable to meet. Because of their small size and weight, the AT-6Cs were able to land on existing roads and unimproved airstrips which greatly increased the flexibility of the M-FARPs. As the Forward Line of Troops (FLOT) advanced and increased its distance from the EAB our operations became increasingly dependent on the M-FARPs. AT-6C maintenance teams and spare pilots were pushed forward to the M-FARPs. The maintenance teams conducted required minor maintenance and repairs at the M-FARPS while aircraft needing major repairs and inspections were sent back to the EAB. The spare pilots and the maintenance teams operating from the M-FARPs greatly increased our AT-6C sortie generation rate and allowed uninterrupted CAS support to our Marines on the ground. In the few cases when M-FARPs went down or were not in place on time our AT-6Cs were able to land on improved and unimproved roads near III MEF forces and refuel over the wing as well as rearm with standard .50 caliber ammunition.

As the operation progressed and Joint forces flowed into the battlespace, the enemy air-to-air and ground based radar threats were eliminated. With air dominance established and the enemy ground forces dispersing into the population to conduct irregular warfare the need for the 5th generation capabilities of our F-35Bs was greatly diminished. All but one F-35B squadron was retrograded which left the bulk of the air support mission to our AT-6Cs. With a focus on Counterinsurgency (COIN) operations the primary mission of our AT-6Cs became Air Reconnaissance to locate the enemy followed by pinpoint, low collateral damage strikes. The AT-6C with its more than 4.0 hours of endurance loaded with two LAU-131 pods of 14 APKWS

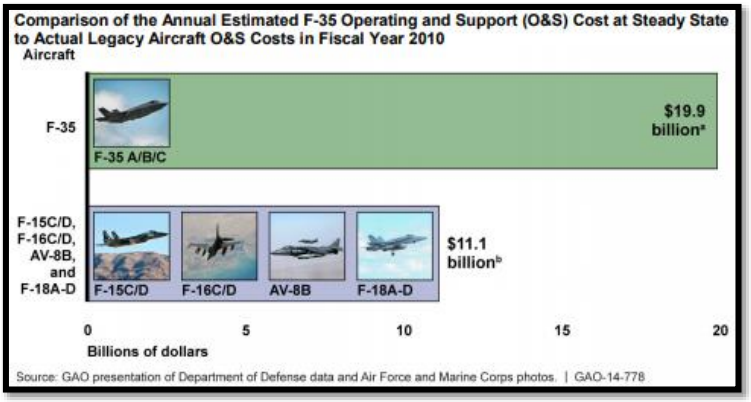
laser guided rockets proved its worth against an entrenched insurgency operating in both complex urban terrain and rural countryside.

When Phase IV operations were in full swing it was identified that the Host Nation's (HN) defense force would require an Offensive Air Support capability. Through a contract negotiated with Beechcraft and the HN we were able to negotiate the sale of our AT-6Cs to the HN. Beechcraft's production line was already at full rate production and was able to backfill our AT-6Cs back in the United States. As AT-6C squadrons retrograded they transferred their aircraft to the HN (after being field converted to an export configuration) and fell in on new aircraft once they returned to their home stations. Not only did the use of the much cheaper AT-6C save directly on wartime expenses, it extended the lifetime of our high dollar F-35s by not utilizing them during the multiple years of COIN operations that took place. Additionally, through a purchase of new AT-6Cs financed largely from the transfer of our wartime AT-6Cs to the HN our AT-6C fleet has maintained its readiness despite years of full operational utilization.

The 2016 Marine Corps Operating Concept (MOC) states, "Our greatest risk is that we become unbalanced in our development of a future Marine Corps that is at once Naval, expeditionary, agile and lethal."[34] Investing the future of Marine Corps tactical aviation in a single asset presents increased risk to the future force becoming unbalanced. The Marine Corps touts that "The F-35 is designed to participate in a wide variety of operations from routine, recurring military activities, to major theater war and peace keeping operations.[35] Within the Range of Military Operations (ROMO) the JSF will undoubtedly play a large role in major operations and campaigns as well as Crisis Response and Limited Contingency Operations. At a projected annual Operating and Support (O&S) cost of $19.9 billion (a 79% increase over the

joint assets the JSF will replace) the JSF is an expensive asset to operate in support of lower scale operations.

