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VMLO: THE STRATEGIC, OPERATIONAL AND TACTICAL IMPERATIVE FOR A LIGHT OBSERVATION SQUADRON WITHIN THE USMC

by

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June 2012

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Submitted in partial fulfillment of the
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LIST OF ACRONYMS AND ABBREVIATIONS

A2/AD	Anti-Access and Area Denial
AAA	Anti-Aircraft Artillery
AAV	Amphibious Assault Vehicle
ACC	Air Combat Command
ACE	Air Combat Element
ACO	Airspace Control Order
AFRICOM	Africa Command
AFSOC	Air Force Special Operations Command
AGL	Above Ground Level
AGM	Air to Ground Missile
AMC	Air Mobility Command
ANAAC	Afghan National Army Air Corps
AO	Area of Operations
AOR	Area of Responsibility
ASBM	Anti-Surface Ballistic Missile
ASRR	Airfield Suitability and Restrictions Report
ATO	Air Tasking Order
ATP	Advanced Targeting Pod
BLOS	Beyond Line of Sight
BPC	Building Partner Capacity
C2	Command and Control
CAOC	Combined Air & Space Operations Center
CAS	Close Air Support
CASEVAC	Casualty Evacuation
CBE	Capabilities Based field Experiment
CEP	Circular Error Probable
CENTCOM	Central Command
CIA	Central Intelligence Agency
CLG	Combat Logistics Group
CMC	Commandant of the Marine Corps
COCOM	Combatant Commander
COIN	Counterinsurgency
CONOP	Concept of Operations
COTS	Commercial Off The Shelf
CRFI	Capability Request for Information
CSAR	Combat Search and Rescue
CSG	Carrier Strike Group

DCA	Deputy Commandant of Aviation
DF	Dong Feung
DO	Distributed Operations
DoD	Department of Defense
ECO	Enhanced Company Operations
EEZ	Economic Exclusion Zone
EFV	Expeditionary Fighting Vehicle
ESG	Expeditionary Strike Group
EO	Electro-Optical
FARP	Forward Area Arming and Re-Fueling Point
FAC(A)	Forward Air Controller, Airborne
FID	Foreign Internal Defense
FMC	Full Mission Capable
FOB	Forward Operating Base
FOD	Foreign Object Damage
FSC	Fire Support Coordinator
FSO	Fire Support Officer
GCAS	Ground Alert CAS
GCE	Ground Combat Element
GPF	General Purpose Force
HQ	Headquarters
HQMC	Headquarters Marine Corps
IADS	Integrated Air Defense System
IED	Improvised Explosive Device
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IR	Infrared
ISAF	International Security and Assistance Force
ISR	Intelligence, Surveillance, and Reconnaissance
IW	Irregular Warfare
JCAS	Joint Publication 3-09.3, Close Air Support
JEFX	Joint Expeditionary Forces Experiment
JOC	Joint Operating Concept
JP	Joint Publication
JSF	Joint Strike Fighter
JTAC	Joint Terminal Attack Controller

KIAS	Knots Indicated Airspeed
KTAS	Knots True Airspeed
LAA	Light Attack Aircraft
LAAR	Light Attack Armed Reconnaissance
LAS	Light Air Support
LD	Laser Designator
LRF	Laser Range Finder
LOC	Line Of Communication
LOS	Line of Sight
LSS	Laser Spot Search
LST	Laser Spot Track
MANPADS	Man Portable Air Defense Systems
MAGTF	Marine Air Ground Task Force
MARSOC	Marine Special Operations Command
MEU	Marine Expeditionary Unit
MILF	Moro Islamic Liberation Front
MISO	Military Information Support Operations (formerly known as PSYOP)
MOB	Main Operating Base
MPH	Miles per Hour
MSL	Mean Sea Level
MWSS	Marine Wing Support Squadron
NA	Naval Aviator
NCTC	National Counterterrorism Center
NFO	Naval Flight Officer
NPS	Naval Postgraduate School
NVG	Night Vision Goggles
OA-X	Observation/Attack Aircraft
ODA	Operational Detachment-Alpha
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OPTEMPO	Operations Tempo
OTH	Over The Horizon
PACOM	Pacific Command
PLAN	People’s Liberation Army’s Navy
PN	Partner Nation
PPF	Peace time Planning Factor
PRC	People’s Republic of China
PSYOP	Psychological Operations (now known as MISO)

QDR	Quadrennial Defense Review
QLR	Quick Look Report
QRF	Quick Reaction Force
ROVER	Remote Off-Board Video Enhanced Receiver
RPA	Remotely Piloted Aircraft
RPG	Rocket-Propelled Grenade
RTB	Return to Base
RVN	Republic of Vietnam (AKA South Vietnam)
SATCOM	Satellite Communications
SDB	Small Diameter Bomb
SEAL	Sea, Air, Land
SECDEF	Secretary of Defense
SLOC	Sea Line Of Communication
SOF	Special Operations Forces
SOAR	Special Operations Aviation Regiment
SOCOM	Special Operations Command
SOS	Special Operations Squadron
SOW	Special Operations Wing
TIC	Troops in Contact
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Aerial Vehicle
UHF	Ultra-High Frequency
USASOC	United States Army Special Operations Command
USAF	United States Air Force
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VMLO	Fixed Wing Light Observation Squadron
WOC	Wing Operations Center
WSO	Weapons System Officer
XCAS	Airborne On-Call CAS

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I. INTRODUCTION

During the Vietnam War, the U.S. military depended heavily on a large number of different aircraft to support distributed forces across the length and width of the Area Of Operations (AOR). The military depended on these aircraft to provide support across a range of missions that required aircraft with varying lift and performance capabilities. Their capabilities and sophistication ranged from a two-seat piston powered airplane capable of operating only in day Visual Meteorological Conditions (VMC) in a low to medium threat environment to the latest generation of all weather fighter/attack jets delivering the latest iteration of munitions against one of the most sophisticated Integrated Air Defense Systems (IADS) existing at the time. Since Vietnam, the focus of the aviation elements of the U.S. military have been focused on the development and acquisition of aircraft capable of penetrating and defeating the latest generations of IADS to achieve operational and strategic objectives. Following a decade of combat focused on a Counterinsurgency (COIN) strategy in Iraq and Afghanistan, considerable discussion and research has occurred advocating the development and acquisition of a turbine powered Light Attack Armed Reconnaissance (LAAR) aircraft in support of a COIN strategy.[1]

The concept of an organization composed of Light Air Support (LAS) aircraft combined with an LAAR capability has generated a discussion about the use of low cost, comparatively low technology aircraft in support of the Air Force Special Operations Command (AFSOC) Foreign Internal Defense (FID) mission. FID advocates a partnership with allied nations in the continuing battle against counterinsurgency elements.[2] Generally, the discussion has not included the potential benefits of developing an existing commercial off-the-shelf system (COTS) to meet the existing light mobility, Persistent Intelligence Surveillance Reconnaissance (PISR) and observation gap.

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[1] Global Security, "Light Mobility Aircraft (LIMA)," July 7, 2011, http://www.globalsecurity.org/military/systems/aircraft/lima.htm.

[2] Robert C. Owen and Karl P. Mueller, "Airlift Capabilities for Future U.S. Counterinsurgency Operations," Project Air Force Report (Santa Monica: RAND, 2007).

The wars in Iraq and Afghanistan are coming to end. With the end of these conflicts, the focus of operations moves from protracted land battles in the Middle East to the growing potential threat from China in the Pacific Command (PACOM) AOR and to strategic Sea Lines of Communications (SLOCs). According to the new strategic vision for the Department of Defense (DoD), the administration wishes to focus military capability in the Pacific region in general and the South China Sea, specifically.[3] At the same time the military is refocusing its efforts in the PACOM AOR it is also facing a decade of fiscal austerity as the financial priorities of the nation shift from war expenditures to domestic financial expectations. This new reality, with new constraints in acquisitions and operations, offers the Marines the opportunity discuss what a fixed wing light observation squadron (VMLO) built around low cost, comparatively low technology aircraft can offer to a service that is only 7.8 percent of the DoD budget, which is poised to be positioned between the traditionally larger land army General Purpose Forces (GPF) and the Special Operating Forces (SOF).[4]

A. STRATEGIC CONTEXT

Within the next decade, the DoD is facing a reduction in spending from the current fiscal year to the levels of funding in 2008. This is a reduction of $487 billion over the next 10 years. Following the failure of the Congressional Super Committee, the DoD faces a further reduction in funding of $500 billion to $600 billion over the same decade, which amounts to almost $1 trillion in reduced spending for the DoD.[5] For the Army and the Marines, it means that the future holds a reduction in forces of 10 to 15 percent and renewed scrutiny of current and future war-fighting capabilities. For the Marines specifically, it means they will experience a reduction in their force from its current levels of 202,000 back to its pre-war posture of 175,000 personnel.

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[3] Todd Harrison, "Defense Cuts Could Only Be the Beginning," *Cable News Network*, January 9, 2012, http://articles.cnn.com/2012-01-09/opinion/opinion_harrison-defense-plan_1_defense-cuts-defense-budget-american-military-strategy?_s=PM:OPINION.

[4] Commandant of the Marine Corps, *Role of the United States Marines Corps* (Washington, DC: HQMC, September 2011).

[5] Harrison, "Defense Cuts Could Only Be the Beginning."

In accordance with these fiscal realities, it was necessary for the Pentagon to reassess its ability to fight two wars across different fronts simultaneously. The new model calls for the ability to fight one major war and the ability to spoil an adversary's ability to start a second front. It also calls for a reduced permanent military presence globally. Most importantly, it called for a change in the focus of the U.S. military. Instead of focusing on the Middle East, the Pentagon has announced a greater focus on the Pacific Ocean, Asia, and specifically, China. Since the 1990s, China has embarked on an extensive military modernization program focused on reducing the U.S. influence in the western Pacific.[6] The United States also accepts the premise that by abandoning the ability to fight two wars, it will reduce the amount of ground forces while relying more on air and naval forces.

1. The China Sea and Its Strategic Importance

One new area of strategic focus consists of the South China Sea and the East China Sea. It has a total of 2,150,000 square miles of space dominated by 30,000 islands and strategic waters that form the main waterborne access points to the Pacific and Indian Oceans, as well as shipping routes to Japanese and north pacific ports.[7] The South China Sea, with a total of 1,400,000 square miles, plays the greatest role of strategic importance to the People's Republic of China (PRC) and its armed forces. The PRC has attempted to isolate the South China Sea, as well as its oil and natural gas resources and its international shipping routes, as territorial waters in violation of conventional international agreements. It is the position of the PRC that since the United States has no territorial claims to the South China Sea, it has no right to free and unchallenged passage in the same waters. The PRC has also used longstanding disputes with Taiwan, Japan, South Korea, and the Philippines as provocation to threaten to use anti-access and area denial operations in the South China Sea.[8]

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[6] Global Security, "People's Liberation Navy-Doctrine Development," November 2011, http://www.globalsecurity.org/military/world/china/plan-doctrine-offshore.htm.

[7] Encyclopedia Brittanica Online, "South China Sea," (n.d.), http://www.britannica.com/EBchecked/topic/556146/South-China-Sea.

[8] Michael J. Cole, "South China Sea all PRC's, Op-Ed Claims," *Taipei Times*, November 29, 2011, http://www.taipeitimes.com/News/front/print/2011/11/29/2003519472.

The South China Sea includes the strategic Strait of Malacca that is an essential SLOC for the free flow of commerce and information in the region. It is strategically important to the United States and its allies as a route to reduce passage time to the Persian Gulf and its essential natural resources. The ability of China to reduce access or close these strategic waterways through passive aggressive military basing and political posturing or physical military intervention would have serious economical and political impact on the international community.

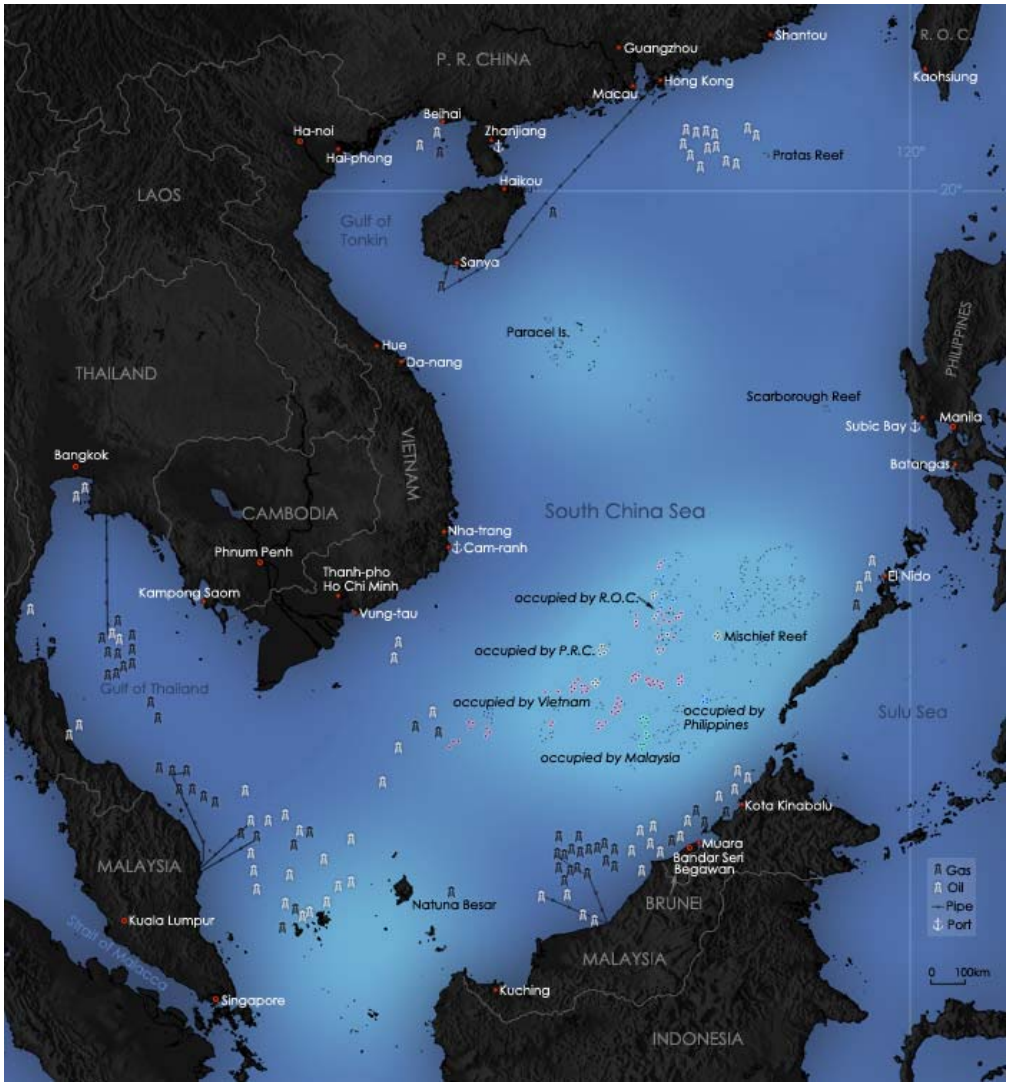

Figure 1. South China Sea[9]

[9] Wikipedia, "South China Sea," March 2, 2012, http://en.wikipedia.org/wiki/File:South_China_Sea.jpg.

The South China Sea presents the U.S. military with a series of new challenges it has not faced in the last decade of land warfare in the Middle East. With a size of over 1,400,000 square miles, it would seem that a large conventional surface and amphibious force would have the necessary space to conduct effective sea denial operations against an emerging blue water threat, such as the People's Liberation Army Navy (PLAN). However, the proliferation of Anti-Ship Ballistic Missile (ASBM) technology has greatly reduced the size of the South China Sea and the U.S. Navy's, and by association the Marines', amphibious ability to conduct forcible entry operations by either an Expeditionary Strike Group (ESG) or a Carrier Strike Group (CSG).

The PRC has adopted a strategy of offshore defense to protect its claim to territorial waters in the South China Sea. It has three essential missions. The first is to keep the enemy within limits and resist invasion from the sea. The second is to protect the nation's territorial sovereignty and the third is to safeguard the motherland's unity and maritime rights. It aims to achieve these missions with the doctrinally recognized first and second island chains by creating an Economic Exclusions Zone (EEZ) out to 200 nm.[10] Together, the two chains have encompassed maritime areas to an estimated distance of over 1,800 nm to include many of the essential SLOCs in East Asia.[11] With the introduction and proliferation of ASBM technology, combined with an emerging blue water navy and Nuclear Fast Attack Submarines (SSN) Nuclear Ballistic Submarine (SSBN) capability, the PRC represents a credible threat to area and access denial operations for the international community and the U.S. Navy and Marines, in particular. The development and deployment of the Dong Feng-21 (DF-21) "Carrier Killer" missile could allow the PRC sea denial or access denial success in the limited space of the South China Sea. With a range in excess of 1,500 miles, it represents an ability to remove the U.S. advantage of a carrier-borne strike force and the ability to close with and engage the amphibious assault force. It also speaks to China's ability to threaten forward deployed forces in locations, such as Okinawa, mainland Japan and South Korea.

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[10] Global Security, "People's Liberation Navy-Doctrine Development."

[11] Global Security, "DF-21," July 24, 2011, http://www.globalsecurity.org/wmd/world/china/df-21.htm.

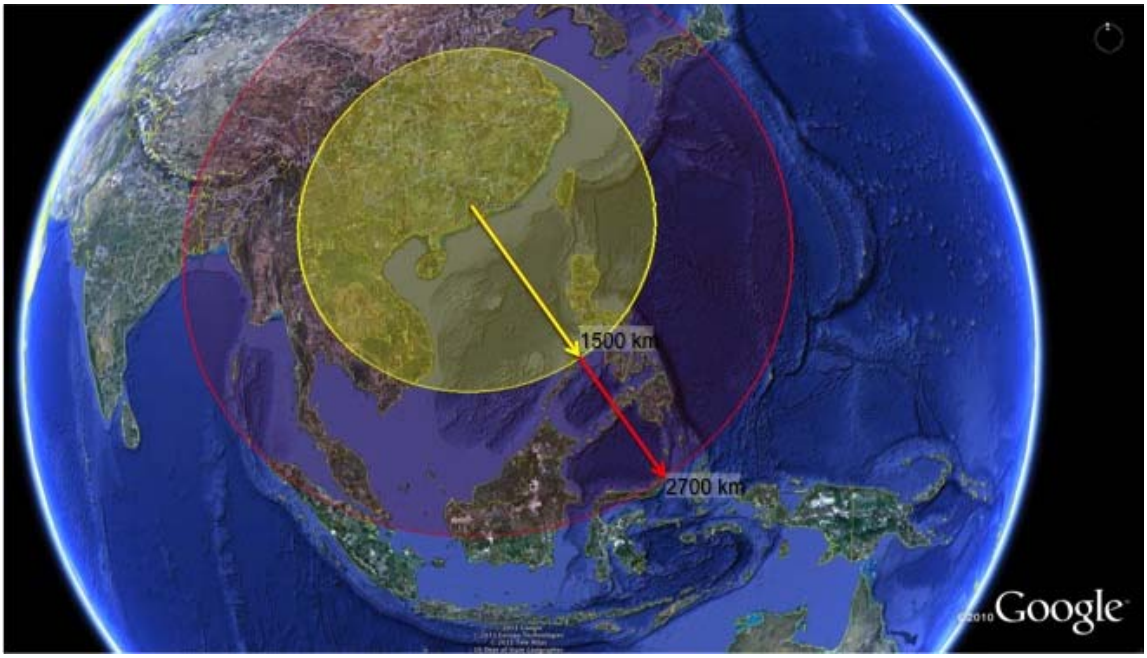

Figure 2. DF-21D Ranges[12]

The loss of a Nuclear Powered Carrier (CVN) and its associated airwing or an Amphibious Assault Ship (multi-purpose) LHD with its Marine Expeditionary Unit (MEU) components due to PRC use of the DF-21 ASBM would be a significant strategic defeat for U.S. naval forces in the region. The use of the DF-21, combined with the use of intra-theater ballistic missiles against aircraft, surface units and their associated logistical support bases, could close the South China Sea that would allow the PRC to control a major portion of the SLOCs in East Asia.

