REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
23-02-2015	Master of Military Studies Research Paper	August 2014 - June 2015

4. TITLE AND SUBTITLE
Amphibious Combat Vehicle 1.1

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
Lloyd, Aaron C., Major, USMC

5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USMC Command and Staff College
Marine Corps University
2076 South Street
Quantico, VA 22134-5068

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSOR/MONITOR'S ACRONYM(S)
N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
N/A

14. ABSTRACT

The Amphibious Combat Vehicle 1.1 is the interim solution for modern mechanized mobility for USMC forces in the near term. The vehicle that will be procured will be selected from a group of three to four competitors; the key performance parameters describe a highly mobile and protected wheeled vehicle that possesses great potential. The advantages of off road mobility, increased lethality from a modern weapons station, modern communications and data transfer abilities, as well as excellent protection characteristics are impressive and offer hope for greater mechanized effectiveness in the future. There are, however, some challenges inherent with the introduction of a new vehicle. Structure in terms of personnel and logistical supportability will have to be addressed. Most importantly, the lack of a real amphibious self-deploying capability inherent in the vehicle will prove to be the Achilles Heel of the entire program. Operating in an anti access and area denial environment will demand that the amphibious force remain much farther from shore than had been projected in the past. Without significant investment in connectors or a change in mindset, the ACV will simply be another mobility asset that must wait for the completion of amphibious operations before its introduction.

15. SUBJECT TERMS
Amphibious Combat Vehicle, ACV, Anti-Access/Area Denial; Expeditionary Force 21; Amphibious Forcible Entry

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	UU	39	Marine Corps University/Command a
Unclass	Unclass	Unclass			19b. TELEPHONE NUMBER *(include area code)* (703) 784-3330 (Admin Office)

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE: Amphibious Combat Vehicle 1.1

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

AUTHOR: Major Aaron C. Lloyd

AY 14-15

Mentor and Oral Defense Committee Member: Dr. Richard DiNardo
Approved: [signature]
Date: 24 February 2015

Oral Defense Committee Member: Dr. Paul Gelpi
Approved: [signature]
Date: 24 February 2015

Oral Defense Committee Member: LtCol David Bardorf
Approved: [signature]
Date: 24 Feb 2015

Table of Contents

Page

Executive Summary

Title: Amphibious Combat Vehicle 1.1

Author: Major Aaron C. Lloyd, United States Marine Corps

Thesis: The ACV represents a leap-ahead development in mechanized mobility for the Marine Corps while on the ground, but falls woefully short in supporting revolutionary amphibious concepts vital for the sustainment of viability of the Marine Corps as the premier expeditionary force for the nation.

Discussion: The Marine Corps has pursued a modern high speed assault amphibian for decades. Three programs resulted in cost overruns, seemingly insurmountable technological hurdles, and eventual cancellation. The Amphibious Combat Vehicle 1.1 is the interim solution for modern mechanized mobility for USMC forces in the near term. The vehicle that will be procured will be selected from a group of three to four competitors; the key performance parameters describe a highly mobile and protected wheeled vehicle that possesses great potential. The advantages of off road mobility, increased lethality from a modern weapons station, modern communications and data transfer abilities, as well as excellent protection characteristics are impressive and offer hope for greater mechanized effectiveness in the future. There are, however, some challenges inherent with the introduction of a new vehicle. Structure in terms of personnel and logistical supportability will have to be addressed. Most importantly, the lack of a real amphibious self-deploying capability inherent in the vehicle will prove to be the Achilles Heel of the entire program. Operating in an anti access and area denial environment will demand that the amphibious force remain much farther from shore than had been projected in the past. Without significant investment in connectors or a change in mindset, the ACV will simply be another mobility asset that must wait for the completion of amphibious operations before its introduction. This seems to fly in the face of the majority of what *Expeditionary Force 21* advocates for – long range platforms to exploit gaps in the enemy's defenses.