Figure 4: F-35 O&S Comparison to Legacy Aircraft



The current state of the Marine Corps' Hornet fleet is a prime example of what can happen when the Marine Corps depends on high performance aviation assets to perform a mission that a simpler, cheaper asset could perform. The Air Force is currently evaluating several Commercial Off-The-Shelf (COTS) low-cost, light attack aircraft as part of its OA-X concept. The requirements for OA-X contenders are "a commercial-off-the shelf aircraft with a turboprop powerplant--easier to maintain and more fuel-efficient than a jet engine, thus much cheaper to operate--and big guns, along with modern precision munitions, sensors and communications suites."[36] Two COTS options that the Air Force is currently evaluating are the Embraer EMB 314 Super Tucano and the Beechcraft AT-6C Wolverine. The Beechcraft T-6B Texan is an aircraft currently in the Navy/Marine Corps and Air Force inventories with active production lines in the United States. The Embraer EMB 314 Super Tucano is not currently in production in the United States, in accordance with the Buy American Act, Embraer would have to build a production facility in the United States to receive a government contract. Therefore,

rather than present the details of both aircraft to argue the merits of a light attack aircraft, the specifications of the AT-6C will be used to provide cost and performance comparison to current Marine Corps aircraft.

The AT-6C Wolverine is a single engine, 1,600 shaft horse power (SHP) turboprop with a top speed of .67 Mach (316 KIAS) that "is purpose-built for light attack, armed reconnaissance and counterinsurgency missions."[37] Within the Marine Corps functions of aviation the Wolverine is equipped to execute Close Air Support (CAS), Deep Air Support (DAS), Visual and Multisensor Imagery Reconnaissance, Battlefield Illumination, Active Air Defense, and Air Control (FAC[A], TAC[A]). The Wolverine executes these functions using a state of the art avionics suite that features a full Flight Management System (FMS) with Heads Up Display (HUD), GPS Navigation, Digital Terrain Elevation Data (DTED), and Precision GPS Approach (WAAS LPV) capability.[38] Included with the Wolverine's OTS package is datalink compatibility, digital CAS, and Full-Motion Video (FMV) all of which are staples of the modern battlefield.[39]

IV. Cost

As described in the previous fictitious account of Operation WOLVERINE, the AT-6C augments and does not replace the F-35B within the Marine Corps' fixed-wing aviation inventory. In determining the correct ratio of AT-6Cs to F-35Bs, the simplest answer is to replace the Marine Corps' current CAS platform, the AV-8B Harrier, with an equal number of AT-6Cs. The past ratio of roughly one AV-8B to three F/A-18s has served the Marine Corps well and will be used to analyze the costs associated with the acquisition and sustainment of the AT-6C.

In terms of cost, the AT-6C would yield significant cost savings in flyaway cost, Operations and Support (O&S), training pipeline, and preservation of F-35B service-life. The AT-6C is estimated at a flyaway cost of $16 million per aircraft for the first 24 aircraft produced. As orders are increased and the assembly line reaches full rate production this cost will likely decrease. Even at the initial flyaway cost of $16 million the Marine Corps could purchase 8.75 AT-6Cs for the price of a single F-35B. If the Marine Corps were to replace all five of its AV-8B squadrons, 80 aircraft total, with the AT-6 it could do so for a flyaway cost of $1.28 billion. Contrast this with the $11.2 billion price tag of replacing those same AV-8B squadrons with F-35Bs. In flyaway costs alone, the acquisition of the AT-6C would yield a cost savings of $9.92 billion.

Since the service-life of the F-35B is projected at 32 years, O&S costs will be the primary concern for the Marine Corps. The F-35B O&S Cost Per Flight Hour (CPFH) of $38,400 ($38,400 is the 2012 affordability target for the F-35B; the actual O&S CPFH is unpublished but based on the 7 March 2018 statements by the Chair of the House Armed Services Committee, Representative Mike Turner, the actual F-35 O&S CPFH is 33% over the target) is based on an annual usage rate of 302 hours per aircraft.[4041] For the sake of dollar-to-dollar comparison the same annual usage rate of 302 hours will be used for the AT-6C. The 80 AV-8Bs, if replaced by F-35Bs would cost over $927.7 million annually in O&S costs. This annual cost represents a sizeable portion of the Marine Corps' FY18 $25.5 billion total budget.[42] Compare this to the estimated $3,500 CPFH of the AT-6C for a total annual cost of $84.5 million, just over 9% of the annual F-35B O&S cost.[43]