B. THE MARINES

In September 2011, the Commandant of the Marine Corps (CMC) delivered a paper to the Secretary of Defense (SECDEF) outlining the future role of the Marines in light of the new fiscal reality within the DoD. It described the future of the Marines with

[12] Google, 2010, http://www.google.com/imgres?imgurl=http://blog.usni.org/wp-content/uploads/2011/07/DF-21D_ranges.jpg&imgrefurl=http://blog.usni.org/2011/07/18/re-enter-the-df-21d-asbm/&h=374&w=658&sz=94&tbnid=dS-yJ0q6LYihOM:&tbnh=69&tbnw=122&prev=/search%3Fq%3DDF-21%2BRanges%26tbm%3Disch%26tbo%3Du&zoom=1&q=DF-21+Ranges&docid=IpH2Z2pO9ppJIM&sa=X&ei=zcChT_mHAoGoiQK5heiaBw&ved=0CHYQ9QEwCA&dur=476.

the vision that the United States is a maritime nation that relies heavily on the maritime commons for the exchange of commerce and ideas.[13] It recognizes the importance of a naval force as part of the solution set to meeting and fulfilling the global maritime responsibilities. Within the paper, the CMC describes the need for an amphibious force able to move seamlessly between the three domains of air, land and sea through operational reach and agility. This movement would allow national leaders to "buy time" and "decision space" during an emerging crisis halfway across the globe. The Marines are currently the only task-organized service capable of supporting modular and scalable operations of an expeditionary nature.

Seventy-five percent of the planet's entire population lives within 200 miles of a coast. The ability to control the littoral environment in future conflicts takes greater importance when taken in this context and the fact that 95 percent of commercial cargo to support those people living near the coast, travels through the littoral battlespace.[14] It will be essential for the Marines to support small-task organized operations in such a large area without the constant presence of the ESG and CSG that has been the signature of major naval operations in the Pacific.

1. The Reality for the Marines

Following a decade of warfare in Iraq and Afghanistan, the Marines face a difficult post-war period of refocusing themselves on the expeditionary nature of amphibious operations. While continuing to rely on Marine Air Ground Task Force (MAGTF) resources that have been heavily engaged in the Middle East, they have experienced the cancellation of the next generation of the amphibious assault vehicle, the EFV, as well as continued acquisition issues with the F-35B. Continued delays have also occurred with the F-35B impact legacy platforms, such as the AV-8B Harrier, F/A-18C/D Hornets and the EA-6B Prowler. The Aviation Combat Element (ACE) has also had to contend with simultaneous integration of the MV-22 Osprey and the KC-130J Hercules.

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[13] Commandant of the Marine Corps, *Role of the United States Marines Corps*.

[14] Commandant of the Marine Corps (CMC), IDGA Amphibious Ops Summit, July 2011.

Cancellation of the Expeditionary Fighting Vehicle (EFV) means that the Marines will continue to use the current Amphibious Assault Vehicle (AAV) for their forcible entry missions. The Over The Horizon (OTH) assault capability that the EFV was to provide will now fall more heavily on the Osprey assault support aircraft. The F-35B was placed on probation by SECDEF Robert Gates following major delays in the flight testing program. While the program has recently experienced increases in flight testing, the aircraft is still not scheduled for IOC until 2015.[15] The entire Joint Strike Fighter (JSF) program has experienced a doubling in the cost per model because of the delays in development.

The Marines expect to meet future operations, and shortfalls, with Distributed Operations (DO) and Enhanced Company Operations (ECO). The increased Area of Operations (AoR) in the South China Sea seems to maximize the offensive potential of the Marines and does increase the number of small units to be supported in accordance with the six functions of Marine Aviation. In other words, aircraft will have to fly more sorties to meet increased demand for the ACE, which will impact aircraft and organizations that experienced flight operations at three and four times their Peace Time Planning Factors (PPF) during the last decade of combat.[16]

Increased flight operations and support requirements may lead to an even more rapid degradation in aircraft availability and capability. As the Prowler and Hornet communities continue to age, their performance envelope has changed. Aircraft now have limitations on airspeeds and g-loads to extend their useful life cycle.

The Headquarters Marine Corps (HQMC) office of the Deputy Commandant of Aviation (DCA) has stated that the Marines are experiencing a gap in their ability to provide persistent ISR, CAS and FAC(A) support to their general purpose forces.[17] The major Component Commanders (COCOMS) have listed the lack of light mobility and

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[15] Bob Cox, "Is the F-35 Flying High or Stuttering?," *Star-Telegram*, January 21, 2012, http://www.star-telegram.com/2012/01/21/3676170/is-f-35-program-flying-high-or.html.

[16] Marine Corps Center for Lessons Learned (MCCLL), "VMFA(AW) Operations VMFA(AW) 533 Quick Look Report," August 2006.

[17] BGen Gary Thomas, USMC, phone conversation with the author, August 9, 2011.

ISR platforms at the top of their integrated priority lists.[18] With the introduction of Marine Special Operations Command (MARSOC), which could be a major player in the new national strategy announced by the Pentagon, the Marines also have had to answer the question of how to support MARSOC with MAGTF elements.

The current solution to the Marines persistent ISR, CAS and FAC(A) gap is to increase the number of Unmanned Aerial Systems (UAS) within the Marine Unmanned Aerial Vehicle Squadron (VMU). An increased number of Unmanned Aerial Vehicle (UAVs) seemingly increases the battlefield visibility for the supported commander. Like the KC-130J, UAV operations require air superiority to be effective. UAVs are vulnerable to the satellite communications (SATCOM) disruptions, active Anti-Air Warfare (AAW) measures, jamming and weather effects.

The Marines also plan to purchase additional modular gunships systems for the KC-130J along with the introduction and integration of the F-35B.[19] For the KC-130J to be an effective CAS platform, the Marines must have air superiority. China would be able to contest Marine air superiority in a manner that has not been experienced in Iraq and Afghanistan.

Each of these systems represents a large financial obligation from the Marines to allow them access to the battlefield of tomorrow across the full spectrum of warfare. The increased use of UAVs reduces human exposure to enemy fire and provides the Marines additional sensors to conduct multi-sensor based ISR. The Harvest Hawk modular gunship enables a current platform to conduct CAS to fill the CAS gap and act as a Tactical Air Controller (Airborne), (TAC)(A) to direct aviation fires.[20] The F-35B should allow the ACE to penetrate the latest iteration of IADS in a worst case scenario.

Each of the previous systems is a force multiplier in the MAGTF inventory. Anytime that the Marines are able to leverage existing programs with future capability is a win for a service that receives a small percentage of the overall DoD budget. However,

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[18] CAPT Kenneth Klothe, USN (ret), e-mail message to the author, November 20, 2011.

[19] Thomas, USMC.

[20] J. S. Payne, II, "Harvest Hawke ISR/Weapon Mission Kit," 2010.

does a systemic mindset of "doing more with less" mean that the future limited budget is being spent wisely when the war of the last decade may have no relation to the strategy of tomorrow?

C. PARADIGM SHIFT FOR THE MARINES

A paradigm shift is a radical change in underlying beliefs or theory,[21] which calls for a fundamental shift or change in approaches and assumptions. The new strategic vision and the end of conventional warfare in Iraq and Afghanistan give the Marines an opportunity to redefine their mission and utility while maintaining their expeditionary identity.

Since World War II, the Marines have been the preeminent experts in amphibious operations. They have preserved their place in the DoD by being lighter, faster and more agile than their sister services. They have also experienced more deployments than their sister services. From the sea was more than a saying within the Marines prior to Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). It was the way they justified their existence within the DoD.

Distributed operations are described as "small, highly capable units spread across a large area of operations will provide the spatial advantage commonly sought in maneuver warfare."[22] In its tactical application, it calls for small units, distributed down to the squad sized element, to operate in disaggregated fashion outside of the range of mutually supporting organic direct fires but able to coordinate and direct supporting arms to include joint fires whose purpose is to disrupt enemy access to key terrain and avenues of approach.

Consider the Marines shifting their operations to more closely support and align themselves with SOF operations. Distributed units can act as blocking forces, tactical communications teams and security forces for SOF. Consider a Marine infantry company

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[21] Dictionary.com, "Paradigm Shift," (n.d.), http://dictionary.reference.com/browse/paradigm+shift.

[22] Commandant of the Marines Corps (CMC), "A Concept for Distributed Operations," April 25, 2005, http://www.marines.mil/unit/tecom/mcu/grc/library/Documents/A%20Concept%20for%20Distributed%20Operations.pdf.

coming from the sea to support a SOF mission. It can secure a beach landing site (BLS), a helicopter landing zone (HLZ) and provide security for SOF into the target area. A platoon can provide security to a team conducting strategic reconnaissance or military assistance missions. The BLT has a wide range of capabilities that match SOF operational requirements.

With this paradigm shift, the Marines are able to still provide their conventional amphibious presence, which is necessary in an area like the South China Sea. They are also able to closely associate themselves with the new strategic vision, and thus, ensure their place within DoD and relevance in a shrinking military environment.

1. Strategic Implications

Employment and allocation of airlift capabilities is a zero-sum experience. Demands for routine and contingency airlift will always exceed the supply of inter and intra-theater lift.[23] Distributed units will only increase the demand placed on strategic airlift capabilities. Increased demand equals an increased military presence.

Political realities can make the overt presence of U.S. military forces a liability. In 2007, the PRC refused entry to multiple naval vessels.[24] Japan has continuously tried to effect the rebasing of U.S. forces from Okinawa. Smaller, civilian based aircraft can be suitable for shaping operations when used as a part of a theater engagement plan. An organization like the VMLO can provide a small footprint, in terms of aircraft size and support personnel that are required.[25] Civilian style aircraft, without the large overt military markings, can potentially reduce political sensitivities in which an overt presence is not desirable.

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[23] Steven H. Stater, "Modifying Intratheater Airlift for Irregular Warfare"(master's thesis, U.S. Army War College, 2009).

[24] Foster Klug, "China: We Are Moving Past Spat Over Port Calls," *The Associate Press*, December 4, 2007, http://www.navytimes.com/news/2007/12/ap_china_071204/.

[25] Stater, "Modifying Intratheater Airlift for Irregular Warfare."

2. Operational Implications

Operationally, Marines can meet a majority of their intra-theater lift with KC-130J, MV-22 and CH-53E aircraft. They are purpose built, equipped with advanced systems for defense and built to withstand battle damage.[26] However, the KC-130J is also a strategic intra-theater lift asset, aerial refueling aircraft and now CAS platform.[27] The MV-22 and the CH-53 are the major lift components of the MEU ACE. As of FY2010, the Marines have 99 of 360 planned MV-22Bs, 33 CH-53Ds, 148 CH-53Es and 37 KC-130Js.[28]

The use of small, civilian based aircraft would greatly enhance the Marines' ability to conduct dispersed airlift operations in support of distributed units and enhanced company operations in a semi-permissive environment. It would also enable the Marines to close the gap of light mobility and persistent ISR that the creation of distributed operations would create.

3. Tactical Implications

Small, reliable aircraft are designed to land in remote locations in very short distances. They are inexpensive to purchase, operate and maintain when compared with current military aircraft. These small aircraft, combined with a short field capability, allow these aircraft to operate from the smallest distributed unit. Their reliability and ease of maintenance will mean that they can operate from remote locations for a sustained period and the aircrew are able to conduct most routine maintenance to make them full mission capable (FMC).

These types of aircraft bring a right technology, not necessarily "high technology" answer, to light mobility, persistent ISR and CAS/FAC(A) support of a distributed unit. The decision-making matrix is flattened when seconds count in a tactical scenario. Co-

[26] Stater, "Modifying Intratheater Airlift for Irregular Warfare."

[27] Payne, II, Harvest Hawke ISR/Weapon Mission Kit.

[28] Daniel Fasci, Operations Research Analyst, NAVAIR Cost Department Air-4.2.2.3, e-mail message to author, July 28, 2011. Derived from attached Excel spreadsheet for FY10 Operations and Sustainment (O&S).

locating an aircraft with CAS/FAC(A) capabilities, with short field performance, can mean the difference between victory or defeat in a distributed environment. When seconds count, air support can be minutes away.

D. WHY THE MARINES

The United States Air Force (USAF) has been using AFSOC to provide BPC and FID support since the creation of the 6th Special Operations Squadron (SOS).[29] The fight over LAAR has left the Air Force unable to see the benefits of using small, civilian aircraft in support of conventional U.S. forces. The Marines have not been involved in the fight over LAAR and LAS. Institutional experience with the MAGTF also gives the Marines an understanding for the need of timely aviation support to distributed units.

It is envisioned that distributed operations will operate in a disaggregate fashion. These units must have the ability to "rapidly re-aggregate in, order to exploit fleeting opportunities to reinforce or support another unit in need."[30] The ability to re-aggregate rapidly changing tactical environment and do it faster than the enemy requires an increase of tactical mobility assets for small units.[31]

The proposed VMLO can provide for the increased tactical mobility required by distributed operations. It provides for additive and complimentary capability to existing inter-theater and intra-theater operational and tactical support.

E. SUMMARY AND OVERVIEW

The use of low cost, low technology aircraft is not unfamiliar to the U.S. military in general. The USAF has been using aircraft, such as the Cessna 208 Caravan, configured as the U-27A in support of Foreign Internal Defense Mission (FID), to train and equip allied air forces with low cost aircraft capable of providing persistent ISR/CAS/FAC(A) missions. They have provided the Iraqi Air Force aircraft that have been equipped with defensive missile approach warning equipment to increase

[29] Stater, "Modifying Intratheater Airlift for Irregular Warfare."

[30] Commandant of the Marines Corps (CMC), "A Concept For Distributed Operations."

[31] Ibid.

survivability. These aircraft are also equipped with Forward Looking Infa-Red (FLIR) targeting systems capable of employing Hellfire missile systems, as well as meeting increased ISR demand.[32] If this type of capability has utility for an emerging nation with limited financial resources and physical resources facing a threat over a large AOR, it is not unlikely that the same capability has a role to play in the future of the U.S. military as well.

The look into the advantages or disadvantages of manned low technology in the battlefield of tomorrow is more than a simple discussion of the types of platforms suitable for supporting distributed units. It requires a discussion of what a light observation squadron should look like organizationally. It must explore the type of skills that military pilots must master to fly fixed wing aircraft in remote locations. It would be inappropriate to simply choose an aircraft and say it meets the mission requirements for a VMLO. Multiple aircrafts with different configurations must be reviewed and their performance characteristics compared against one another and the definition of the operating environment. The discussion must also include how the aircraft and the organization can augment existing capabilities and fill future capability gaps in a distributed environment. The following discussion touches one each of these topics to evaluate the additive value of a light observation squadron built around low cost, low technology manned aircraft.

Figure 3. AC-208 Caravan[33]

[32] Bill Sweetman, "Keep It Simple | Aviation Week," *aviationweek.com*, March 15, 2010, http://www.aviationweek.com/aw/generic/story_channel.jsp?

[33] Feral Jundi, "Posts Tagged Cessna Grand Caravan 208 B, Funny Stuff: The MAV (Manned Aerial Vehicle), Armed With Hellfire Missiles!!!," (n.d.), Iraq, http://feraljundi.com/tag/cessna-grand-caravan-208-b/.

II. CONSIDERATIONS FOR MANNING AND OPERATIONAL ORGANIZATION

The Marines have extensive experience with aircraft and organizational detachments and utilize modular and scalable approaches. They have used these task-organized units to meet the full spectrum of missions that define current military operations. In the past decade, they have supported an array of Humanitarian Assistance/Disaster Relief (HADR) missions and combat missions by way of ARG shipping, as well as land based, fixed airfields and operating bases.

The rotary wing war in both Iraq and Afghanistan has been referred to as the section leader's war. In other words, the tactical environment did not consistently call for large flights of helicopters to move men and material throughout the AOR. The AORs in Iraq and Afghanistan began to look like a bicycle's wheel. They consist of a few major logistical hubs connected to smaller FOBs connected either by ground convoy or aerial LOCs. Small sections, consisting of two helicopters, became the logistical lifeline for these locations.

The physical distance of these FOBs from the main air bases made it unsustainable for squadrons to support daily flights to and from these remote locations. Squadrons could not afford to expend the flight hours on transiting between the FOBs. Ground forces could not afford to be without air support. To close this supportability gap, the Marines forward deployed elements of AH-1W and UH-N's along with CH-46E's. To sustain these aircraft for an extended period of time, the Marines have been forced to push maintenance support personnel to the FOBs.

Support personnel being utilized at the FOB means that the parent unit experiences a shortage in aircrew, aircraft and support personnel, which places an increased demand on the men and material that remain behind. In addition, a larger number of personnel are at risk in the forward deployed location. The supported unit must now also sustain the additional Marines within the FOB, which increases the logistical demand and support required to the FOB.

It is very possible that the near future for the Marines includes the doctrinal paradigm shift described in Chapter I. Established conventional Marine forces and their operations already place a steady demand on aviation availability. Distributed operations will only increase the demand for additional aircraft and additional sorties.

The multi-year procurement for FY2008–2012 allows for the purchase of 167 MV-22s with a total purchase of 360 MV-22s for the program. It has only sustained a readiness rate in the 70th percentile during combat operations in Iraq and Afghanistan. From October 2007 to June 2008, CH-46E and CH-53 aircraft maintained a readiness rate of 85 percent or higher.[34] The CH-53K heavy lift replacement for the CH-53E has experienced delays in acquisition that have postponed introduction until 2018. The initial design review was completed in July 2010, a full 16 months behind schedule. It has also experienced an increase in overall design cost of $1.7 billion and will not reach initial operating capability until 2018.

A. PURPOSE OF THE PROPOSED VMLO SQUADRON

Through 2018, the Marines will experience a period of transition in the aircraft traditionally tasked to support heavy and medium assault support. Small commercial aircraft can relieve a future capability gap in the Marines with an increased number of distributed units to support. Turbine powered aircraft capable of carrying 14 passengers or 3000 lbs of cargo 900 nm that operate from remote locations exist in the commercial market. They are readily available in the arena of 1,900,000.00, a fraction of the cost of 42,300,000.00 MV-22 and its associated operating cost of 19,000.00 per flight hour.[35]

The purpose of the proposed VMLO squadron is to alleviate the additional burden for aviation support that distributed operations create. The current Marine aircraft are task organized to the MEU ACE or Marine Expeditionary Force (MEF). The current doctrinal construct leaves little room to support small, distributed units not directly related to MEU operations. The inability to provide a dedicated aviation element to MARSOC because

[34] U.S. Government Accountability Office, *Defense Acquisitions: Assessments Needed to Address V-22 Aircraft Operational and Cost Concerns to Define Future Investments* (GAO-09-482), Washington, DC: GPO, 2009.

[35] Fasci, Operations Research Analyst.

they are small platoon sized elements outside of the conventional Marine construct, does not speak well to the Marines' ability to meet the substantial additional demands of distributed operations.[36]

Aircraft within the VMLO should be significantly less expensive to purchase, operate and maintain than the aircraft within the current ACE. The program unit cost of a CH-53K is estimated at $109.1 million. The CH-53E, legacy platform to the CH-53K, has an hourly operating cost of $11,079.00 according to the flight hour program. The addition of other operation and sustainment costs, modifications and mission personnel results in an hourly cost of $28,215.00. By comparison, the Quest Aircraft Kodiak K100 hourly operating cost is $500.00 that includes fuel, instructor and maintenance considerations.[37]

Manned aircraft are capable of acting as a UAV surrogate that integrate a man in the cockpit with the sensors associated with current UASs fielded by the U.S. military. By integrating the man and systems, increased situational awareness can be achieved by providing a three-dimensional situational awareness to the supported command and enhanced by the multi-sensor imagery provided.

The VMLO must provide for the six functions of Marine aviation in such a way as to augment current capabilities and provide for a value added on the battlefield. The pilots and aircraft must be able to provide capabilities not currently considered standard within conventional military aviation. Examples of these skills are the use of a seaplane to extend the reach of aviation support, as well as tailwheel equipped aircraft suitable for austere, off airport locations. While UAS technology has rapidly grown over the last decade, algorithm driven software within the vehicle is unable to match these capabilities and may not be able to do so for another decade.[38]

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[36] Thomas, USMC.

[37] Larry Duscher, Chief Pilot for Quest Aircraft, personal conversation with the author, January 19, 2011.

[38] Bob Bluth, Director of the Center For Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS), personal conversation with the author, March 17, 2012.

B. EXAMPLES OF DISTRIBUTED OPERATIONS SUPPORT

Distributed operations provide an example of what a hub and spoke support structure could look like in a future battlespace. Small detachments of aircraft could operate beyond the limits of traditional operational level lift, such as the KC-130J or maritime ISR assets like the P-3 or P-8A in politically sensitive environments. The use of a forward deployed naval vessel, such as the proposed use of the USS Ponce as a SOF mothership,[39] could act as seaplane tender while supporting SOF missions. For the Ponce, the offensive capability is the assigned SOF or conventional military force. The question is how are these distributed units supported once deployed. It is possible that to augment the conventional assault support aircraft, five or six amphibious operations capable aircraft are operated from alongside for an extended period of time. They are able to conduct covert insertion and extraction missions, MEDEVAC/CASEVAC and movement of men and material within the AOR. The purpose is not create the equivalent of a seaplane tender dedicated to supporting the aircraft, but the ability of the aircraft to operate from alongside the vessel to increase the tactical reach and support of the distributed units.

Air America and the less known Continental Air Service conducted light mobility missions throughout Southeast Asia during the period of the Vietnam War in support of small, distributed units. Their pilots and support personnel had an extensive working knowledge of how to conduct aviation support missions in a low to medium threat environment.[40] They operated a hub and spoke network that relied on certain amount of centralized control and decentralized execution. It was determined that operations at the Lima Sites, satellite fields at the end of the spoke, required a highly flexible and decentralized C2 structure.

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[39] Defense Tech, "USS Ponce to Become Spec Ops Mothership," January 28, 2012, http://defensetech.org/2012/01/28/uss-ponce-to-become-spec-ops-mothership/.

[40] Lee Gossett, Air America Pilot and Central Intelligence Chief Pilot, interview at Naval Postgraduate School, December 14, 2010.

Both of these companies operated a mixture of fixed wing and rotary wing aircraft. The primary aircraft used for operations at the major hub facility of Long Thien was either the C-130 or twin engine C-123. For operations at the remote Lima Sites, the tailwheel configured Pilatus PC-6 was the primary aircraft.

In addition to the experiences of Air America and Continental Air Service, the commercial operations of Kenmore Air were considered. Kenmore Air has been conducting commercial seaplane operations in the Pacific Northwest since 1946. From 1946 to 1985, it conducted a mixture of charter flights and government contract work throughout Washington, Alaska and Canada. In 1985, it inaugurated a dedicated passenger service to the San Juan Islands from Lake Washington and Lake Union in Seattle, WA.[41]

For the purposes of this work, it was important to consider Kenmore Air for a number of reasons. The most important consideration is that Kenmore is a commercial operation. It must find the best business model to be successful and grow to meet additional commercial demand in the Pacific Northwest. Second is that Kenmore has over 60 years experience purchasing, operating and maintaining the very type of aircraft with the capabilities essential to a proposed platform for the VMLO. Its knowledge of manning requirements, aircrew responsibilities and the working knowledge of aircraft in the challenging environment of the Pacific Northwest made it a suitable example of what to expect in the composition of a VMLO.

1. Kenmore Operations

Kenmore supports 78 satellite locations throughout the San Juan Islands, Puget Sound and international operations to the port of Victoria in British Columbia. It has two primary hub locations. The first location is its primary passenger and cargo terminal located on the west side of Lake Union, which is dedicated to movement of passengers and cargo to and from the satellite locations. It only acts as a point of embarkation and

[41] C. Marin Faure, *Success on the Step: Flying With Kenmore Air* (Seattle, WA, Earmark Publishing, 2007).

debarkation. The only service available for the aircraft is refueling. Typical personnel assigned are two ticket agents and one lineman to assist the pilots between flights.

The second location is its primary administrative and maintenance facility located on the north end of Lake Washington, which is also its primary administrative and maintenance support facility. It also conducts regularly scheduled passenger operations from this location. In addition to the daily schedule, Kenmore conducts initial seaplane and recurrent seaplane training.

To support these operations, Kenmore maintains 12 full time pilots. During the peak summer season, it has between 47–50 pilots. It also maintains a small pool pilots who are called on for mission specific flights and clients. Much like an average Marine squadron, Kenmore produces a daily flight schedule. Any similarity to the daily flight schedule stops there.[42] Kenmore pilots arrive at the scheduled time and location and are given their assignments for the day. They are required to coordinate with fellow pilots an effective method for the movement of men and material through their AOR.

Kenmore's operations are optimized to utilize its limited resources. The satellite locations are the local marinas and resort docks where it has land use agreements. It has no additional overhead in buildings, ticket agents or baggage handlers in these remote areas. It maximizes the utility of the individual pilot to minimize its overhead. When shown the organizational structure of a typical Marine squadron, the Director of Operations, Tim Brooks, determined that Kenmore would be unable to sustain such a large administrative overhead for little economic gain.[43]

2. Kenmore Aircraft and Maintenance

Flight operations are conducted with a fleet of 22 aircraft. The Director of Maintenance has 24 full time maintainers to support a mixture of piston and turbine powered aircraft. Its initial and recurrent training is conducted with PA-18-180 Super

[42] Tim Brooks, Chief Pilot Kenmore Air, personal conversation with the author, September 8, 2011.

[43] Ibid.

Cub. It supports the operation of float equipped and fixed gear, land based Cessna 208 Caravans. The mainstay of its fleet is a mixture of piston and turbine powered DHC-2 Beavers and DHC-3 Otters.

The three primary costs to Kenmore operations are fuel, turbine engines and personnel. The price of fuel and turbine engines is a cost of the commercial aviation model and cannot be avoided. Without either, the operation does not work. Personnel are one variable that Kenmore can control. Just as the pilots are required to act as pilot in command (PIC), ticket agent and baggage handler at the satellite locations, they are also responsible for maintenance actions on their aircraft. The daily pre-flight inspection is the civilian equivalent of the daily and turn around inspections for military aircraft. Kenmore pilots are responsible for this daily inspection, as well as turning the aircraft around for the next flight to include unloading passengers and baggage, as well as refueling the aircraft.

Maintenance personnel are used to conduct the repairs that require an individual qualified as an Aviation Mechanic Powerplant (AMP) to conduct the repair. Kenmore has also eliminated the need for an equivalent to the military Functional Check Pilot (FCP) to conduct pre-maintenance evaluations and post maintenance Functional Check Flights (FCF). Kenmore saves time and money by using a pilot-qualified AMP to fly the aircraft when a discrepancy is found and then repairs it, which allows a pilot to remain on the schedule, moving men and material to meet the Kenmore mission.[44]

3. Kenmore's Pilots

The average pilot applicant to Kenmore must have a minimum of 500 hours total flight time with 150 to 300 of seaplane time. Typical successful applicants have 700–800 hours of flight with the appropriate commercial ratings from the Federal Aviation Administration (FAA). Once selected to fly with the company, each pilot undergoes a one day ground school followed by 20 hours of flight experience with full time pilots.

[44] Robert Richey, Chief Maintenance Officer Kenmore Air, personal conversation with the author, September 9, 2011.

Kenmore does not use a specific mentor for each pilot during this phase. The new pilot is expected to fly with several different pilots to build upon each of their experiences.[45]

Commercial seaplane operations are demanding and require a level of skill, situational awareness and decision making similar to the level of expertise demonstrated by military pilots. The airways and waterways of the Puget Sound are full of other small aircraft and shipping. Obstacles, such as other aircraft, ships and changing weather conditions, force the pilot to make a continuous string of good decisions to safely complete each day's flight without damaging the aircraft.

In a Marine aviation unit, Combat Readiness Percentage (CRP) "is a measurement of demonstrated proficiency."[46] If a crewman falls outside of the refly factor for a particular event, then that individual will lose CRP for that event. To regain proficiency, the unit must provide additional aircraft and aircrew to revalidate the proficiency of that individual to restore CRP.[47] When asked about currency and training issues for this demanding environment, Mr. Brooks said they had none because daily exposure to the operating environment negated artificial standards of performance.[48]

4. Kenmore's Chosen Model and Relevance to the Marines

Profit has driven Kenmore to its current commercial model. It is driven by a need to reduce its overheard expenses to maximize the profits and ability to remain in business. It has minimized its administrative requirements and eliminated duplication of personnel by assigning non-traditional roles to its pilots. By having the pilot fill the role of ticket agent, baggage handler and intermediate maintainer, it has been able to remain relevant in commercial aviation.

The Marines could maximize their effectiveness by emulating many of Kenmore's business practices by reducing or eliminating administrative jobs for the distributed aircrew. A small administrative team located at MEF headquarters should be

[45] Brooks, Chief Pilot Kenmore Air.

[46] George J. Flynn, *MV-22 T&R Manual NAVMC 3500.11*, February 2007.

[47] Ibid.

[48] Brooks, Chief Pilot Kenmore Air.

able to meet the needs of the small detachments. Commercial aircraft companies like Quest provide for intermediate maintenance training for aircrew when no available depot level equivalents are available. Other than preconceived notions about the role of a pilot, no reason exists that a pilot cannot be responsible for maintaining an aircraft. If higher level maintenance is required, small maintenance tiger teams operating from one of the hub locations is capable of going to the aircraft and conducting required maintenance. If that is not possible then the aircraft can be flown back to a more suitable maintenance facility.

C. MISSIONS OF THE VMLO

Traditional aviation support for Marines is detailed in Marine Corps Warfighting Publication 3-6. MCWP 3-6 states that when planning for a mission, planners initially consider the functional area that needs support, not the means with which the support is provided.[49] To provide for the integrated, task organized support expected of the aviation element, six functions of Marine Aviation provide the following.

- Assault Support
- Air Reconnaissance
- Control of Aircraft and Missiles
- Electronic Warfare (EW)
- Offensive Air Support (OAS)
- Anti-Air Warfare (AAW)[50]

Each of these functions is further divided into sub categories of defined missions. The purpose of the VMLO is not to meet a need in each of the functions of Marine aviation but to augment existing capabilities within the ACE to provide for the existing gap in light mobility, ISR and CAS/FAC(A) capabilities for distributed operations and support extending the life of more expensive platforms.

Low cost, mechanically reliable, Short Take Off and Landing (STOL) aircraft capable of austere field operations can provide for the stated capabilities gap over the last

[49] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations, May 2000.

[50] Ibid.

tactical mile. They provide for a timely, cost effective augmentation to current aircraft. Such an organization should be able to conduct the following missions relative to small, distributed operations.

- Assault Support
- Aerial Reconnaissance
- Offensive Air Support (OAS)
- Control Of Aircraft and Missiles

1. Assault Support

MCWP 3-2 defines assault support as supporting the warfighting functions of maneuver and logistics and uses aircraft to provide for the tactical mobility and logistical support of the MAGTF for movement of personnel and cargo within the immediate area of tactical operations. It consists of seven sub categories. Aircraft and aircrew capabilities should consider these sub categories when evaluating roles and capabilities within the light mobility capabilities gap over the last tactical mile.

- Combat Assault Transport
- Air Delivery
- Aerial Refueling
- Air Evacuation
- Tactical Recovery of Aircraft and Personnel (TRAP)
- Air Logistical Support
- Battlefield Illumination[51]

2. Aerial Reconnaissance

Aerial reconnaissance is defined by the publication as the employment of visual observation and/or sensors in aerial vehicles to acquire intelligence. Aircraft of all types are capable of supporting the aerial reconnaissance function. The Marines employ three types of reconnaissance: Visual, Multisensor Imagery and Electronic that are employed tactically, operationally and strategically according to MCWP 3-2.

[51] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

Consideration of aircraft and aircrew should include suitability of current sensor systems on manned and unmanned aircraft for modification and inclusion. Additional significance should be given to non-standard employment. The use of ISR and targeting pods on an amphibious capable aircraft could have operational and tactical implications on an AOR the size of the South China Sea with the ability to help address the persistent ISR capability gap within the Marines.

3. Offensive Air Support

Offensive air support is air operations conducted against enemy installations, facilities, personnel to assist in meeting the MAGTF objectives, and destroying enemy resources. It consists of close air support (CAS) and deep air support (DAS). OAS is what allows a commander to shape events in time and space through firepower, as well as the ability to delay enemy movements and reinforcements, degrade critical functions and delay enemy perceptions.

The fixed and rotary wing communities have traditionally provided CAS to troops in contact (TIC), which is the engagement of enemy forces within close proximity to friendly forces. CAS properly done requires the detailed integration between air and ground forces.[52] With the increase in UAS technology and numbers, these platforms have also been involved with TIC scenarios.

Aircrew selected for the VMLO should have the ability to coordinate and integrate fires within close proximity to friendly forces. By co-locating an aircraft with the distributed unit, it is possible to achieve a high state of situational awareness. Any aircraft considered for the VMLO ought to be able to incorporate Precision Guided Munitions (PGMs) and non-precision guided munitions to delay the enemy. This use of right technology, not high technology reduces the exposure of expensive, high technology aircraft available in limited numbers. It ensures use at the right time and place commensurate with the capabilities and cost of aircraft and aircrew.

[52] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

4. Control of Aircraft and Missiles

Doctrinally, the control of aircraft and missiles falls under air direction and air control. It integrates the five other functions to give the commander the ability to exercise command and control authority over Marine assets.[53] However, Marine aircraft have the ability to exercise some method of airborne command and control during missions. The UH-1/AH-1 and F/A-18D aircraft provide for FAC(A) and TAC(A) capabilities. The larger context of control of aircraft and missile is the doctrinal discussion of positive or procedural control.

The ability to conduct FAC(A) and TAC(A) missions in support of distributed operations will be essential. Aircrew must be qualified to direct fixed and rotary wing aircraft. They must also be capable of coordinating indirect fires for the supported units. The systems within an aircraft considered for the VMLO should be capable of supporting the multi-role qualifications of the aircrew.

D. AIRCREW CONSIDERATIONS FOR THE VMLO

Experience has shown that an organization built around non-standard aviation operations requires a crew with considerably more experience than someone freshly graduated from initial pilot or flight officer training. Kenmore requires a minimum of 500 hours total time. Continental Air Service and Air America required a minimum of 2,000 hours total time to be competitive for a pilot position. The typical pilot was hired with closer to 3,000 hours total time.[54] To be considered competitive for a position with the CIA sponsored Raven FAC program, pilots were typically recruited by reputation. At a minimum, they must have had six months flying experience in Vietnam. It also required a six month extension to their combat tour.[55] It was understood that junior pilots directly assigned from initial training did not have the experience or situational awareness to be an effective part of these organizations.

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[53] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

[54] Gossett, Air America Pilot and Central Intelligence Chief Pilot.

[55] Christopher Robbins, *The Ravens: The Men Who Flew in America's Secret War in Laos* (Philadelphia: Crown Publishing, October 1987).

Crew composition typically consisted of the pilot and an observer. Some Air Force organizations flew the OV-10 as a single seat during daytime conditions but utilized a second pilot for night operations to reduce workload. The pilot was responsible for directing air strike, fixed and rotary wing, against a target. The observer was responsible for coordinating with artillery and naval gunfire for indirect fire against a target. The observer also acted as the tactical air control (airborne) (TAC(A)) who gave holding instructions and familiarization of the tactical situation.

1. Pilot Considerations

A pilot within the VMLO should bring knowledge and experience to the organization similar to that described above. It is necessary to establish a baseline of experience for a potential pilot for example.

- Second tour pilot
- Minimum 1000 hours total time
- Section Leader
- Ground FAC or FAC(A) experience

The Marines has many pilots with current combat experience. As the wars in Iraq and Afghanistan fade, this pool of experience will also fade. This thesis has been influenced by the study of three experienced military aviators conducting research involving the proposed VMLO type of aircraft.

Two researchers are Air Force AC-130 aircraft commanders with overseas combat experience. The third, the author, is a Marine CH-46E pilot with prior ground FAC and flight instructor experience.

Table 1 represents the amassed flight experience of the three researchers primarily involved in evaluating LAAR and LAS. General aviation (GA) experience is not uncommon to military aviators. Upon graduation from the undergraduate flight training, a rated military aviator is able to receive the equivalent civilian commercial ratings,[56] which is representative of the type of flying experience suitable to a future VMLO.

[56] U.S. Department of Transportation, *FAR/AIM 2012, Rules and Procedures for General Aviation, Sport Pilots, and Instructors* (Newcastle, WA: Aviation Suppies and Academics, 2012).

Pilot	General Aviation	Military Jet	Military Propeller	Rotary Wing	Total Time
Bamford	175	0	120	2600	2895
Jesurun	170	0	3000	0	3170
Sharpe	8	100	2400	0	2508

Table 1. Total Flight Time Hours for NPS Research Students

a. Pilot Training

It is recognized that the military does not provide the type of aviation training that a VMLO might require. Seaplane training and tailwheel endorsements are functions of the type of aircraft with which the organization is equipped. Air America and Continental depended on multiple configurations of land-based aircraft. Kenmore has a mixture of land and sea based aircraft to support its commercial operations.

To evaluate the time to train and the cost, the researchers also attended training programs designed to provide initial single engine seaplane (SES) rating and tailwheel endorsement. Two researchers received their training during a ten-day evolution with Alaska's Cub Training Specialists. Their total cost in training also reflects associated travel costs. The third researcher received his SES with Kenmore Air over four days and his tailwheel endorsement over a period of 10 days with Adventure Wings Aviation in Monterey, CA. The SES training was conducted in Piper PA-18-150 Super Cubs for each of the three pilots. Two researchers also received their tailwheel endorsements in the PA-18-150. The third researcher received his tailwheel endorsement in a Bellanca Super Decathlon.

Table 2 represents the total time to train and cost for the three researchers primarily involved in evaluating the LAAR and LAS concept.

Pilot	T/W Hours	SES Hours	Total Hours	Total Cost
Bamford	7.5	10.0	17.5	3,600
Jesurun	10.5	6.0	16.5	7,000
Sharpe	11.0	6.5	17.5	7,000

Table 2. Total Time to Train and Total Costs for Training

It is possible to offer timely and cost effective support to distributed operations if the organization is provided the proper aircraft and aircrew trained for off

airport operations. Three military pilots received a combined total of 46.5 hours of flight instruction and six initial qualifications for $17,600. By comparison, the total cost is less than the $19,105 for one hour of flight time in an MV-22B.[57] In those 46.5 hours of flight time, the military gained a capacity to operate aircraft from remote locations, as well seaborne aircraft opening up a number of previously closed tactical and operational options for small, distributed units.

2. Aircrew Considerations

An additional purpose of the VMLO proposal is to reduce the number of people required to support actual flight operations. The proposed crew composition is a pilot and an observer. The first possibility is to use a NFO who has experience in managing fuel consumption, navigation and coordination of aircraft in TIC situation to occupy the co-pilot's position. A second option is to utilize a JTAC qualified Non-Commissioned Officer (NCO) as aircrew. As the second member of the crew, this individual would be accountable for the coordination of indirect fire coordination and the TAC(A) roles in the aircraft to allow the pilot to identify, mark and direct the terminal control of tactical aviation (TACAIR) assets.

The additional member of the crew must also be responsible for coordinating the loading and unloading of passengers, as well as with the pilot to determine the most efficient method of moving men and material. As in the Kenmore example, this member becomes the ticket agent, baggage handler and flight attendant and is also responsible for the role of jump master for aerial delivery and parachute operations. The following are recommended minimum requirements for the second member of the aircrew.