In addition to the direct acquisition and sustainment cost savings that the AT-6C would produce, it could yield further savings in the training pipeline. The current pipeline begins with a

short, six-week course at Naval Air Station (NAS) Pensacola, FL after which Student Naval Aviators (SNA) receive orders to either NAS Whiting Field, FL or NAS Corpus Christi, TX to undergo primary flight training in the T-6B Texan. Primary flight training can take anywhere from six to twelve months depending on a myriad of factors. Each SNA's performance in primary flight training plays a role in their selection to an advanced training pipeline of either jet, multiengine, helicopter, or tiltrotor. The current jet advanced training pipeline utilizes the T-45 Goshawk to teach a lengthy syllabus that prepares SNAs to fly the F/A-18, AV-8B, or F-35B. In recent years this pipeline has become extremely lengthy due to training delays caused by issues with the T-45's On-Board Oxygen Generation System (OBOGS) system. When SNAs eventually complete the advanced training pipeline they are given orders to a Fleet Replacement Squadron (FRS) where they will undergo training to become qualified in either the F/A-18, AV-8B, or the F-35B.

By eliminating the AV-8B FRS, VMAT-203, at Marine Corps Air Station Cherry Point, NC and instead conducting the AT-6C pipeline as follow-on training at both NAS Whiting Field and NAS Corpus Christi the Marine Corps could streamline and shorten what is currently an overly lengthy pipeline. Because the AT-6C Wolverine is the same basic aircraft as the T-6B Texan, SNAs would not have to learn a completely new aircraft as they do now. This model already exists in the Air Force's T-6B follow-on syllabus that they conduct for Air Force students following the standard Navy primary syllabus. This syllabus could be built upon to fully qualify a combat ready AT-6C pilot in as little as six months. Because the infrastructure already exists to support T-6Bs at both NAS Whiting Field and NAS Corpus Christi all that would be required is the acquisition of several AT-6Cs. By conducting follow-on AT-6C training at the SNA's primary training location, the Marine Corps could achieve cost savings

through a greatly shortened pipeline that does not require multiple Permanent Change of Stations (PCS) and by reducing personnel through the elimination of VMAT-203.

Another, potentially hidden, source of cost savings that could be achieved with the AT-6C is the preservation of the service life of the Marine Corps' F-35B fleet. Instead of using more expensive assets in long duration small wars and conflicts, the AT-6C would be utilized. When the Marine Corps is involved in small scale wars and conflicts F-35B pilots could deploy in AT-6Cs. Since all F-35B pilots would have previously flown the T-6B Texan the aircraft would not be unfamiliar to them. Instead of working up for a deployment in their F-35Bs they would conduct their work ups at either NAS Whiting Field or NAS Corpus Christi in the AT-6C. For this to work, additional AT-6Cs would have to be acquired and transferred to either the Maritime Prepositioning Force or strategic land-based locations so that Marine Corps F-35B squadrons could fall in on the AT-6Cs that they would be flying while deployed. In doing so the Marine Corps would ensure that it is preserving its high dollar F-35Bs for major conflicts that require its 5th generation capabilities. This would yield cost savings in the significant CPFH difference between the F-35B and the AT-6C. Additionally the Marine Corps would alleviate flying excess F-35B flight hours which would cause the F-35B fleet to reach its service life sooner than the projected 32 years.

V. Operations and Capability

Clearly the AT-6C would yield cost savings over the F-35B, but does the AT-6C fit into the 21st Century force as outlined in the Marine Operating Concept (MOC)? The MOC outlines five critical tasks: "integrate the Naval force to fight at and from the sea, evolve the MAGTF, operate with resilience in a contested-network environment, enhance our ability to

maneuver, and exploit the competence of the individual Marine."[44] This next section will argue that the AT-6C fits within the framework of the MOC and will fill existing capability gaps that currently exist in the envisioned 21st Century force.

The first critical task of the MOC regarding integrating and fighting from the sea will undoubtedly cause any opposed to the AT-6C to make the obvious argument that the AT-6C is not capable of launching or recovering from either an LHD/LHA or an aircraft carrier. My response would be, "Do we need it to have this capability?" The Marine Corps will still have 14 F-35B squadrons if it replaced its five AV-8B squadrons with AT-6Cs. These 14 squadrons can easily fill the Marine Corps' Marine Expeditionary Unit (MEU) and Carrier Strike Group (CSG) responsibilities. In fact, the Marine Corps has been increasingly relying on forward deployed, land based Special Purpose MAGTFs (SP-MAGTF) to augment its forces afloat the MEUs. The AT-6C could in this way participate with the integration of the Naval force while using a low-cost asset to do so. While operating from strategic locations and EABs the AT-6C can fulfill the sub-tasks of the MOC's first critical task by playing a part in control of key waterways, creating lodgments from MFP squadrons, and play a part in defending those EABs and projecting power from them into the littorals. As a forward deployed asset, the AT-6C would also serve to enhance the Marine Corps' ability to work with partner nations, which is a sub-task mentioned in the MOC, many of which do not operate 5th generation or even 4th generation aircraft. Foreign Military Sales (FMS) of AT-6Cs to partner nations that can't afford more costly platforms builds partner capacity without the implication that they are being sold an asset that the United States is not willing to use itself.