- Second tour NFO or NCO
- FAC(A)/TAC(A) qualified NFO
- JTAC qualified NCO

The Take Charge and Move Out (TACAMO) model of aircraft requires that each of its flight crew be qualified to handle all servicing tasks for the aircraft. Each is essential enough to the strategic posture of the United States in that these crews must be

[57] Fasci, Operations Research Analyst.

enabled to service them to meet their mission responsibilities. It is not as much as a doctrinal shift as some readers may think for aircrews to change their roles and responsibilities.

E. SUMMARY AND OVERVIEW

The military has an extensive history of using commercially available aircraft, flown by military pilots, to meet capability gaps within its modern air forces. The Air Force provided the Central Intelligence Agency (CIA) with pilots for the Raven FACS through the Steve Canyon Program who flew the O-1E in Laos.[58] The CIA used contracted pilots to support covert operations throughout Southeast Asia in the form of Air America and Continental Air Service. The Army and Marines provided direct support of conventional ground forces from forward locations by utilizing off airport operational techniques, in the form of the Reconnaissance Air Company (RAC) and the Marine Observation Squadron (VMO).[59] They also used the Cessna built O-1E.

To place the VMLO within the ACE construct, it is important to align potential missions with the four functions of Marine Aviation previously discussed. However, slightly modified, a paradigm shift is required within those missions to realize the full capacity of commercially available aircraft capable of off airport operations. By combining the Short Take Off and Landing (STOL) performance of these aircraft with their flexible missions capacities, it is possible for the Marines to close their light mobility, persistent ISR and CAS/FAC(A) gap now without waiting a decade or more for UAVs. It is an opportunity for the Marines to lead the services forward in a demonstrably cost effective and tactically relevant model to employ low technology and comparatively low cost in the next conflict.

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[58] Gene Sumner, Raven 21 Forward Air Controller, Laos 1971, interview, Naval Postgraduate School, December 14, 2010.

[59] Jim Hooper, *A Hundred Feet Over Hell: Flying with the Men of the 220th Recon Airplane Company Over I Corps and the DMZ, Vietnam 1968–1969* (Minneapolis, MN: Zenith Press, 2009).

III. AIRCRAFT COMPETITIVE FOR CONSIDERATION

The purpose of considering certain types and models of aircraft is to best identify the characteristics and capabilities that would allow additional research and eventually to conduct an analysis of alternatives (AoA). Two basic factors were considered when identifying the four aircraft taken into account over the course of this research. First, they must offer a cost effective solution to supporting distributed units capable of sustained off airport operations. Second, they must be available for acquisition as commercial off-the-shelf systems.

Cost effective solutions should be evaluated using the following considerations. The first is the cost per airframe. Second is the cost per flight hour. The third is the impact on the individual services' ability to support the aircraft logistically. Does it share a common fuel source with current military aircraft? Is it able to integrate currently available aircraft survivability equipment (ASE) and multi-sensor equipment in use on manned and unmanned aircraft?

The commercial market has many aircraft that have proven their capability for off airport operations. Common to bush pilot operations in Alaska is the family of Cessna piston powered aircraft, such as the C180/185 and the C206/207. The newest workhorses in remote area operations are the Cessna 208, Quest Kodiak K100, re-emergence of the Pilatus PC-6, as well as the emergence of the Sherpa K-650T on the commercial market. Their capabilities typify the performance that commercial operators are seeking; turbine powered, high wing aircraft with reinforced airframes to allow for rough and ready operations built for the utility mission.

A. GENERAL CHARACTERISTICS

Commercial operators depend on the reliability, ruggedness and durability of the aircraft they use. Airplanes are considered the trucks of the sky in Alaska.[60] Reliability means that the aircraft spends more time on the flight schedule than in the maintenance

[60] F. E. Potts, *Guide to Bush Flying* (Tucson, AZ: ACS Publishing, 1993).

department. Ruggedness implies that the aircraft performance meets or exceeds the requirements to operate in remote areas. Durability is the ability to consistently operate in this environment for a long period.

The four aircraft considered for research share the desired characteristics. Three of the four aircraft were purpose built for remote area operations. The fourth is a commercially designed aircraft proven suitable for remote area operations and is a common aircraft throughout Alaska and other operating environments. In addition, the four aircraft share the following general characteristics required for the VMLO to be successful.

- Single piloted
- 800 nm range
- 2,000 lb cargo capacity
- Certified for Instrument Meteorological Conditions (IMC)
- STOL capable

B. SPECIFIC CHARACTERISTICS

In July 2009, the Aeronautical Systems Center (ASC) Capabilities Integration Directorate outlined what it was looking for in a light mobility aircraft in support of irregular warfare (IW) operations. ASC was looking for an aircraft capable of integrating within traditional C2 organizations and "existing joint Tactics, Techniques and Procedures (TTPs) for Air Transportation operations."[61] It required that a competitive aircraft be able to multiple missions. It was meant to conduct movement of men and material. The aircraft had to capable of conducting air drops for forward area resupply, as well as also be able to conduct MEDEVAC and CASEVAC flights. The following specific characteristics should be existing capabilities on the aircraft or have the ability to support integration of these systems.

- Turbine engine capable of using JP-5, JP-8 and JET-A equivalent
- Dual crew station, certified for single pilot operations
- Category 1 precision approach certification

[61] Global Security, "Light Mobility Aircraft (LIMA)."

- Dual Line of Sight (LOS) and Beyond Line of Sight (BLOS) Very High Frequency (VHF) and Ultra High Frequency (UHF) encrypted radios and Satellite Communications (SATCOM).
- Capable of seaplane operations
- Take off and land within 2500’ over a 50’ obstacle
- 170 Knot Indicated Airspeed (KIAS) cruise
- 25,000’ service ceiling with integrated oxygen
- Side loading cargo door
- Minimum eight passengers
- Certified for aerial deliver and parachute operations
- ISR platform compatible
- Integrate with precision and non-precision munitions (CAS/FAC(A))

Aircraft	Turbine Engine	Dual Crew	CAT 1 IFR	Dual LOS/BLOS/USF/SATCOM	Seaplane	T/O < 2500	170 KIAS Cruise	25,000' Service Ceiling	Side Loading Cargo Door	Minimum 8 passengers	Aerial and parachute delivery	ISR	CAS
Cessna 208	X	X	X		X	X	X	X	X	X	X	X	X
Quest K100	X	X	X		X	X	X	X	X	X	X	X	
Pilatus PC-6	X	X	X		X	X		X	X	X	X	X	
Sherpa K650T	X	X	X		X	X	X	X	X	X			

Table 3. Aircraft Capability Comparison to ASC RFI for Light Mobility

Initially, each of the aircraft fail to meet the dual LOS and BLOS VHF, UHF encrypted radios and SATCOM requirement. Existing communication solutions currently exist within the military that would enable each of the four aircraft to meet this requirement. The Air Force has found a suitable solution to the communication shortfall in their AFSOC application of U-27A. The Marines have also enabled secure voice and data communications through the RQ-7B Shadow UAV by installing the Army/Navy Personal Radio Communications (AN/PRC) 152 radio as a Communication relay payload.[62] Produced by Harris Tactical Communications, it is "a single-channel, multiband, multimission" radio currently in use by each branch of the DoD, as well multiple federal agencies. It supports SINCGARS, VHF/UHF AM and FM HAVEQUICK operations.[63]

The Sherpa 650T is designed to enable aerial deliver and parachute operations. The K650T was not originally designed as an aerial delivery capable aircraft. It was built with back-country utility operations. Sherpa's production model supports aircraft modifications to meet the individual user's needs. The production team at Sherpa has stated that the addition of the required hardware for static and free fall operations could be easily and inexpensively added in the production process.[64] Integration of ISR assets within the aircraft would also require re-engineering early in the design and manufacturing process. A large number of options are available for multi-sensory imagery. Just as the Marines can evaluate integration of the AN/PRC-152, effective integration of existing payload packages can be applied not only to the K650T but also to the other three aircraft for consideration as well.

The Cessna 208 is the only aircraft used in recent military operations as a CAS platform. Modification of the 208 is known as the Armed Caravan (AC-208) by ATK

[62] Commandant of the Marine Corps (CMC), NTTP 3-22.3-VMU, July 2011.

[63] Harris, "AN-PRC-152 Type-1 Handheld Multi-band Radio," (n.d.), http://rf.harris.com/capabilities/tactical-radios-networking/an-prc-152/.

[64] Wes Gordon, Designer of the Sherpa K650T, personal conversation with the author, September 29, 2011.

Aerospace Systems and been supplied to the Iraqi Air Force.[65] It features an MX-15D Electro Optic/Infra-red (EO/IR) with an integrated laser designator. Survivability features include ballistic panels for cockpit and passenger protection, as well as AAR-47 Missile Warning System (MWS) and ALE-47 countermeasures dispenser. The Pilatus PC-6 was used as the AU-23 Peacemaker by the Air Force during Vietnam. Utilization of existing commercial capabilities to modify a chosen light mobility platform will fulfill the shortfalls that three of the four chosen aircraft currently experience.

C. THE AIRCRAFT

To study fully the capabilities of multiple aircraft and identify the aircraft type or types suited to support the proposed VMLO, it was necessary to review the configurations of commercially available aircraft. Each of the aircraft considered was turbine powered. They are all high-wing configurations. In other words, the wings are mounted on top of the aircraft fuselage to allow additional obstacle clearance and increased visibility for observation of the ground. Two of the aircraft are equipped with the more common tri-cycle landing gear configuration that consists of two main wheels under the cabin of the aircraft and a third wheel mounted under the engine. They are non-retractable fixed gear. The last two aircraft are tailwheel configured. They have two main mounts also under the fuselage and a third smaller wheel located under the tail. Advantages and disadvantages of the two configurations are discussed. All four aircraft are modern designs widely used in commercial operations and currently still in production.

Table 4 illustrates the varying cost, capacity and performance of the proposed aircraft and capabilities that exist within the civilian general aviation community.

[65] ATK, AC-208 Combat Caravan," (n.d.), http://www.atk.com/products/documents/ac-208%20wpafb%2088abw_2010_3676.pdf.

Aircraft	Cost	Max Gross WT	Empty WT	Useful Load	Range	Max Cruise	Service Ceiling
Cessna 208[66]	1.9 million	8785 lbs	4680 lbs	4105 lbs	862 nm	175 KIAS	25,000’
Quest K100T[67]	1.7 million	7305 lbs	3770 lbs	3535 lbs	979 nm	172 KIAS	25,000’
Pilatus PC-6[68]	1.9 million	6173 lbs	3086 lbs	2646 lbs	870 nm	119 KIAS	25,000
Sherpa K650T[69]	.9 million	6500 lbs	3550 lbs	3000 lbs	1091 nm	174 KIAS	25,000’

Table 4. Research Aircraft

Each of these aircraft is available in multiple configurations. For the duration of this paper, the cargo variant is the standard configuration discussed.

1. Cessna 208 Basic Description

A basic 208 comes as a high winged fixed gear aircraft. It may also be configured with straight seaplane floats or amphibious floats able to operate on land or water. The aircraft is powered by the Pratt and Whitney PT-6A-114. It is capable of producing 675 shaft horsepower (SHP) at full power. The cabin of the aircraft is unpressurized. For high altitude operations, it is capable of supporting 17 oxygen ports for aircrew and passengers. It features the Garmin G1000 integrated avionics panel.

The U.S. military currently uses the Caravan for BPC and FID missions in multiple AORs and configurations. It is known as the U-27A. In the civilian market, it is being used for medical transport, cargo movement, executive and regional airline operations, as well as sky diving operations. In the 25 years that the Caravan has been in production, over 2,000 aircraft have been produced.

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[66] Cessna Aircraft Company, “Grand Caravan Specification and Description,” 2010, http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_s&d.pdf.

[67] Quest Aircraft Company, “Kodiak Pilot’s Checklist; Model Kodiak 100 with PT6A-34 (750SHP) Engine,” 2007, http://questaircraft.com/kodiak/specs/index.html.

[68] Pilatus Aircraft Company, “Performance and Specifications,” (n.d.), http://www.pilatus-aircraft.com/#20.

[69] Sherpa Aircraft Company, “Sheroa K650T Turbine,” September 2011, http://sherpaaircraft.com/650specs.html.

Figure 4. Cessna 208[70]

2. Quest Kodiak K100T Basic Description

The Kodiak was purpose built as a bush/utility aircraft capable of supporting missionary and humanitarian requirements throughout the third world. The aircraft specifications are a result of the collaboration of designers, engineers and the Quest Outlook Team, which is composed of several humanitarian and missionary organizations with over six decades of back country experience.[71]

It is a high wing turbine powered aircraft. The design also supports configuration as a either a straight seaplane or amphibious seaplane aircraft. It is powered by the PT-6A-34 turbine engine. The engine is capable of producing 750 SHP. To support high altitude operations in the unpressurized cabin, it is capable of supporting 12 oxygen ports, two pilots, and 10 passengers. The aircraft also incorporates the Garmin G1000 integrated avionics system. It is currently being used in the civilian market for humanitarian and missionary missions, as well as by the U.S. Department of Forestry, cargo operations and small regional sky diving operations.

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[70] JETPHOTOS.NET, (n.d.), http://jetphotos.net/viewphoto.php?id=6665258.

[71] Quest Aircraft Company, (n.d.), http://questaircraft.com/quest/mission/index.html.

Quest has produced 56 aircraft and is currently producing an average of one aircraft every seven days dependent on demand from commercial operators. It has supplied amphibian K100s to the Royal Canadian Mounted Police (RCMP) and the U.S. Fish and Wildlife services.

Figure 5. Quest Kodiak K100T[72]

3. Pilatus PC-6 Porter

The PC-6 is the first of two tailwheel configured aircraft to be considered. It was first flown in 1959. Since its inception, it has undergone several modifications and upgrades to the airframe, powerplant and avionics. Like the Cessna 208, the aircraft has a previous history with IW and COIN operations with the USAF.

In addition to the tailwheel configuration, the PC-6 is a high wing aircraft with an unpressurized cabin. It can be configured for seaplane operations like the 208 and K100T. It is powered by a Pratt and Whitney PT-6A-24 turbine capable of producing 650

[72] Larry Duscher, disk provided to the author during research trip to Quest Aviation, January 19, 2012.

SHP at takeoff and flat rated to 550 SHP in flight.[73] Its cabin is capable of supporting 10 passengers with oxygen and accessible with a sliding cargo door that the pilot is able to open and close inflight. It uses the Garmin 960 avionics for integrated instrumentation, similar to the Garmin G1000. In the civilian market, it is being used for humanitarian operations, movement of personnel and cargo, medical transportation and sky diving operations. As of August 2012, 562 aircraft have been built since production began on the turbine porter in 1961.

Figure 6. Pilatus PC-6 Porter[74]

4. Sherpa Aircraft K650T Sherpa

The K650T does not have the history of military operations associated with the previous aircraft. Cessna, Pilatus and now Quest have become industry staples for commercial aviation. Their respective aircraft have each received the required FAA certification for commercial operations. The K650T is still classified as an experimental category aircraft by the FAA. Development of the K650T started in 1994. Since then, the aircraft has been under continuous modification and improvement to the airframe,

[73] Pilatus Aircraft Company, "Performance and Specifications."

[74] Pilatus Aircraft, "General Missions, Performing any Role That Comes Its Way," (n.d.), http://www.pilatus-aircraft.com/#147.

powerplant and avionics. The basics of the K650 were "lots of power, lots of wing, lots of flap, lots and lots of structural durability."[75] The designers focused on reducing the length of take off and landing, increasing the useful load of the aircraft, while improving stability and stall performance at slow speeds. Due to the company's small infrastructure and lack of financial backing of the other aircraft companies, the number of aircraft is small in comparison to the other platforms being evaluated. However, three additional aircraft were recently purchased for commercial operations in Alaska.

In addition to being configured as a tailwheel aircraft, it has a high wing unpressurized cabin with side by side crew seating. The powerplant is a Honeywell TPE331-5 turbine engine that produces 840 SHP. Testing is currently under way on an optional TPE3331-10 1000 SHP turbine. It has the capacity to sustain eight passengers with available oxygen to the each pilot and passenger. Unlike the previous aircraft, the avionics package for the Sherpa is an option for each purchase. However, it does have the ability to incorporate the latest advanced technology avionics like Cobham and Garmin Avionics.[76] It is designed for movement of cargo and personnel, as well as medical transportation and aerial delivery and seaplane operations.

[75] Budd Davisson, "Big Foot Saves Lives," *EAA/Sport Aviation*, June 1995, http://sherpaaircraft.com/Budd.html.

[76] Sherpa Aircraft Company, *News*, January 2012, http://sherpaaircraft.com/news.html.

Figure 7. Sherpa Aircraft K650T[77]

The three previous aircraft are all currently in production. The Sherpa is in the early stages of commercial production and sales. It is included for a number of reasons. First, it has an unparalleled short field take off and landing performance. Second, the ability to move men and material is equivalent to the other three aircraft. Third, while carrying equivalent payloads, it is able to meet or exceed the radius of action for the other three aircraft. Since Sherpa is not a large company with an established production line, necessary modifications may be easier and less expensive to achieve. That same small production facility and capability also means that a certain amount of cost associated with increasing the production output and facility capacity are applicable.

D. SUMMARY AND OVERVIEW

The military considers more than per unit cost of an aircraft when determining the overall cost of a program. Research and Development (R&D), modifications and life

[77] Larry Duscher, disk provided to the author during trip to Sherpa Aircraft, September 25, 2012.

cycle costs all figure in to whether or not an airframe meets it mission requirements for what it costs to procure. Military aircraft are built to survive in a non-permissive threat environment. Inherent to their design process is built in defensive systems and the ability to sustain high levels of battle damage.[78] The result of the arduous acquisition process over at least a decade is a capable military aircraft.

The performance and reliability of aircraft has improved within the general aviation market as the fleet of aircraft has aged. The advent of advanced technology avionics has improved the safety and reliability of these aircraft as simplicity, ruggedness and durability has decreased the maintenance demands being experienced by the older mainstays of commercial operations like the DHC-2 and DHC-3. Mission requirements for humanitarian and missionary organizations have created a fleet of robust, multi-purpose aircraft capable of off airport performance.

The commercial market is supplying commercial operators with aircraft capable of sustained remote area and off airport operations. These aircraft demonstrate an ability to support the four proposed missions on a daily basis in the general aviation community. The ability to utilize companies, such as ATK, to modify them to survive in a low threat environment has been proven by their operations in support of Iraq's and Afghanistan's emerging air forces.

Per flight hour costs of these commercial aircraft are dependent on several variables, just as per hour cost of military aircraft. Military costs can exceed tens of thousands of dollar per flight hour depending on the airframe. These proposed aircraft must be cost effective to operate and able to meet the demands of those they support. The

MV-22 costs over $19,000 an hour to operate.[79] It is a complex aircraft that took decades to design, develop, test and implement at a cost of $42.3 million per copy. The K100T costs under $2 million per unit and $500 an hour for a commercial operator.[80]

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[78] Stater, "Modifying Intratheater Airlift for Irregular Warfare."

[79] Fasci, Operations Research Analyst.

[80] Duscher, Chief Pilot for Quest Aircraft.

The proposed aircraft will not replace the current medium and heavy lift, ISR and CAS/FAC(A) capable platforms within the military. The Marines must maintain the ability to support their deployed forces across the spectrum of warfare scenarios. However, the aircraft can provide cost effective support to distributed units that augments ACE elements, as well as also enable the Marines to reduce costly wear and tear and airframe fatigue issues on a fleet of aircraft after a decade of war.

IV. ORGANIZATION AND CAPABILITIES VERSE LIGHT MOBILITY REQUIREMENTS

The following description of conditions within the PACOM is just a scenario that builds upon emerging political and military realities. It describes an environment in which the United States must maintain a military presence to protect its national political and economic objectives. However, the United States is unable to maintain a traditional presence with large conventional naval and marine units and is forced to incorporate distributed operations to meet strategic and operation objectives with the region.

At the end of operations in OIF and OEF, the U.S. military has a significant military presence in the Persian Gulf.[81] The Navy and Marines remain an important part of the U.S. military strategy to ensure that the Strait of Hormuz remains open. Regional security requirements continue to draw heavily on an overtasked U.S. military, which leaves few additional units for the increasing hostile South China Sea.