The MOC's second critical task, "Evolve the MAGTF," makes the point that "The MAGTF of the future will most likely be composed of some combination of forward-deployed

forces, rapidly deployable forces, and land and maritime prepositioning forces."[45] This allows space for assets like the AT-6C that are not based on Navy ships but that could be forward deployed to strategic locations or onboard MPF squadrons. When forward deployed along with the Marine Corps' MV-22 Ospreys, the AT-6C would help evolve the MAGTF to fill a currently vacant capability gap. Before the introduction of the MV-22, its predecessor the CH-46 conducted assault support missions and was generally escorted by AH-1 Cobras and UH-1 Hueys. This is no longer possible because the MV-22 outpaces and outranges both AH-1s and UH-1s. F-35Bs can fly slow enough to escort them but can't provide the required close in support at a Landing Zone (LZ) or the required time on station. The AT-6C can easily maintain a slow enough airspeed to escort MV-22s while also having enough range and endurance to stay on station above an LZ and provide close in support before exfiltrating with the MV-22s. The ability to orbit in a 1.5-mile radius circle above an LZ allows the AT-6C to provide better and more timely support to Marines on the ground than an F-35B can from 18,000 feet and 10 miles away. This contribution alone to the evolution of the MAGTF makes the AT-6C worthy of consideration.

The final sub-task in the MOC regarding the critical task of "Evolve the MAGTF" deals with conducting distributed operations. As described in the fictional Operation WOLVERINE the AT-6C very much fits into this construct. While it does not have the Short Take-Off and Vertical Landing (STOVL) capability of the F-35B it can land on unimproved strips and roads to refuel and rearm at M-FARPs. The F-35B STOVL capability certainly provides a critical capability in allowing it to takeoff and land from LHDs and LHAs but risking one by using this capability to land at an unimproved M-FARP seems a leap too far. As the Marine Corps has already demonstrated, the F-35B is prone to FOD damage when operating from austere airfields.

The relatively low cost of the AT-6C and the training of its crew make it a much more suitable asset for this kind of risk.

The MOC's third critical task, "operate with resilience in a contested-network environment", emphasizes the need to both take advantage of advanced networking technology and to be prepared to operate without it when adversaries have the capability to contest our networks. The AT-6C is equipped with Enhanced Position Location Reporting System (EPLRS) as well as LINK-16 and is capable of digitally aided CAS. These capabilities enable it to feed information to and utilize the Marine Corps' Command and Control (C2) networks. More importantly the AT-6C can function without them. The General Accounting Office determined that "While conducting bombing operations from high altitudes is much safer for pilots and aircraft, it also becomes more difficult to properly identify and distinguish certain targets, particularly when the enemy employs denial and deception tactics."[46] The AT-6C can fly low enough and slow enough to visually confirm friendly and enemy locations. This is what truly separates the AT-6C as a dedicated CAS platform from the multipurpose F-35B which is reliant on sensors and networks.

The MOC's fourth critical task involves enhancing the Marine Corps' ability to maneuver in urban and complex terrain with the flexibility and ability to distribute or concentrate forces as needed. The AT-6C with its diverse array of conventional, guided, and low collateral damage ordnance can provide effective support to ground Marines and facilitate their maneuver in urban and complex environments. Its ability to carry 14 APKWS, low collateral damage laser rockets gives it the ability to conduct multiple precision strikes in challenging urban environments while minimizing the risk of civilian and friendly casualties. Inherent to maneuver is the ability to sustain the force through the MOC's concept of expeditionary logistics. Besides

the inherent risk to landing an F-35B at a M-FARP there are serious logistical challenges presented by the F-35B's 46% greater fuel requirement than the AV-8B. The AT-6C on the other hand has a 71% less fuel requirement than the AV-8B and its lighter weight and smaller ordnance make it the clear choice for expeditionary logistical support.