Japan has been able to remove U.S. forces from the island of Okinawa. The III MEF has been moved to the city of Darwin on the northern coast of Australia. The MEU has been moved from Camp Hansen, Okinawa to the island of Guam, which is 1,600 miles from the South China Sea.

The Japanese government has also been able to remove the forward deployed USS George Washington (CVN-73), as well as her accompanying CSG and CAW. MAG-12 has also been asked to vacate Marine Corps Air Station (MCAS) Iwakuni. Former U.S. military facilities within mainland Japan are to be only used for transitory personnel, aircraft and shipping. Japan no longer allows a sustained offensive U.S. military presence.

The Navy is unable to sustain a two MEU presence in the PACOM AOR. The mandatory presence of a MEU within the Persian Gulf dominates the deployment cycle

[81] Department of Defense (DoD), "Sustaining U.S. Global Leadership: Priorities for 21st Century Defense," January 2012, http://www.defense.gov/news/Defense_Strategic_Guidance.pdf.

of west coast MEU's. The 31st MEU is unable to deploy as an aggregate force. Due to material readiness issues, the LHD has been unable to support MEU operational commitments for seven months.[82]

The U.S. military has been pushed east across the Pacific from its bases in the second island ring. It has gained temporary basing agreements for USS George Washington in the Philippines. Singapore has agreed to support basing options as well. For the first time since the Battle of Midway, June 1942, the U.S. naval presence has been challenged and successfully blunted in the PACOM AOR.

III MEF has moved MAGTF elements to three central locations within the AOR. Darwin acts as the primary logistical and administrative support hub. Temporary basing agreements with Singapore support operations along the Straits of Malacca, Indian Ocean, Indonesia and Borneo. Additional conventional units along with Force Reconnaissance and MARSOC operate from Camp Zamboanga, Republic of the Philippines.

The Marines have been forced to change the way they think about engaging the Chinese threat in this low intensity conflict, as well as their role in a future full spectrum war. Radio Reconnaissance Teams (RRT) can be placed in strategic locations throughout the South China Sea. They conduct strategic reconnaissance, electronic warfare operations and support expeditionary networks for other distributed units. Infantry companies are tasked with military assistance, civil affair operations, as well as acting as blocking positions and security elements during SOF operations while operating from Afloat Forward Sea Basing elements. It is in the context of this very real operational and tactical scenario that the utility of the VMLO has been developed.

A. DISTRIBUTED AVIATION ELEMENT SUPPORT

If the above scenario occurs, the Marines are faced with a difficult challenge in supporting their distributed units. Traditional logistical support LOCs are severely limited

[82] Matthew M. Burke, "USS Essex Unable To Fill Mission for 2nd Time in 7 Months," *Stars and Stripes*, February 1, 2012, http://www.military.com/news/article/uss-essex-unable-to-fulfill-mission-for-2nd-time-in-7-months.html?ESRC=marine-a.nl.

due to the political and military posture within the region. Intra theater lift assets are operating at the limits of their range. The ability to resupply and support remote outposts is limited because many of the available airfields are less than the required minimum operation length. Rotary wing assault support is limited by their range in an area as large and as diverse as the South China Sea. The large numbers of distributed units also places a heavy burden on their limited number of available aircraft.

Conventional military aircraft will be focused on supporting large operational movements of men and material. The MAGTF is focused on supporting the one MEU presence in the Middle East, PACOM and Europe. The 18 month work up, deployment and recovery cycle dominates the available tactical lift assets within each of the three MEF elements In the above scenario, it is possible to envision use of the proposed utility aircraft to reduce the burden on the tactical aircraft and open them up to support dedicated combat missions from naval shipping and in support of SOF forces.

The off airport capability of proposed aircraft could maximize the use of the number of small paved and unpaved fields available in these countries. In the example of Singapore, its lack of runways under 3,000’ is balanced by its stable political environment, pro-U.S. affiliation and willingness to act as a forward deployed base for the United States. It can be used as a major logistics hub to support distributed operations. If Darwin is used as the primary point of entry for U.S. forces within the region, then Singapore and the Philippines can act as secondary hubs within the AOR on an operational and tactical level.

Table 5 illustrates the short field and unimproved surface environment that exists in the nations that compose the South China Sea AO and PACOM.

Country	Area in sq mi.	Water Area in sq mi.	Coastline in miles	Highest elevation in feet	Paved Runways < 3000’	Unpaved Runways < 3000’
Indonesia	699,450	35,907	33,998	16502	34	484
Malaysia	127,354	459	2905	13,451	7	73
Singapore	265	3.8	193	545	0	0
Philippines	115,124	706	22549	9691	10	99
Brunei	203	193	100	6069	1	0
Cambodia	168,152	1745	275	5938	1	1
Vietnam	119,718	8162	2140	10314	9	3
Burma	252,320	8907	1199	192941	1	23
Spratley Islands	1.9	0	926	13	1	1

Table 5. South China Sea Nations[83]

China was not included in Table 5 because any type of military presence within China’s physical border is beyond the scope considered for this thesis. Any pretense to conducting low intensity conflict or passive aggressive political posturing would be lost. The Spratley Islands were included because they are a source of political and military tensions within the region. According to the Central Intelligence Agency (CIA) World Fact Book, they are composed of over 100 islands. Forty-five islands, as well as their abundant energy resources, are contested by China, Thailand, Vietnam, the Philippines and Taiwan.[84]

B. HUB AND SPOKE OPERATIONS.

Distributed operations will depend on hub and spoke operations to support their logistical support needs. In AOs, the size of the South China Sea and Africa, distributed units will be dependent on established FOBs acting as hubs. Air support will be the spokes that provide for their requirements. It becomes a system of systems with multiple layers of hub and spoke operations. An apt description for the operation will be the drivetrain of a bicycle that consists of the pedals, front sprocket, chain, rear speed cassette (sprocket) and the spokes emanating from the rear hub.

[83] Central Intelligence Agency, “World Factbook: Countries,” (n.d.), http://ciaworldfactbook.us/countries.

[84] Central Intelligence Agency, “World Factbook: Spratly Islands,” (n.d.), http://ciaworldfactbook.us/asia/spratly-islands.

The pedals on a bicycle are attached to a front sprocket. When the pedals turn, the sprocket moves the chain. The chain is attached to the back sprocket. The back sprocket is attached to the wheel via spokes. Envision that the main sprocket is the III MEF headquarters in Darwin, Australia. The Chain is inter and intra theater lift composed of C-5's, C-17's and a mixture of C-130 and KC-130 aircraft. Singapore and the Philippines are the back sprocket. They support more distributed units with intra theater tactical lift like the CH-53, CH-47 and the MV-22. The aircraft proposed for consideration can fill this additional need and provide another layer of light mobility to distributed units. They can ensure that the tactical helicopters are available to support MEU and MEF operational considerations in the AO while still providing the required support to the distributed units.

1. Shorter, Rougher and Dirtier

The hub and spoke would be the infrastructure for the VMLO within the region. Aircraft capabilities will be what ensure that the hub and spoke is operationally and tactically feasible. The VMLO can maximize the utility of the existing infrastructure or non-infrastructure as described in Table 6.

The proposed aircraft give the Marines access to areas that existing transportation infrastructure does not support. The Marines do not have a fixed wing lift capability of landing in less than 3,000'. AFSOC contains a capability to operate aircraft in a remote location. However, they are limited to 2,000' on a semi-prepared surface.[85] These aircraft and organizations are also limited to FID and BPC missions. They are not tasked or structured to support conventional units.

The proposed aircraft are capable of supporting off airport operations in an environment not support by the AFSOC NSAV units. They offer a variety of maximum take off and landing distances over a 50' obstacle. Combined with the pilot's ability to select and utilize off airport locations, achieved with back country flight training, they are able to operate in direct support of distributed units in remote or austere locations.

[85] Dave Jesurun and Grant Sharpe, "Irregular Ware (IW) Aviation Lessons Learned in the Alaskan Bush," Trip Report, Naval Postrgraduate School, 2011.

Table 6 compares the proposed aircrafts performance over a 50’ obstacle.

Aircraft	Take Off Ground Roll (feet)	Maximum Take Off Distance (feet)	Landing Ground Roll (feet)	Maximum Landing Distance (feet)
Cessna 208[86]	1405	2500	915	1740
Quest K100T[87]	779	1212	931	1681
Pilatus PC-6[88]	646	1443	417	1,033
Sherpa K650T[89]	N/A	336	N/A	240

Table 6. Aircraft Performance over a 50’ Obstacle

2. The Next Step Is to Just Add Water

An aircraft’s ability to utilize small fields or off airport locations is important in a restricted environment. The ability to utilize inland waterways or expansive coastline is another way to maximize the utility of distributed units. From Table 5, the aggregate coastline of the South China Sea is over 61,400 miles. The number of islands within the region is in excess of 30,000, which is a significant amount of shoreline to secure. It is also a considerable amount of shoreline to exploit.

[86] Cessna Aircraft Company, “Grand Caravan Specification and Description.”

[87] Quest Aircraft Company, “Kodiak Pilot’s Checklist; Model Kodiak 100 with PT6A-34 (750SHP) Engine.”

[88] Pilatus Aircraft Company, “Performance and Specifications.”

[89] Sherpa Aircraft Company, “Sheroa K650T Turbine.”

Figure 8. Cessna 208 Amphibian[90]

Seaplanes are able to conduct covert insertion and extractions of GPF and SOF organizations within the region. Seaplanes are able to conduct water landings anywhere along these shorelines. They can beach the aircraft for transfer of men and material. If the beach is inaccessible, they are able to land offshore, unload the men and material and allow the force to motor ashore aboard a Combat Rubber Reconnaissance Craft (CRRC). The aircraft are not the fastest, nor the most technologically advanced; however, they are utilitarian when the operators are innovative in their application. In this configuration, it allows for the aircraft to be hidden in plain sight. Many of the political implications of overtly military aircraft are avoided and increased mission flexibility is achieved.

[90] Cessna Aircraft Company, "Caravan Special Missions," September 2011.

Figure 9. Dehavilland DHC-2 Beaver with an External Load[91]

C. COST EFFECTIVE COMPARISON FOR LIGHT MOBILITY

When the Marines were short of medium and heavy lift requirements, they determined the best way to compensate was to increase the number of CH-53E aircraft and squadrons. To support additional units, they removed existing airframes from AMARG and returned them to operational status. They also removed all CH-53E aircraft from HMX-1. An alternative option could have been to introduce a light mobility aircraft into the scenario.

Table 7 describes the capacity of aircraft considered for the VMLO against existing rotary and tiltrotor aircraft within the USMC and uses cost per cubic foot and per hour for comparison.

[91] Jesurun and Sharpe, "Irregular Ware (IW) Aviation Lessons Learned in the Alaskan Bush."

Aircraft	Operating Cost Per Hour	Passenger Capacity	Cubic Capacity (Cubic Feet)	Cost Per Passenger Per Hour	Cost Per Cubic Foot Per Hour
CH-53E	28,215	55	1463	513	19.28
MV-22B	37,979	24	739	1582.45	51.39
Cessna 208	393	10	451*	39.3	.87
Quest K100	500	8	248	62.5	2.01
Pilatus PC-6	248	10	106	24.8	2.34
Sherpa K650T	400	8	220	50	1.82

* Includes cargo pod configuration

Table 7. Aircraft Cost Comparisons

Assault support is the function of Marine Aviation that supports the warfighting functions of maneuver and logistics. Maneuver warfare depends on rapid, flexible maneuverability to achieve a battlefield decision.[92] Combat assault support is used to deploy forces in offensive maneuver warfare to bypass obstacles and quickly redeploy their forces. In a distributed operations environment, the number of units to support and the distances involved to travel will increase the demand on existing units. The ability of a light mobility aircraft to support these functions and existing capabilities has the ability to enhance the speed and distance that the Marines can influence the tactical situation.

The proposed aircraft offer the Marines the ability to provide rapid, flexible maneuverability while allowing their medium and heavy lift units to remain focused on their more doctrinal relationships with the MEU and the MEF. They are also a cost effective solution to providing additional lift assets that forced the Marines to remove previously retired aircraft from AMARG. Instead of requiring five years to refurbish, commercially available aircraft are available to support almost immediately.[93]

D. UTILITY IN CONFIGURATION AND CAPABILITY

Two configurations of aircraft are considered for proposed VMLO aircraft. While both types of configurations are turbine powered and high winged, two are configured as tri-cycle aircraft and two as tailwheel aircraft. The merits of range, cargo and passenger

[92] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

[93] Cathy Hopkins, "DLA Helps Navy Resurrect CH-53 Helicopters," *Defense Logistics Agency*, July 1, 2010, http://www.aviation.dla.mil/externalnews/news/20100702.htm.

capacity and operating cost have been discussed. They have also been compared to the operating environment that the VMLO may encounter in the South China Sea or other remote locations.

While external configuration differences exist, the proposed aircraft provide similar internal mission capabilities. Multiple aircraft configurations support missions that closely resemble the seven mission subsets of assault support that lend to their utility as light mobility airlifters.

The argument about whether to use a tailwheel or tri-cycle configure aircraft is varied depending on the source. Tailwheel training is an additional cost when considering time and cost to train for prospective pilots. However, they offer an advantage during off airport operations to be discussed later.

1. Internal Configuration Options

Each of the four aircraft was designed to take advantage of their internal capacity and aircraft performance. In addition to their STOL performance and ability to carry large internal loads, the interiors were designed with multi-mission capabilities.

To meet the multi mission requirement, each aircraft must be able to change its internal configuration rapidly, which typically means going from a passenger arrangement to supporting cargo operations. Each of the four aircraft supports this requirement through the use of quick removal seats that allows the aircraft to be reconfigured without additional personnel or maintenance support.

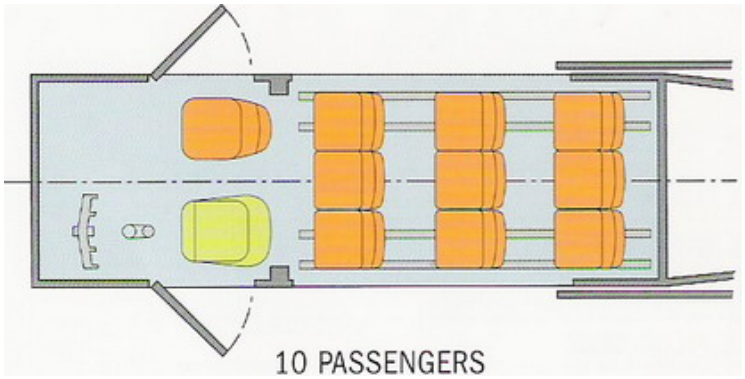

Figure 10. PC-6 Passenger Configuration[94]

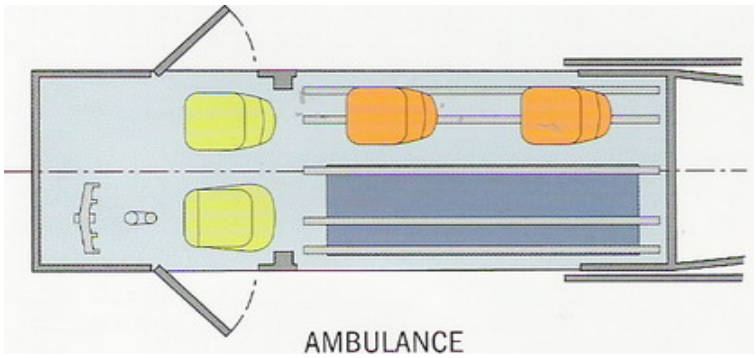

Figure 11. PC-6 Air Ambulance Configuration[95]

Common to each of the aircraft is the ability to support high altitude passenger operations. Each aircraft has a service ceiling of 25,000'. An aircraft requires either a pressurized cabin or it must provide oxygen to each seat to operate above 10,000' mean sea level (MSL). A pressurized cabin is expensive and adds additional weight that would reduce the aircraft's STOL performance. All four of the aircraft provide for oxygen to each passenger seat. Internal oxygen support also enhances the aircrafts capability to act as a MEDEVAC or CASEVAC platform.

Three of the four aircraft have demonstrated their ability to support parachute operations and are common within the general aviation/sky diving community. The

[94] Pilatus Aircraft Company, "PC-6 Turbo Porter: Anywhere, Anytime In Any Environment," June 2010, http://www.danieleicher.com/pdf/Pilatus-PC-6-Brochure.pdf

[95] Ibid.

Cessna 208 and Kodiak are both equipped with electrically driven roll up doors on the left hand side of the aircraft to support parachute operations. The Pilatus PC-6 has a manually activated sliding door system that supports parachute operations from either side of the aircraft. Each one comes with required equipment to support either free fall or static line operations. It is possible for them to support either GPF or SOF resupply and covert insertion without reconfiguring the aircraft's cargo doors from mission to mission.

Figure 12. External View of Cessna 208 Factory Installed Roll Up Door[96]

Since the aircraft are configured as utility platforms, they have diversity in the missions that they can support. Their ability to move men and material allows them to fulfill either a combat assault support mission or air logistical support missions. Installation of the roll up or sliding doors as a standard feature supports mission transition

[96] Airport-Data.com, Aircraft N208TS Photo, (n.d.), http://www.airport-data.com/aircraft/photo/633863.html.

for air drop and parachute operations in a restricted environment. Oxygen and litter configurations support an immediate CASEVAC or MEDEVAC capability essential in any GPF or SOF mission.

Figure 13. Internal View of Cessna 208 Factory Installed Roll Up Door[97]

a. Sometimes More Is Less

Downed aircraft, and more specifically, downed aircrew, is a very sensitive subject in the current military. A TRAP mission is a complicated tactical problem that has many moving parts. It is an example of when the mission flexibility and aircraft utility of the VMLO would enhance aviation capability within a distributed environment. Current doctrine requires a large assault package supported by various

[97] AirTeamImages.com, Cessna 208 Caravan, (n.d.), http://www.airteamimages.com/12949.html?srch_p3=&srch_p2=95&srch_p1=22&srch_s1=&srch_s2=&srch_t1=&srch_t2=&srch_tax1=&srch_trm1=&srch_img_ori=&srch_phtg_id=&srch_img_id=&srch_sort=&srch_reg=.

strike aircraft and personnel. When operating from amphibious shipping or a central location, such a robust package has its advantages. When operating in a distributed environment, it requires a large amount of logistical support to maintain the appropriate posture. In addition to the large number of aircraft, it has an associated operating cost.

Table 8 is the doctrinal USMC TACSOP TRAP package. It details the amount of aircraft and personnel considered to be required for successful execution for a variety of scenarios dependent on distance to the downed aircraft.

STANDARD TRAP PACKAGE

Package	Distance	Conditions	Aircraft	Lift (as required)
A	<90 NM	Over water	2xCH-46E 2xMV-22B	12 Man TRAP Corpsman 1 SAR Swimmer
B	> 90 NM	Over water	2xCH-53D/E 2xMV-22B	12 Man TRAP Corpsman 1 SAR Swimmer
C	< 90 NM	Day/Night Over land	2xCH-46E 2xMV-22B 2xCH-53D/E 2xAH-1W 2xAV-8B 2xF/A-18	2 24-48 Man TRAP Corpsman
D	> 90 NM	Da/Night Over land (long range FARP or TBFDS required for AH-1W)	2xCH53D/E 2xMV-22B 2xAH-1W 2xAV-8B 2xF/A-18	2 24-48 Man TRAP Corpsman
E	> 90 NM	Day/Night Over land (KC-130 may be required for HAR/TAR distances beyond 250 NM)	2xCH53E 2xMV-22B 2xF/A-18 2xAV-8B	2 24-48 Man TRAP Corpsman

Table 8. USMC MAWTS-1 Rotary Wing TACSOP TRAP Package[98]

Package E requires some combination of assault support aircraft (CH-53E or MV-22B), both fixed and rotary wing strike aircraft, as well as a KC-130 for Helicopter Aerial Refueling (HAR) or Tiltrotor Aircraft Refueling (TAR), which is for a mission in excess of 250 nm. If the mission takes two hours, assuming use of the MV-22B, the combined hourly cost of those aircraft is $378,724. It is also a significant

[98] Director of the Commander, Naval Air Systems Command, "Air NTTP 3-22.5-RWTACSOP Tactical Pocket Guide, USMC RWTACSOP," November 2006.

investment in aircraft and additional aircrew when assuming that the location of the aircrew is predetermined and that actions on the objective are immediate. Additional time on station, TOS, will require additional refueling support, as well as additional sections of fixed wing attack aircraft to maintain air superiority.