The fifth and final critical task outlined in the MOC is "Exploit the competence of the individual Marine." This task and its subtasks address the Marine Corps' need to develop and retain competent and proficient Marines able to operate in the complex terrain of modern conflicts. Marine Corps and military aviation in general has recently experienced retention issues stemming from a hiring wave in the commercial airlines and aircraft readiness issues along with several other factors contributing to a lack of job satisfaction. The AT-6C certainly can't solve these issues but it can provide a capable, enjoyable to fly airframe that shortens the training pipeline and keeps Marine pilots engaged by allowing them to operate closer to the Marines that they support.

VI. Conclusion

The Marine Corps should rethink its aviation plan to operate the F-35 as its only fixed wing strike aircraft. The F-35B was built as a jack of all trades which has resulted in it not being as capable in several areas as previous 4th Generation assets. The decision to declare IOC and field the F-35B prior to IOT&E has resulted in an operational fighter that is expensive, unreliable, requires significant contractor support to operate, has limited CAS capability, will not reach its intended 32-year service life without significant structural modification, and has an untested egress system that poses a risk to F-35 pilots.

For a joint program envisioned to realize cost savings through aircraft commonality across the services, the less than 35% commonality between the F-35B and its two other variants has not met the envisioned cost savings. As the data shows, the F-35 is an overly expensive asset to sustain for the duration of its 32-year service life. GAO reports bring into doubt the ability of the military to obtain the quantities of F-35s that is has planned for due to competing high dollar programs. Additionally, cracks in the F-35's titanium bulkhead will continue to delay production, further increasing costs, while also shortening the projected 32-year service life of every F-35 produced. A capable yet cheap asset like the AT-6C Wolverine can help alleviate some of the budgetary concerns of the F-35 program. It can do so while providing an asset that can meet many of the Marine Corps' requirements of a CAS platform while filling current capability gaps that the F-35 is unable to fill.

Many of the F-35's operational deficiencies lie in its Offensive Air Support functions. Several limitations that Director Gilmore specifically brought to light in his testimony were "digital communications deficiencies, lack of infrared pointer capability, limited ability to detect infrared pointer indications by a controller, inability to confirm coordinates loaded to GPS-aided weapons" and no night vision capability from the helmet."[47] Additionally, while operating with Block 2B software the F-35 can only carry two AIM-120 Advanced Medium-Range Air-to-Air Missiles (AMRAAM) and two bombs with no gun. These significant limitations in Offensive Air Support present a significant risk to the Marine on the ground which depends on the aviation support of the MAGTF to overcome the inherent limitations of a lightweight, expeditionary force. With a diverse loadout of ordnance and greater on station time than the F-35 the AT-6C can provide the close in CAS support that the F-35 is unable to. When coupled with promising new technologies such as the Defense Advanced Research Projects Agency's (DARPA) Aircrew

Labor In-Cockpit Automation System (ALIAS), the AT-6C bridges the gap between Unmanned Aircraft Systems (UAS) and manned aircraft.[48] The future flexibility to fly the AT-6C either manned or unmanned further enhances its Operational Air Support capabilities and the argument for its procurement.

The distributed operations that the MOC and 2017 Marine Aviation Plan envision are not viable with the risk to F-35Bs from FOD and the large amount of contractor support that is required. The AT-6C on the other hand would pose much less risk while operating from M-FARPs. If damage does occur to an AT-6C it is much simpler to repair and if the circumstances dictate the loss or abandonment of a damaged AT-6C would be more feasible than losing an F-35. Additionally, the much smaller fuel requirements of the AT-6C make it more feasible to support from an M-FARP in support of the Marine Corps' vision of distributed operations.

The Marine Corps has never relied on a single fighter asset before. Historically a diverse mix of fixed wing platforms has minimized the risk of a single platform in the inventory experiencing maintenance issues or operational issues resulting from changing enemy technology and tactics. Despite the weaknesses and limitations of the F-35 the Marine Corps is at this point committed to acquiring the F-35. While the program can't be cancelled, its risks can be mitigated by the acquisition of a fixed wing light attack aircraft such as the AT-6C. The Air Force has recently cancelled its planned combat demonstration of several light attack variants in favor of a program of record that will facilitate rapid acquisition.[49] The Marine Corps should join the Air Force in this effort and immediately begin the necessary planning and preparations to facilitate a rapid acquisition.

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