Envision the same scenario at the same distance. The MV-22B has a 70 KIAS cruise advantage over the proposed light mobility aircraft. However, the proposed aircraft have a 20 KIAS advantage over the CH-53. It does not require additional HAR/TAR support from the KC-130. It is able to loiter over the crash site or in the vicinity without the additional logistical support. The VMLO can assign a fixed gear aircraft, seaplane or amphibian to conduct the TRAP mission. It is a single aircraft with a crew of two able to conduct the very same mission in a distributed environment.

It is possible to provide an effective SAR presence with an aircraft able to move quickly between mission sets. A seaplane operating from an afloat forward sea base could go from an ISR or air drop mission and assume the mantle of SAR aircraft. It is able to land on the ocean and affect a crew rescue or coordinate the recovery from an island within the AOR. A single aircraft attracts less attention and is less of a target than a large number of aircraft in a confined operating area.

2. External Configuration

Each of the four proposed aircraft has a demonstrated ability to support multi-mission internal configurations. The external configuration discussion is oriented to whether or not the suitable aircraft is a tailwheel or tri-cycle landing gear configured aircraft and the advantages or disadvantages of each.

Each of the aircraft for consideration share the same high wing characteristic. The high wing allows for a considerably larger amount of obstacle clearance in off airport operations,[99] as well as also making for a more suitable ISR and CAS/FAC(A) platform.

Two common characteristics defined good FAC(A) aircraft during the Vietnam War. The first was excellent visibility from the cockpit. The second was a high wing to

[99] Potts, *Guide to Bush Flying*.

facilitate visibility and obstacle clearance, which can be seen in the O-1E, OV-1D, O-2 and OV-10 series of aircraft. An aircraft operating in remote locations can apply the benefit of the high wing to capability and mission performance.

Commercial operators in Alaska choose the aircraft most useful to their operations. Many operators use the Cessna 208 and Quest K100T on improved and unimproved strips everyday. True off airport operations are a completely different consideration when determining the most useful type of aircraft. Unforeseen obstacles and terrain pose challenges to tri-cycle landing gear aircraft.

The tri-cycle gear has an advantage over tailwheel aircraft on a paved runway in high wind conditions. Experience in Alaska has shown that the nose gear has shown a tendency to collapse in off airport conditions. For a commercial operator, the weight required to reinforce it sufficiently would negatively impact its profit margin for operations.[100]

When a tailwheel is placed on an aircraft, it naturally raises the angle of the fuselage in relation to the ground. It forces the nose of the aircraft up and increases the distance of the blade tips to the ground, which helps to reduce the possibility of striking the prop. This fact alone is enough for most off airport operators to rely on the tailwheel configuration. Replacing a turbine engine is the number one cost at Kenmore Air.

In addition to the increased safety of the raised nose, it also has an effect on the longitudinal stability of the aircraft during take off and landing, which is important because the terrain and size of obstacles are unpredictable; achieved by changing the geometry of the landing gear and having as much distance between the main mounts and the third wheel. Thus, the center of gravity is placed behind the main mounts.[101]

3. Pilot Training Impact for a Tailwheel Aircraft

The FAA FAR part 61 describes the additional training requirements for a tailwheel endorsement. It is an additional cost and time to train when considering the two

[100] Potts, *Guide to Bush Flying*.

[101] Ibid.

configurations of aircraft. Table 2 shows that each pilot was able to complete the training with an average of 9.6 hours. During Vietnam, the USAF required an additional 20 hours of tailwheel proficiency before acting as a pilot in command (PIC).[102] It is possible that the VMLO has a small number of piston powered aircraft on which to train incoming pilots to reduce the cost of training, as well as allow assigned aircraft to remain forward deployed. The additional 20 hours of proficiency in type can be gained with the forward deployed detachments while conducting area familiarization and standardization flights for new pilots.

E. UNMANNED LIGHT MOBILITY COMPARISON

When the Marines are unable to conduct missions of resupply in support of isolated units due to restrictions in terrain, available assault support aircraft or a prohibitive threat environment, they resort to the use of aerial delivery.[103] In the past, they have used KC-130 aircraft to deliver required supplies via parachutes and pallets. During OIF and OEF, advances have been made in the use of Cargo Resupply UAS (CRUAS) and Joint Precision Air Delivery Systems (JPADS).

1. Joint Precisions Air Delivery Systems

JPADS was developed to meet COCOMS requirement of using high altitude, precisions airdrops as a direct theater delivery method to sustain combat operations power.[104] The Advanced Concept Technology Demonstration (ACTD) concept of operations for JPADS recognized that the current CENTCOM AOR and possible future conflicts would encompass non-contiguous, expansive territories in which asymmetric threats are the norm while occurring over an expansive area. Driven by the increasing threat of Man Portable Air Defense Systems (MANPADS) and IADS, resupply aircraft have been driven to higher altitudes to accomplish their missions.

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[102] Sumner, Raven 21 Forward Air Controller.

[103] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

[104] Richard Benney, Mike Henry, Kristen Lafond, and Andrew Meloni, DoD New JPAD Programs NATO Activities, 20th Annual Aerodynamic Decelerator Systems Technology Conference and Seminar, May 4–7, 2009, http://www.nps.edu/academics/centers/adsc/papers/jpads%20-%20benney%20-%20dod%20new%20jpads%20programs%20and%20nato%20activities.pdf.

Several premises are involved with the introduction and utilization of JPADS. It is a high altitude delivery to take advantage of GPS steering capability to ensure accuracy within 50 to 100 meters circular error of probability (CEP) when utilizing a KC-130 or C-17. It uses a flexible computed aerial delivery release point (CARP) to determine when and where in relation to the intended point, accounting for wind, as well as the lift and drag characteristics of the load. Finally, it integrates an enroute mission planning and satellite communications (JPADS-MP) to conduct mission planning and mission changes enroute to the delivery point.[105]

2. Cargo Resupply UAS (CRUAS)

In October 2011, the Marines deployed both the Kaman K-MAX and Boeing A160 Hummingbird to evaluate the battlefield utility of CRUAS in Afghanistan. The purpose was to demonstrate an ability to provide logistical support of 10,000 lbs within 24 hours with a round trip distance of 150 nm supported by a BLOS capability.[106] Operational organization is a mixture of Marine Corps personnel and contract personnel.

Figure 14. Kaman K-MAX in Afghanistan[107]

[105] Benney, Henry, Lafond, and Meloni, DoD New JPAD Programs NATO Activities.

[106] Seth E. Tufveson, MAWTS-1 UAV Department, personal conversation with the author December 5, 2011.

[107] Zimbio, "K-MAX Flies in Afghanistan," December 20, 2011, http://www.zimbio.com/Aircraft/articles/YfxKqRRT_tm/K+MAX+flies+in+Afghanistan.

K-MAX is rated for a useful load of 6,855 lbs. The A160T Hummingbird is rated for a useful load of 1,500. The required crew for their operation is a VMU mission commander, UAS operator at the Landing Zone (LZ), and is contractor operated. Each of the aircraft has achieved the delivery of 2,500 lbs over 75 nm within a six-hour period, BLOS with GPS enroute waypoint navigation and delivery of the cargo within 10m of the terminal controller. However, they have been unable to sustain cruise operations above 15,000' MSL.[108]

Figure 15. Boeing A160T Hummingbird

Introduction of automated systems continue to enhance the Marines' ability to provide for logistical support in remote locations. While JPADS is filling a niche that even a STOL capable aircraft may not be able to provide, the introduction of another

[108] Tufveson, MAWTS-1 UAV Department.

UAS within the airspace does not offer a full and timely solution to an ever increasing demand on light mobility aircraft. The CRUAS is not slated for introduction until 2016.[109]

F. SUMMARY AND OVERVIEW

The demand for an American military presence is not going to diminish over the next decade. The end of combat operations in Iraq and Afghanistan does not spell the end of deployments for military forces. Reductions in military spending are going to require that each of the services find innovative, low-cost solutions with small footprints to meet overseas military challenges.[110]

As illustrated in the given scenario, the South China Sea is not the only location that future distributed operations will be conducted. It is an example of how large and diverse of an operating area that the armed forces in general, and the Marines specifically, will be operating. This tyranny of distance applies in more locations than the South China Sea. Emerging SOF and conventional operations with AFRICOM will continue to place heavy demand on light mobility assets. Combined with new political realities that affect forward deployed units and the possibility that material readiness issues will prevent capital naval vessels from deploying, it describes an area that can benefit from alternative methods of conducting doctrinal Marine assault support missions in support of widely dispersed units.

Emerging autonomous technologies still have significant technological hurdles to overcome before they are a significant player in a distributed environment. They require a large presence of manpower to support their operations. Both the A160 and K-MAX are operated by civilian contractors that can have drawbacks in a more aggressive combat environment than that currently being experienced in Afghanistan. It is a permissive

[109] Tufveson, MAWTS-1 UAV Department.

[110] Department of Defense (DoD), "Sustaining U.S. Global Leadership: Priorities for 21st Century Defense."

operating environment that allows for exploration of these emerging technologies but may not be truly representative of the challenges faced in future AOs.

General aviation utility aircraft have a role to play in this scenario. They have documented STOL performance characteristics, comparable cargo capacity and mission flexibility when compared to more conventional fixed and rotary wing aircraft. They are efficient and cost effective augments and alternatives to supporting small squad and platoon sized elements.

The researchers originally focused on determining if one aircraft could meet the mission requirements of the proposed VMLO. However, as researched progressed, it became apparent that it was possible to have mix of aircraft to increase the utility of the VMLO and still have an advantage over conventional organizations. The ability of each aircraft to reconfigure quickly mid mission has shown that each of the four are equally viable. Range and airspeeds are relatively comparable. Even though the PC-6 has a slow cruising airspeed, it has better short field characteristics that gives it an advantage over the Cessna 208 and Quest K100T. Considering the area of the South China Sea and the large number of possible units to support, a combination of tri-cycle and tailwheel equipped aircraft would be the best solution.

The cost of the aircraft is not a prohibitive factor. Consider the $109,000,000 price tag of the F-35B. Four F-35B's will cost $436,000,000. If the Marines were to purchase 200 of these aircraft, according to Table 7, it would cost only $400,000,000 for the aircraft. The author is not advocating the purchase of 200 aircraft. The proposal is the creation of three squadrons, 40 aircraft per squadron, and to task them with supporting emerging or current theaters. It is recommended that one squadron support operations in PACOM, one in CENTCOM and the third support AFRICOM operations.

Already doctrinally spoken for are the conventional military aircraft. The MEU requires an entire VMM of 10 MV-22Bs. They also deploy three UH-1Y and four AH-1Ws, 4 CH-53Es and six AV-8Bs to just support a deployed BLT. A single infantry company has three line platoons, a weapons platoon and command element. In distributed operations, it is possible that the company can create 10 distributed units when using

squad sized elements and assuming that the weapons platoon is either co-located with the command element or sourced out to support one of the distributed squads. Then consider that each battalion has three infantry companies, each regiment has three line battalions and each division has three infantry regiments, which does not include the Combat Logistics Battalions (CLB), artillery regiments and batteries, as well as their robust command elements.

The VMLO is not a permanent solution. It is an organization able to fill the capabilities gap with low cost alternatives until the Marines are able to support distributed operations materially and technologically. Sufficient rotary wing aircraft do not exist to support the escalating demand. UAS presence on the battlefield is increasing. However, they are limited by their inability to change rapidly between mission sets while airborne and the fact that they are unable to move men on the battlefield. Until technology develops to the point that the UAVs are truly autonomous and trusted to move combat troops on the battlefield, they will have limited value for distributed units.

V. REDUCING EMERGING CAPABILITY GAPS WITH MANNED AIRCRAFT

The U.S. military is moving to replace manned aircraft providing PISR and CAS/FAC(A) with increased utilization of UAVs. The ability to reduce the exposure of aircrews to possible capture or death is attractive to the military and the political class within the U.S. government. The use of a manned aircraft means that the possibility, however remote, of an aircrew being captured and used as a propaganda tool on the nightly news is a very real scenario. Video and pictures appearing on television and the Internet of dead Americans has a very strong impact on the psyche of the American people and their continued commitment to the conflict at hand. However, an over reliance on the abilities of UAVs can place distributed units in equal danger that imperils the safe and successful completion of their missions.

Future battles will be fought in contested environments. The experience of uncontested airspace that has been the norm in Iraq and Afghanistan may not be repeated if a war with China breaks out in the South China Sea. The UAS will be increasingly vulnerable to physical and technical attacks in AO. Slow airspeeds and limited maneuverability make the UAVs vulnerable to aircraft to air engagements, surface to air missiles and air to surface anti-aircraft artillery (AAA). A heavy reliance on established data links carried over commercial connections with little central oversight means that the link can be easily and frequently interrupted.[111]

Future UAV applications also face number of technical and economic challenges as an increasing number of them are used. A finite number of geostationary satellites exist that provide for worldwide coverage and transponder availability. SATCOM requirements will exceed capacity with an increased number of UAVs. In addition to the limitations of the electronic spectrum, the costs of continuous UAV capability will become prohibitive.[112]

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[111] Scott Fontaine, "USAFE Chief: Don't Rely on UAVs," July 30, 2010, *Air Force Times*, http://www.airforcetimes.com/news/2010/07/airforce_UAVs_073010/.

[112] Bluth, Director of the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS).

A. MANNED AIRCRAFT UAV SURROGATES

The use of manned aircraft as surrogates to UAVs would appear to be a step backwards in technological development and employment. UAVs were the method that would remove the threat to aircrews, provide for PISR and CAS/FAC(A) shortfalls, and decrease operating costs and infrastructure. However, the Air Force has cancelled the RQ-4 Global Hawk in favor of the older, manned U-2 reconnaissance aircraft. Cancellation of the Global Hawk was due to high costs of operation and maintenance and shortfalls within its operational capabilities.[113]

The Air Force determined that it was more cost effective and responsive to utilize manned aircraft for ISR missions. AFSOC utilizes the Pilatus PC-12 and MC-12 aircraft because they are cost effective long endurance options for light cargo movement and PISR.[114] In other words, the vaunted UAV is unable to fill the needs of distributed units effectively. The military has recognized that manned aircraft, with the same capabilities as the UAV, is the more affordable, responsive and flexible option for distributed units. The fact that a commercial company finds it more economical to use a small manned aircraft as a UAV surrogate is very telling about the utility of light weight, manned, STOL capable aircraft.

1. Pelican Cessna Skymaster 337

The Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) is an independent research center, associated with Naval Postgraduate School (NPS), that utilizes a modified Cessna 337 Skymaster referred to as Pelican to provide a low-risk, low-cost test and evaluation alternative to Predator and other UAV type, model and

[113] Richard Clements, "RQ-4 Global Hawk in Shock Cancellation News: Old Planes Better Than New?," *The Aviationist*, January 27, 2012, http://theaviationist.com/2012/01/27/rq4/.

[114] "U.S. Military Orders More King Air 350ER Aircraft [MC-12]," *Defense Industry Daily*, June 19, 2011, http://www.defenseindustrydaily.com/US-Military-Orders-More-King-Air-350ER-Aircraft-05165/.

series.[115] Its operational premise is that by using Pelican, it is giving access to an asset not readily available to a unit. Since 2001, it has provided experience with Predator and other UASs to units to which they may not have had access.

Figure 16. Cessna 337 Skymaster in CIRPAS Pelican Configuration[116]

The Pelican Surrogate UAV (SUAV) system has an estimated $11,000 daily operating cost, which consists of one Pelican, six flight hours, radio relay, mobile GCS and Rover utility. The systems itself consists of the General Atomics Predator mobile GCS, portable GCS, portable GDT, and Vestatron Westcam 14" Skyball sensor. The capability the Pelican mimics is identical to the Predator RQ-1A system.[117]

[115] Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS), (n.d.), http://www.cirpas.org/index.html.

[116] Arizona Aviation Photographers, (n.d.), http://www.azaerophoto.com/SoAR/?p=185.

[117] Bluth, Director of the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS).

An additional advantage of the Pelican for comparison is that the aircraft has a history with the U.S. military. During the war in Southeast Asia, it was used by the Air Force as a FAC(A) platform in support of both conventional military and SOF operations. Through CIRPAS's efforts, it has become a proven low cost, low risk alternative to using an UAV. It is a low cost example of how existing civilian aircraft can be modified and operated in association with existing manned and unmanned aircraft within the military airspace structure.

B. PHYSICAL PRESENCE ON THE DISTRIBUTED BATTLEFIELD

Future AOs in a distributed environment may not allow for the luxury of unopposed airfield operations that have enabled extensive use of UAVs in Iraq and Afghanistan. UAV operations are large complicated affairs that require a certain amount of infrastructure to operate.

A VMU is the parent organization for UAV operations within the Marines. Each VMU consists of three detachments led by either a major or captain. The personnel assigned to the detachment are approximately 50 Marines. They fulfill the functions of command, administration, intelligence, operations, logistics, communications, safety and operations.[118] In addition to the amount of personnel required for operations, the following equipment is assigned to a detachment.

- Four RQ-7B air vehicles
- Two ground control stations/ground data terminals (GCS/GDT)
- Two tactical automated landing systems (TALS)
- One portable ground control station/portable ground data terminal (PGCS/PGDT)
- One hydraulic pneumatic launcher
- Four one-system remote video terminals/modular directional antenna systems (OSRVT/MDAS)

The detachment is designed to operate independently from the VMU but it is not purpose built to act autonomously from the supported unit. Since the unit is not designed to operate without external support, it places a requirement for support from the

[118] Commandant of the Marine Corps (CMC), NTTP 3-22.3-VMU, July 2011.

supported unit. The RQ-7B has been "right sized" according to NTTP 3-22.3 to minimize the burden. It requires the traditional logistical support for Marines of food, billeting and security. In addition to these expected demands, it places a heavy demand for long-term power generation and heavy equipment for establishing and maintaining its airfield.

1. Impact on Battlefield Mobility

The VMLO proposal advertises an ability to self deploy the aircraft and personnel within the AOR. While the detachments would require some of the same logistical requirements, such as security, billeting and food, they are able to move from supported unit to supported unit. When the VMU moves from location to location, it is dependent on a number of vehicles and aircraft to facilitate its movement.

The initial entry operation for a VMU consists of one GCS, AVT and launchers along with three air vehicles (AV). It requires one KC-130J to move the two wheeled vehicles, trailer and AVs. To conduct split site operations, it would require a second KC-130J. For sustained operations and full detachment capability, it would require 3 KC-130Js,[119] which is a significant amount of airlift when a VMGR detachment in Iraq is composed of just six KC-130Js and two of those are designated as Harvest Hawk gunship variants.

[119] Tufveson, MAWTS-1 UAV Department.

Figure 17. MAWTS-1 VMU Overview Airlift Requirements[120]

A single VMU detachment is considered as appropriate for direct support of a regiment or MEB deployment. All three detachments should be considered when considering deployment of a MEF or division level event.[121] Experience in Iraq and Afghanistan has shown that the size and mobility requirements of the VMU force them to operate from established and fortified FOBs. While they are able to extend the range of the RQ-7B by 67 nm with the use of the PGCS/PGDT an area the size of PACOM and AFRICOM, along with the challenging terrain, it does not appear very useful when deploying in direct support of company and platoon sized elements.

2. Aircraft vs. UAV Size Comparisons

It is possible to argue that the size of the proposed VMLO aircraft can make their operations in a remote location prohibitive. They appear to be large aircraft with significant length and wingspans to be landing in space restricted conditions. However, it is necessary to consider that even the RQ-7B requires a runway of at least 710’ in length and a width of 164’ for safe operation. The Sherpa K650T requires just half of that

[120] Capt Seth E. Tufveson, personal conversation with the author, December 5, 2012.

[121] Commandant of the Marine Corps (CMC), NTTP 3-22.3-VMU.

distance to land in and has a wingspan of just 47’ 4”. In addition to the amount of equipment required to operate the UAV, a space in which to store the aircraft while not being utilized must also be available.

Table 9 illustrates the relative footprint of existing UAS and proposed VMLO aircraft. Important to note is the physical presence of the aircraft as well as the comparable take off requirements. The table does not include the associate footprint required to support the UAS operations.

Aircraft	Length	Wingspan	Take-Off Distance (Feet) to clear a 50 ft obstacle
RQ-1 Predator	27 ft	49 ft	5000
RQ-7B Shadow	11 ft 4 in	14 ft	710
Cessna Pelican	40 ft 11 in	42 ft	1500
Cessna 208	41 ft 7 in	52 ft 1 in	2500
Quest K100	33 ft 4 in	45 ft	1,001
Pilatus PC-6	35 ft 9 in	52 ft 1 in	1,444
Sherpa K650T	34 ft 1 in	47 ft 4 in	336

Table 9. Aircraft Size Comparisons

While the RQ-7B has an advantage in physical size over the proposed aircraft, it has a significant footprint associated with its administrative demands for the operational detachment. The RQ-1 is the largest of the UAVs and is comparable in size to the four proposed aircraft. However, it has a significantly larger take off distance to clear a 50’ obstacle in its path. The proposed aircraft are capable of providing the same types of ISR and CAS coverage. They also provide FAC(A) capability and the ability to rapidly change missions. They require less take off and landing distance than the multiple models of the predator. They are also able to operate from unimproved surfaces unlike Predator and Global Hawk. In addition to these performance advantages, they do it with a significantly smaller number of support personnel. A 24-hour mission for a Predator requires 160 personnel.

C. PERSISTENT ISR SUPPORT WITH LIGHT MOBILITY AIRCRAFT

In a perfect world, the ability to provide the right amount of ISR capable aircraft would permanently close the PISR gap currently experienced by the Marines. Sufficient aircraft, support personnel, physical space to occupy, an over abundance of the electronic

spectrum and operating funds would be available to meet each and every need of distributed units. The reality is that each of these resources is finite and is becoming increasingly scarce with each budget cut and technological innovation.

Anti-access and area denial (A2/AD) operations can entail more than the ability of an enemy nation to prevent a significant military support presence within an AO. It is possible that A2/AD can be accomplished by eliminating the communication link to the United States that enables long range UAV operations. An electrical storm located along the LOC from Afghanistan to the United States can interrupt data and communication links that control the UAV. Significant cloud cover and heavy rains can render the sensors on a UAV ineffective when most needed. It can leave a supported unit alone and unafraid deep in enemy territory.

While the use of SATCOM has enabled the U.S. military to operate UAVs at arms length from the actual field of battle, the ability of foreign militaries to interfere with them limits potential use, but does not mean that the supported units will no longer demand the same services to which they have become accustomed in the last decade. Through a combination of direct support operations and technology integration, light mobility aircraft can increase the situational awareness of the supported unit.

1. Distributed Utility with Direct Support Operations

The VMLO enhances distributed operations by the way in which it ought to be organized and employed. The Marines ought to capitalize on the lessons learned from organizations that have perfected hub and spoke operations to their commercial advantage. In a scenario like the South China Sea, the VMLO could operate an administrative hub in Darwin, co-located with III MEF. Smaller facilities in Singapore and the Philippines would act as maintenance and logistical support facilities. They would then function as a rear area element for the smaller aircraft detachments operating from battalion and company level locations. The mission needs of the supported unit would determine the number and type of aircraft required to support their mission.

A VMU is not designed to support expeditionary operations. A detachment of 50 personnel that requires a full KC-130 to move about a battlefield will have difficulties

matching a fluid combat environment in an area the size of the South China Sea or northern Africa. Modularity and scalability are central themes to how the VMLO would operate and maximize its presence. Since the aircraft require only a crew of two, they are cross trained to sustain the aircraft in the field and are self-deployable within the AO; it is able to move quickly and easily between supported units as the focus of effort changes within the operational and tactical construct.

The aircraft themselves enhance how direct support is provided to these smaller units. They take advantage of significant useful loads and short field performance to access areas once off limits to fixed wing support or out of the unrefueled range of the current rotary wing fleet of aircraft. Due to their rugged construction, they are able to take advantage of less than ideal landing conditions that would prohibit continuous operations by a VMU without major advanced preparation work prior to the detachment's arrival.

a. Prepping the FOB for a VMU Detachment

In July 2011, VMU-3 was forward deployed to Camp Leatherneck, Afghanistan. In preparation for the arrival of the detachment at the well established facility, Marine Wing Support Squadron (MWSS) 272 utilized heavy equipment to flatten the landing surface. The MWSS expeditionary airfield section then utilized aluminum to reinforce surface of the runway. This process took 10 days. Following the arrival of the VMU detachment, it was an additional three days of aircraft testing and area familiarization.[122]

Bush pilot experience in Alaska and research conducted for this thesis shows that aircraft are able to use a wide variety of techniques to provide air support in remote locations. One example is using shallow water landing techniques to reduce the landing distance required.[123] The Sherpa K650T is able to take off and land in half of the distance required for an RQ-7B and does not require the establishment of a fixed runway

[122] Samantha Herrington, "Marine UAVs Get New Home in Afghanistan," July 13, 2011, http://www.marines.mil/unit/mcascherrypoint/Pages/MarineCorpsUAVsnewhomeAfghanistan.aspx#.T24rKXiPRg.

[123] Jesurun and Sharpe, "Irregular Ware (IW) Aviation Lessons Learned in the Alaskan Bush."

to operate. The possibility exists that the four proposed aircraft could use the expeditionary field established for the VMU and the associated FOB as one more hub to utilize to support the distributed unit.

2. Utilizing Existing ISR Systems

To keep the VMLO aircraft economically feasible, the purpose is not to introduce new technologies and capabilities within the military inventory. The introduction of an additional aircraft within the military is a significant enough impact. Aircraft acquisitions are plagued by costly airframe and system overruns that can delay the introduction for a number of years, if not decades. Both the MV-22B and the F-35 are characteristic of the delays experienced in acquiring the latest generation of aircraft. It is not the intent of the VMLO to complicate the different number and types of systems available. Commonality of payloads is necessity for the VMLO to be an effective cost alternative at the tactical level.

a. RQ-7B Shadow Payload

If an increase in the number of VMUs, equipped with the RQ-7B, is sufficient enough for the Marines, then the first system to consider is the payload that the Shadow currently uses. The Plug-in Optronic Payload (POP) 300D is a dual imagery sensor that supports both Infra Red (IR) and Electro-Optical (EO) day night operations.[124] Built by Israeli Aerospace Industries (IAI), the POP-300D, is also equipped with an eye safe Laser Rangefinder (LRF) and a Laser Designator (LD) compatible with AGM-114 Hellfire operations.[125] IAI offers a number of additional sensor "slices" containing different sensors that can be switched in field conditions in just minutes. The advertised cost for the system with Forward Looking infra Red (FLiR) system and television (TV) is $260,000.

In addition to equipping land based UAVs and manned aircraft, IAI has also developed the POP-300 family of sensors for shipboard use. In other words, the

[124] Commandant of the Marine Corps (CMC), NTTP 3-22.3-VMU.

[125] Israeli Aerospace Industries, "POP Family," 2002, http://www.iai.co.il/18688-16661-en/SystemMissileandSpace_Tamam_Electro-Optical.aspx.

POP-300D is able to operate in the maritime environment typically very abusive on sensitive electronic equipment. Integration of the marinized POP-300D would enhance a seaplane's role as a maritime PISR asset. When a P-8A is unavailable because of limited numbers of acquisition or political pressures, a POP-300D equipped Cessna 208 or Quest K100 could reduce the information gap within the AO.

b. Manned Aircraft Systems

FLiR Systems, Inc. has produced the BRITE STAR II target designation system for a number of airborne and maritime aircraft and vessels. It is currently the systems of choice for the UH-1Y and AH-1Z and ensures commonality on a critical piece of equipment. In addition to the BRITE STAR II, FLiR is providing additional systems and capabilities to the U.S. military and law enforcement agencies. Therefore, the system will be compatible with sister services and other NGOs operating within the AO.

In addition to the systems common to military aircraft, FLiR has introduced a line al all digital, full high definition systems. The Star SAFIRE family of interchangeable sensors utilizes common connectors, wires, gimbals and FLiR common interface, which is a significant increase in capability to an organization looking to reduce the PISR capability gap. In addition to the full digital capability, the sensors provide all of the same capabilities as the BRITE STAR II systems.[126]

c. Emerging Capabilities

The Marines are not the only service experiencing a lack of organic airborne ISR support. CANOPY is a proposed Joint Capability Technology Demonstration (JCTD) attempting to reduce significantly the 1.6 percent ISR support rate experienced by SOF forces in Afghanistan during November 2010.[127] The intent of the JCTD is to leverage Government Off-The-Shelf (GOTS), COTS and an open architecture network to create an ISR capability in one integrated system.

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[126] FLIR, "Star SAFIRE HD Systems," (n.d.), http://gs.flir.com/uploads/file/products/brochures/star_safire_hd_family.pdf.

[127] Bruce Holmes, N833 Science and Technology Advisor and Special Program Analyst for COMNAVSPECWARCOM, personal conversation with the author, February 15, 2012.

CANOPY expects to utilize a number of systems on board the ARES II UAS to provide for a number of mission capabilities that will meet ISR shortfalls. It plans on utilizing the Harris Company family of Small Tactical Terminal (STT) Link 16 network nodes the SEA LANCET system for VHF/UHF communication relays over 100 nm using either the PRC-117G or PRC-152. To provide for full motion video (FMV), the JCTD uses the STARFIRE 380HLD Sensor Ball from FLiR. Other initiatives call for the use of Video Scout and National Security Agency certified Type-1 Secure Network (SECNET) 54 Cryptographic Module (CMOD). Integration of these capabilities with Adaptive Networking Wideband Waveforms (ANW2) and the VHF/UHF relays give the ground commander HD FMV and SIGINT situational awareness. The application of LINK 16 within the JCTD allows for digital (DCAS) utility.

Even though the focus of the CANOPY is geared to SOF applications, the idea of utilizing a common payload to be used on an UAS is an added benefit when considering PISR applications on a manned aircraft. It must be a lightweight payload. If the weight is too heavy, it will have adverse effects on the UAV's ability to reach altitude and have adequate loiter capability. In other words, it would also be light enough for one of the proposed aircraft to carry without affecting its useful load.

To save infrastructure and cost, commonality in parts is essential to any new system being introduced. The Marines are looking for a common or baseline EO/IR ball and are involved with the CANOPY JCTD. A common payload that users and customers are familiar with would go a long way to reducing the PISR cap within the military. The use of CANOPY within the VMLO aircraft would augment existing ISR sensors within the Marine aviation community.

D. IT ALL COMES DOWN TO CAS/FAC(A) AND SOMEONE IN THE OVERHEAD

The ability to provide CAS and FAC(A) capabilities to the distributed unit is a two-part process. CAS is the action taken by fixed and rotary wing aircraft against hostile targets in close proximity to friendly forces. As a subset of the OAS function of Marine

Aviation, it provides fires and force protection, and can directly or indirectly affect the enemy's center of gravity. CAS itself requires detailed integration and coordination with fire and movement of the friendly forces.[128]

According to MCWP 3-2, a FAC(A) is "specifically trained and qualified aviation officer who exercises control from the air of aircraft engaged in close air support of ground troops."[129] As an extension of the Tactical Air Control Party (TACP) who is trained and qualified to perform air reconnaissance, surveillance, terminal control of aircraft as well as controlling artillery and naval surface gunfire. In addition to these capabilities they are qualified and designated to act as radio relays within the AO.[130]

1. The FAC(A)

No argument exists that the ability to place an aircraft overheard for troops in contact (TIC) has a value added. For this reason, FAC(A) designation exists within the Marines. In addition to providing for fires, force protection and situational awareness, it allows for the rapid application of firepower once the aircraft arrive on station. The FAC(A) is able to apply aviation firepower at the time and place the ground commander needs. It also determines the type and amount of ordnance that will best support the developing ground scenario. When done properly, the FAC(A) is able to reduce the workload on the ground commander who is busy fighting a much closer and personal fight with the enemy.

[128] Commandant of the Marine Corps (CMC), MCWP 3-2 Aviation Operations.

[129] Ibid.

[130] Ibid.

Figure 18. Cessna O-2 Skymaster[131]

Depending on the aircraft being used, the FAC(A) was not intended to be a CAS platform directly engaging the enemy. The O-1E and O-2 were armed with 2.75" White Phosphorous (WP) rockets intended to mark the target for TGO[132] but did not intend that they would not conduct impromptu CAS missions. Some pilots carried a combination of WP and high explosive (HE) rockets dependent on the immediacy and need for CAS. Stories exist of some O-1E pilots using personal weapons against the enemy when no tactical jet aircraft were available to provide for support.[133] The larger and more powerful OV-10 was equipped with internal guns and external hard-points for the use of 2.75 and 5" rockets with WP and HE.

a. Detailed Integration and Coordination

When the dedicated FAC(A) aircraft for the Marines is the two seat F/A-18D, how is the ground commander able to achieve detailed integration and

[131] Psywarrior.com, "The Psyop Role of the O-2B Aircraft in Vietnam, 02B Skymaster," (n.d.), http://www.psywarrior.com/02.html.

[132] Robbins, *The Ravens: The Men Who Flew in America's Secret War in Laos.*

[133] Hooper, *A Hundred Feet Over Hell: Flying with the Men of the 220th Recon Airplane Company Over I Corps and the DMZ, Vietnam 1968–1969*.

coordination? While video teleconferencing, chat functions and email are effective methods of communication in a sympathetic electronic environment, it is vulnerable to cyberwarfare operations aimed against U.S. military forces.

The VMLO is able to provide detailed integration and coordination by providing a sustained presence with deployed conventional and SOF. Since the aircraft are built for sustained remote operations in civilian applications, they can maintain their presence in the field for extended periods that conventional squadrons cannot match. They will utilize the performance of the aircraft to support locations that larger fixed wing aircraft are unable to support. Decreased distance to the supported unit allows for an aircraft to carry an increased amount of fuel or ordnance, either increasing the loiter time of the aircraft or its ability to act as intermediate CAS platform until the more conventional fixed or rotary wing aircraft can arrive. By co-locating with the supported unit, it is conceivable that the supported and supporting unit will experience an increased level of situational awareness and more timely level of support.

While the idea of co-location sounds like a common sense idea, it is an idea that could use multiple metrics to either prove or disprove the theory. The Combating Terrorism Technical Support Office (CTTSO) has created the Remote Area Air Mission (RAAM) to explore co-locating a Cessna 208 with a SOF organization deploying to an active AO. CTTSO's purpose is to evaluate the ability to operate and bed down an aircraft in which the aircraft and environment are compatible. However, the issue for CTTSO is the application of this capability with a distributed SOF organization. Consideration for use within then GPF is an subject for a separate experiment.[134] CENTCOM is currently investigating the same possibility with a more CAS oriented aircraft in an alternative AO from CTTSO. The premise of both these experiments is that a more cost effective way exists to provide light mobility, PISR and CAS/FAC(A) capability in an asset limited environment.

[134] CAPT Kenneth Klothe, USN (ret), e-mail message to the author, December 15, 2011.

2. CAS

Keep It Simple Stupid. (KISS). When considering the integration of existing small, precision-guided munitions for these proposed aircraft, the Marines must look no further than existing systems. Within the military inventory, a number of weapons being used to conduct CAS relevant to the considered aircraft are available. In some cases, the weapons have been deployed aboard the specific type/model/series of aircraft or aircraft similar to those considered in this thesis.

a. Advanced Precision Kill Weapons System (APKWS)

British Aerospace and Defense Company (BAE Systems) has developed a semi-active laser head for use on the existing USMC 2.75" rocket. It provides for a plug and play compatibility that requires no additional remanufacturing of existing systems. It is advertised as a field installation friendly systems that requires not additional modifications for existing systems.[135]

In an environment of restrictive Rules of Engagement (ROE) in which collateral damage can have operational and strategic propaganda impact, it provides terminal guidance for a previously unguided missile system. It fires the legacy unguided 2.75" rockets from existing launchers compatible with fixed and rotary wing aircraft, as well as unmanned vehicles. It is compatible with existing laser designators that maximizes accuracy, combined with a low yield warhead, to reduce costly collateral damage.[136]

[135] BAE Systems, Products, "Advanced Precision Kill Weapon System (APKWS)," (n.d.), http://www.baesystems.com/product/BAES_027112/advanced-precision-kill-weapon-system-apkws?_afrLoop=44499533166000.

[136] BAE Systems, "APKWS, Advanced Precision Kill Weapon System WGU-59/B," (n.d.), http://www.baesystems.com/cs/groups/public/documents/document/mdaw/mdqw/~edisp/baes_027114.pdf.

Figure 19. APKWS System on the AT-6C[137]

b. AGM-175 Griffin

Raytheon has developed its own precision guided missile system for use aboard a wide variety of aircraft. It is advertised as an air and ground launched system for precise, low collateral damage engagements.[138] Griffin A is the aircraft deployed model. It has been used aboard the Marines KC-130J Harvest Hawk gunships. The Harvest Hawk has utilized it from the rear ramp of the aircraft as a free fall launched weapon. It is also capable of forward firing from a wide range of aircraft. It has been certified for use on the KC-130J, MC-130W, MQ-1 Predator, MQ-8 Fire Scout, MQ-9 Reaper as well the OH-58D as a test platform.[139]

The system itself weighs 33 lbs and is 42" in length. Raytheon advertises a 12.5-mile range when used from an aircraft. The 13 lb fragmentation warhead maximizes

[137] RP Defense, "APKWS Scores Successful 1st Time Demo on Fixed-Wing Aircraft in Record Time," February 21, 2012, http://rpdefense.over-blog.com/article-apkws-scores-successful-1st-time-demo-on-fixed-wing-aircraft-in-record-time-99837718.html.

[138] Raytheon, "Raytheon Missile Systems Griffin® Real-Time Attack System," (n.d.), http://www.raytheon.com/capabilities/products/griffin/index.html.

[139] Ibid.

effect while minimizing collateral damage. The capability to receive geo-coordinates from UAVs and other aircraft can eliminate the need for the operator to find the target and engage from a BLOS position.[140]

Figure 20. AGM-175 Griffin Small Tactical Munition[141]

c. AGM-114 Hellfire

Hellfire was first built in 1978. It was designed as short-range, laser or radar guided air to ground missile systems. Since 1978, it has undergone a number of design changes and advancements. It has been utilized on a number of different platforms over the years. First used on The AH-64 Apache and AH-1W, it has been adapted to additional helicopters and aircraft. The Marines currently use the AGM-114K from their helicopters and KC-130J Harvest Hawk.[142]

The AGM-114K is a Hellfire II missile first developed in 1994. It weighs in at 100 lbs with a length of 64". It has a range of 9,000 m. The -114K was initially developed for the Navy and the Marines. It was finally adopted for use with all of the

[140] Raytheon, "Raytheon Missile Systems Griffin® Real-Time Attack System."

[141] Defense Update, "Griffin Small Tactical Munition (STM)," 2011, http://defense-update.com/products/g/31122010_griffin_sgm.html.

[142] Boeing, History, "AGM-114A HELLFIRE Missile," (n.d.), http://www.boeing.com/history/bna/hellfire.htm.

services. The -114P is a variant of the -114K that has been optimized for use with high altitude UAVs.[143] ATK has modified the AC-208 to fit two -114K's from underneath the wing and has been in use with the Iraqi Air Force.

Figure 21. AGM-114K Attached to a Cessna AC-208[144]

E. SUMMARY AND OVERVIEW

The current environment in Iraq and Afghanistan has been user friendly to UAV operations. Little opposition has occurred to the air superiority that the United States has been able to achieve. The threat of sophisticated IADS is non-existent.Nevertheless, this does not mean that U.S. forces have not faced a threat from MANPADS and optically guided heavy caliber threats. However, the predominant threat within these AOs is a limited number of MANPADS and an overabundance of small caliber infantry weapons that pose little to no threat to manned and unmanned aircraft providing for light mobility, PISR and CAS/FAC(A) missions.[145]

The increasing dependence on UAVs has not faced a significant challenge in the electronic spectrum from a more sophisticated enemy, such as China. Little to no countermeasures have been used against UAVs, and the satellites and networks that support their operations. If there is to be a lesson learned from the past decade, it is that

[143] Directory of U.S. Military Rockets and Missiles, AGM-114, "Boeing/Lockheed Martin (Rockwell/Martin Marietta) AGM-114 Hellfire," June 23, 2009, http://www.designation-systems.net/dusrm/m-114.html.

[144] ATK, ATK'S Caravan FID Family: ISR, Training and Light Attack Presentation, 2008.

[145] Bluth, Director of the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS).

the way the United States operates and depends on the utility of UAVS has been widely studied and disseminated throughout the world by its enemies. It has also created a false sense of security that the UAV will always be a viable option in a more volatile and disputed environment.

The Marines continue to face force protection issues while operating in Afghanistan. The country is dominated by small Taliban organizations in a heavily entrenched COIN environment. The FOBs are heavily defended to prevent an individual attack, and the military is consistently looking for ways to remove vulnerable convoys from the roads to prevent IED attacks. However, they have not faced a more conventional force looking to decimate their forces and dominate the terrain that they occupy. As the VMU becomes more important, the numbers of detachments increases. They are a large unit dependent on a large logistics network to move them about the battlefield. While they are on the move, they leave the supported units without their PISR capability. In a less static environment, the time and energy required to breakdown and set up their equipment could be problematic at best and impossible if the supported unit is constantly on the move.

The Marines continue to attempt to do more with less. It has become unofficial in the Marine Corps over many decades. It is an institutional idea that stretching the utility of a resource is a better option than identifying a solution that could reduce the wear and tear on and preserve costly assets in a fiscally constrained time. Use of the KC-130J as a modular gunship is an innovative idea. However, it draws focus of the purpose of the aircraft away from providing for assault support and aerial refueling and places a premium on its ability to act as a CAS platform. It does not make sense to purchase a modular capability for $22 million per system at the expense of TACAIR and air mobility operations that reduce the miles driven over IED-infested roads.

The proposed light mobility aircraft can help close this gap. It will maximize its utility by integrating baseline EO/IR systems already in use by the Marines. The CANOPY concept would enable a modular system that can be scaled to the needs of the supported unit quickly and inexpensively to be used on the aircraft with little effect on useful load. By basing the aircraft in close proximity or directly with the support unit,

they would achieve an overhead presence tailored to their specific needs by aircrew intimately familiar with the tactical situation. In a contested electronic environment, they could utilize LOS and BLOS VHF/UHF communications to feed FMV and digital information to the supported unit.

In an environment experiencing active AAW operations, a manned aircraft has several advantages over its UAV counterpart. First, it is equipped with advanced active countermeasures. Current UAVs are not equipped with either chaff or flare dispensers or countermeasures.[146] Second, UAVs operate autonomously in established search tracks to optimize the performance of their sensors. The enemy has been watching and evaluating these operations for over a decade. Manned aircraft can vary altitude, airspeeds and flight paths for weather, threats, and developing situations to support the distributed units more effectively.

[146] Bluth, Director of the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS).

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VI. CONCLUSIONS AND RECOMMENDATIONS

The next decade will present the Marines with many challenges. They are faced with a reduction in their annual budget. From a total of 202,000 Marines, they must reduce their active force to 182,000 Marines. As the OIF and OEF come to an end by 2014, they must realign their forces, doctrine and equipment to support the new national strategy and operate across a distributed environment. In addition to these challenges, they face the acquisition and integration of new aircraft, such as the F-35B and CH-53K, and the elimination of legacy aircraft like the CH-53D/E, AV-8B and the F/A-18B/D. Faced with the costly overruns and delays experienced by each of them, the Marines will be forced to support an increase in support missions to distributed units with a legacy fleet defined by high operating costs, dwindling numbers of aircraft and a declining readiness rate.

Consideration and creation of the proposed VMLO is not the cure all for the challenges of the future. However, it is a cost effective alternative to reducing the light mobility, PISR and CAS/FAC(A) gap for the next 10 to 15 years. It offers an ability to provide remote locations with the flexibility of the MAGTF that supported units have come to expect. The Marines spend a significant sum of money to train their aircrew and maintain their currency and proficiency. The VMLO, and the supported units, would benefit from the sustained presence of the aircrew and the aircraft. Leveraging STOL capabilities and utilizing the skills learned in the back country of Alaska could bring a timely and effective method of air support in areas the size of the South China Sea and Africa. It would leave the more conventional aircraft and organizations to focus their talents and capabilities against a more defined, conventional foe.

A. VMLO CONCLUSION AND RECOMMENDATION

The idea of the VMLO is simply an update to the VMO concept used so effectively by the Marines from World War II through Desert Storm. It depends on a modular and scalable application of detachments to support the specific needs of the supported unit. Utility of the squadron rests on a decentralized command and control

function from higher headquarters. It depends on a small command element to manage the administrative and maintenance needs of the deployed aircrew and aircraft, which reduces the costly administrative overhead that would push proven commercial operators like Kenmore Air out of business. The aircrew is given the ability to focus on flying and fighting their aircraft as an integral part of the supported unit's ground scheme of maneuver.

The South China Sea is not the only location that the model of the VMLO has applicability. It has applicability across a large spectrum of possible areas of conflict. The South China Sea has been used to demonstrate the size and complexity of the AO. The offensive capability of China has the ability to deny large conventional naval forces access. Operations in northern Africa face many of the same challenges when considering distance, response time and number of aircraft available to support. Project RAAM is evaluating the same capability and requirement for distributed units within AFRICOM.

As of October 2011, SOF forces within AFRICOM face significant challenges to achieving a persistent light mobility, ISR and CAS/FAC(A) presence. A C-130 request takes 35 days of notice. AFSOC NSAV planning requires a minimum of 48 hours notice. JSOAC only provides four aircraft to support the entire continent of Africa. In addition to the limited number of aircraft, JSOAC-A NSAV units will only land at a site that has a site survey completed prior to use.[147]

While the AFRICOM operations are SOF specific missions, the new national strategy is calling for an increased presence of more conventional forces to support SOF. If the Marines experience a change in roles and are more closely aligned with SOF, as CMC has called for, it is very possible they will operate extensively in this area. Increasing the number of units will only increase demand for responsive air support.

It is recommended that the Marines evaluate the utility of a VMLO to fill the existing capability gap to allow more conventional units to focus on returning to the challenges of operating aboard amphibious shipping. Additional NPS research should focus on the manpower impact and organization of two VMLOs within the Marines. NPS

[147] CAPT Kenneth Klothe, USN (ret), e-mail message to the author, November 21, 2011.

has an existing relationship with CTTSO and Project RAAM. The evaluation of their experiment in AFRICOM would provide many answers to the utility and viability of co-locating COTS aircraft with distributed units. It is an excellent opportunity for NPS to remain relevant in the evaluation of these aircraft in the COIN/IW arena, even for conventional forces.

B. AIRCREW SKILLS CONCLUSIONS AND RECOMMENDATIONS

Project research took three experienced military aviators and immersed them in the basic skills required to operate the types of proposed aircraft in remote locations. Currency and proficiency training have significant impact on the fiscal budget of each. Considering the high operating costs of existing aircraft, an hour of flight is costly when compared with the training and operating costs experienced by the three researchers.

When compared to initial training and qualification in existing aircraft, the training of the researchers had significant cost savings. In 46.5 hours of flight, they achieved six individual ratings and endorsements for a cost of $17,600. The cost of one hour of MV-22B flight time is $19,100 as a function of just flying. When the administrative overhead cost is added to the operating cost, an hour of MV-22B flight time is in excess of $34,000.

It is possible to train experienced military aviators to fly civilian aircraft of different configurations in remote locations. AFSOC has been demonstrating this capability for a number of years. However, AFSOC NSAV as a community and the military as an institution have remained closed to applying this unique capability to the U.S. military. They remain convinced that the only utility of this capability is for FID and BPC. Significant resistance remains to the discussion of using these skills and aircraft for conventional U.S. military forces. A more adequate evaluation of the type of training, time to train and cost would have been possible if the AFSOC community and the USAF as an institution were to take this capability more seriously.

It is recommended that the Marines take a close look at how AFSOC NSAV units organize, train and deploy COTS aircraft in support of FID and BPC missions. Evaluate what benefits that the Air Force believes that pilots trained to operate in this environment

bring to the service. They must then be able to look at the future of distributed units and an aging legacy fleet and apply the lessons learned in the development of a VMLO that leverages pilots operating STOL aircraft in a distributed environment. In addition, AFSOC in general and the Air Force specifically, must openly discuss the capabilities and advantages that their NSAV units bring in a distributed environment and not treated as a secret to keep from a sister service to protect their piece of the budgetary pie.

C. EXISTING ISR AND CAS/FAC(A) CONCLUSIONS AND RECOMMENDATIONS

Rapid technology development and application has increased the number and types of manned and unmanned aircraft that can support ISR and CAS applications. By adopting a baseline EO/IR system and applying it to the proposed aircraft, combined with their forward deployed nature, the Marines have the ability to close the existing PISR capability gap. Since they are used aboard existing UAV,s they are able to integrate seamlessly within the existing networks and provide the desired last tactical mile of support to the distributed unit. When faced with a challenging electronic environment, manned aircraft can provide that essential communications relay and LOS FMV and digital communications so essential to operations.

The same can also be said for integrating existing small tactical munitions currently being used aboard manned and unmanned aircraft. Retrofitting an aircraft with any of the mentioned weapon systems is a very real possibility as the AC-208 conversion has shown. Operations of Griffin from the cargo ramp of the KC-130J may be no different than from the cargo door of one of the proposed aircraft. If that is not applicable, the A model is compatible with forward firing operations from an aircraft, which brings that desired CAS capability to the lowest supported or distributed unit.

The ability to provide the capability is proven. Additional research on the actual cost and process to install both the EO/IR sensors and the weapons systems would be the next logical step, which would require coordination with the aircraft manufacturers and a

commercial company like ATK to evaluate properly. It is a necessary piece of information not within the scope of this research. The cost of the modifications is necessary to give a more precise cost to the proposed aircraft.

D. WHICH AIRCRAFT AND IN WHAT COMBINATION

The ultimate purpose of this research was to consider what type of aircraft would be best for a proposed light mobility aircraft able to fulfill the light mobility, PISR and CAS/FAC(A) capability gap. Each of the four aircraft is capable aircraft with solid STOL capabilities while providing a significant useful load applicable to distributed units.

Initially, research focused on providing for one aircraft to fill the possible missions for the VMLO. However, this concept continues to feed the do more with less mentality within the Marines and the military. A combination of aircraft will allow for each aircraft to fit a specific and well defined niche to augment existing conventional aircraft. Training has proven aircrews are capable of mastering different type/model/series of aircraft. The fact that the aircraft are relatively unsophisticated means they do not require the extensive training and orientation associated with a MV-22B or AC-130. It also allows for a more responsive structure to the environment and needs of the supported unit. It should consist of one type of proposed tri-cycle gear aircraft and one type of proposed tailwheel configured aircraft. The reason is that the proposed tailwheel equipped aircraft provided additional performance advantages that could enhance the type and amount of direct air support that the VMLO could advertise and provide.

1. Cessna 208

The Cessna 208 is the aircraft that ought to be acquired as the primary light mobility, PISR and CAS/FAC(A) aircraft. Although the Quest K100 and the Cessna 208 are similar in physical appearance, the 208 offers several advantages in both performance and compatibility with the U.S. military that would save time and money over the acquisition cycle.

The first factor is that the aircraft meets all but one of the AMC CRFI requirements for a light mobility aircraft. It has a proven ISR and CAS capable variant in the AC-208. Modification of the avionics for dual BLOS, encrypted VHF/UHF radios can easily be accomplished with systems like the AN/PRC-152 or the ARC-210 radio currently in use with conventional military aircraft. It is also important to note that 208 is presently an approved aircraft within the military, which reduces overall costs when considering aircraft evaluation, acceptance and aircrew training. Flight Safety now handles the initial training and qualification of crews assigned to the U-27A.[148]

The second factor is that the aircraft outperforms the K100 in all but a few performance factors. With a useful load of 4,680 lbs, it has a 910 lb advantage over the K100's 3,770 lb useful load. While the K100 has a range advantage over the 208 of 117 nm (58.5 nm radius of action), the 208 has a three knot cruise advantage with a capacity for 14 passengers compared to the K100's eight passenger capacity. While the K100 has a distance of 1,212' over a 50' obstacle, the discussion of a more capable tailwheel aircraft in combination with the 208 will make clear why this was not a major consideration. Also, considering the number of unimproved runways, sufficient distance for the heavier 208 to operate in exists.

The third factor for choosing the 208 is that the aircraft is available in a larger quantity than the K100. Cessna has overproduced more than 2,000 208s compared to the 60 K100s produced for Quest. The popularity and utility of the 208 secure the aircraft's production for the foreseeable future. Over time, with an increase in orders and a more secure commercial market, Quest may become more competitive with the numbers of aircraft produced and production rate. However, it may take a period of time to meet the demand placed on them by the introduction of the K100 into the U.S. military.

2. Quest K650T

The first question to answer is why the decision to include two type/model/series of aircraft within the VMLO. The Cessna 208 is the 80 percent solution when advocating a STOL aircraft capable of true remote off airport operations. It gives access to a majority

[148] Maj Andrew Jett, personal conversation with the author, January 5, 2012.

of unimproved airfields within future AOs like the South China Sea and northern Africa. It can even take advantage of a number of airfields of opportunity, hastily identified by the supported unit and capable of matching the aircrafts performance factors. However, it does not answer all the questions about where the VMLO can support a distributed unit operating far from home in a very remote location with limited options for airfields and landing zones.

First, in contradiction to one of the very reasons that the 208 was chosen, the K650T is not available in large numbers. Nor does it enjoy an established production facility that even matches the capability of Quest or Pilatus aircraft companies. However, the performance of the aircraft can provide for that last tactical mile and provide the missing piece for true off airport operations. It is viable because the 208 can be the 80 percent solution until the aircraft is available in sufficient numbers to support VMLO operations. The K650T can be introduced in stages to forward deployed detachments as it becomes available.

Future research should focus on three aspects of developing the K650T. The first aspect should be on the impact on design modifications during the design and production phases. Since the aircraft is relatively new, it is possible for the military to have more direct access to the process for modifications. The second is the cost and ability to expand the capability of the production facility and how long that process would take. The final aspect is to consider just how many aircraft would be needed, how long the production would take, and the impact on cost and availability.

The Pilatus PC-6 has a long history with organizations like Air America and Continental Air Service. The U.S. military has used the aircraft for FID and BPC missions. However, it is simply outperformed in by the K650T. It has an advantage of passenger capacity over the k650T when comparing its 10 passengers vs. the K650T's eight.

However, the PC-6 cannot compare to the demonstrated STOL capability of the K650T. At maximum gross weight, the aircraft can take off in under 300' compared to the 1413' required for the PC-6 over a 50' obstacle. The K650T can also land in less than

400’ compared to the maximum landing distance of 1330’ of the PC-6. When considering providing off airport operations to close the last tactical mile, it is essential to minimize the maximum take off and landing distance while maximizing the number of passengers and cargo weight.

With a range of 1,091 nm and a cruise airspeed of 174 KIAS, the K650 far exceeds the PC-6’s range of 870 nm with a cruise airspeed of 199 KIAS. Considering the importance of distance and the ability to traverse a large AO, speed and distance, combined with landing and take off performances, makes the K650 a clear favorite. The performance and the endless possibilities that the aircraft can provide to the VMLO make it well worth the time and cost required to develop its production infrastructure. It would certainly have a significant chance of beating the Initial Operating Capability (IOC) of 2018 for the CH-53K.

E. IN THE END

Over the next 10 to 15 years, the capabilities within the proposed VMLO and their aircraft would provide significant light mobility, PISR, CAS and FAC(A) services to distributed units. Events in Iraq and Afghanistan have shown that UAVs have made significant advances; however, they are not a substitute for manned aircraft overhead troops in contact. The fact that both the Air Force and Army have purchased turbine aircraft to provide more timely flexible responses speaks volumes about the UAV’s limitations. Global Hawk was cancelled because it was more expensive to operate than the legacy manned U-2. Delays, cost overruns and uncertainty over what models of the F-35 the Marines will use are jeopardizing their ability to provide organic CAS to units.

1. Rapid Response

Manned aircraft provide for a rapid response to the needs of the ground component. Since they are built for specific conditions, they require very little of the maintenance overhead experienced by existing rotary wing aircraft. They have significant performance abilities over the KC-130J and the C-17 when considering remote area and off airport operations. They do not require a communications link for mission execution that can span thousands of miles and require several layers of approval authority before

being reassigned a mission. UAVs are built for extended duration missions. They sacrifice performance for fuel to loiter for hours, which means they can do essentially two missions, ISR and CAS. A manned aircraft can do that and more with a simple radio call and on the fly rapid mission planning by the aircrew flying the aircraft.

2. Flexibility

Detached units are modular and scalable to best support the unit they are assigned to or the area in which they are operating. They are a utility squadron equipped with utility aircraft. Each aircrew is trained to fly both types of aircraft and associated missions. Aircraft performance will vary, mission skills will not. It is possible for a pilot to fly a fixed gear aircraft one day and a seaplane configured aircraft the next day. That same crew may start off flying a PISR/CAS/FAC(A) mission but rapidly change to a CASEVAC mission mid-flight without delay or endangering the injured Marine. An UAV is unable to meet that flexibility now or in the near future. It brings the ACE mission flexibility to distributed units as the ACE assets are being rapidly overwhelmed with support requests.

3. Affordable

At $2,000,000 a copy, the proposed aircraft are significant cost savings when compared to existing aircraft. Since they are already in production and some are already used by the military, research and development costs are minimal and should not significantly affect unit price. The same can also be said for integration of sensors and weapons systems. The most significant costs should be the integration of systems on the aircraft themselves, which should be mitigated by the number of commercial organizations, such as ATK, that does this work on the aircraft already.

The physical cost of one unit of either the Caravan or the Sherpa is $2,000,000, which is the same cost of a Predator. However, the two aircraft do not have the additional costs of Control Vans, radar guidance units and the large number of personnel required to operate the Predator. They are fractions of the cost of a MV-22, CH-53K or F-35. As the F-35 is further delayed, partner countries continue to reevaluate their purchases of aircraft. As they modify or cancel orders, it causes an increase in the unit price that the

U.S. military must pay. The Marines have already reduced the number of aircraft being purchased from 600 to fewer than 400 airframes to replace its entire fleet of AV-8Bs, F/A-18s and EA-6Bs.

4. Use of Personnel and Systems

In the end, the VMLO organization should focus on having a larger number of pilots than administrative personnel. The current VMM has 28 pilots assigned. It also has three additional officers for medical, maintenance and intelligence functions. It has 171 enlisted personnel assigned to support those 10 MV-22Bs and 28 pilots. Dividing the number of pilots by enlisted Marines results in a 6.1 to 1 ratio of enlisted Marine to pilot, which is a significant overhead cost to operations.

It should be composed of two types of aircraft to provide options for modular and scalable operations to distributed units. The use of two aircraft will prevent an aircraft being tasked with more missions than originally designed for and at a cost to the TACAIR assets it is meant to support, such as the Harvest Hawk KC-130J. Finally, it must take advantage of existing targeting systems, weapons systems and networks to integrate fully within the MAGTF structure.

In the end, until the Marines are able to support distributed operations materially and technologically, the use of low cost, low technology manned aircraft is a significant alternative solution for the existing capabilities gap. They are not a permanent solution. It is a solution that makes the best use of dwindling finances, existing trained personnel and aircraft, as well as allows for responsive, flexible, and affordable support for troops in contact.

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