Conclusion: The Marine Corps can practice very effective ground based maneuver warfare when assault amphibian battalions are finally equipped with the ACV. The mobility, survivability, range, reliability, and lethality of the platform as envisioned in the proposed requirements documents will add significant capability to the mechanized USMC force and provide greater options to the commander and the joint force.

DISCLAIMER

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

Illustrations

Page

Tables

Page

Preface

The development of a high speed assault amphibian has failed numerous times over that last two decades. The newest solution interests me as an assault amphibian officer, and I wanted to investigate the potential advantages and disadvantages of procuring a vehicle such as the one proposed. This evaluation may provide some insight into the problems that will have to be addressed by future assault amphibian commanders as the vehicle is integrate into their units, as well as the capabilities that are available for exploitation to the betterment of the Marine Corps as a whole.

I would like to acknowledge Dr. R. DiNardo, Dr. P. Gelpi, and LtCol D. Bardorf for providing me guidance and advice throughout my investigation and study. Their assistance was vital in ensuring a thorough and accurate depiction of the information within. Additionally, Maj Brian Vukelic and MGySgt Chris Banus were very helpful in providing a great amount of information and insight into the Amphibious Combat Vehicle program.

The development of a replacement for the venerable USMC Assault Amphibian Vehicle (AAV) has been a program fraught with complications, cancellations, and controversy. The process has seen its share of starts and stops, finally resulting in the cancellation of a high-speed variation in order to concentrate on a lower cost, less technically complex interim solution that will be available for initial operating capability by 2020.[1] The new endeavor, the search for the Amphibious Combat Vehicle (ACV) 1.1, appears to be progressing on schedule and on budget. If all goes according to plan, the Marine Corps will field a modern, 8-wheeled, armored personnel carrier that has amphibious characteristics beginning in 2018.[2] The introduction of such a vehicle has numerous inherent challenges, not only in the technical, but also in the tactical and operational realm. Additionally, there are real opportunities inherent within the new vehicle and its potential employment construct. It appears that the advantages offer increases in numerous factors including range, reliability, lethality, and operational reach. The ACV represents a leap-ahead development in mechanized mobility for the Marine Corps while on the ground, but falls woefully short in supporting revolutionary amphibious concepts vital for the sustainment of viability of the Marine Corps as the premier expeditionary force for the nation.

A brief synopsis of the ideas contained in *Expeditionary Force 21*, published in March of 2014, will be helpful to frame the operational constructs that will benefit - or be hindered - by the introduction of the ACV. This document provides a comprehensive look at potential future missions, the new potential threat environment, new technical and tactical solutions to problems, and finally a reaffirmation of the amphibious roots of the Marine Corps.[3]

The future threat environment appears to be primarily one consisting of a multitude of low grade conflicts, running the gauntlet from threats from non-state ‘bad actors’ to smaller state conflicts, and perhaps even occasionally drawing in regional players, but almost always

occurring in the littorals.[4] In the extreme, major combat operations may be required, but this is not the anticipated norm. The deterrent factor and utility inherent in amphibious forces will be required for many years to come, and the demand signal for amphibious ships and forces is only increasing, evidenced by an 86% increase in combatant commander's requests for Amphibious Ready Groups with an embarked Marine Expeditionary Unit between 2007 and 2010. These forces are valuable for conducting security assistance and stability operations, both in bilateral and multilateral venues.[5] Marine expeditionary forces may provide decision space to policy makers and can mitigate the threats to U.S. interests for the foreseeable future. Marine Corps operations can serve as preventive medicine for many of unstable regions around the globe. Partnering operations, theater security cooperation missions, and crisis response will make up much of the time Marine forces are forward deployed.

In order to access the environment to deal with the threats posed, amphibious shipping is a prerequisite to maneuver and to exploit positional advantage. With decreasing inventories of amphibious 'L' class shipping for the foreseeable future, new and unique ways to forward position Marines and access foreign shores requires the employment of non-standard shipping as well as the use of sea bases.[6] Additionally, anti-access and area-denial tactics by near-peer competitors and smaller state actors, complicate the already difficult problem of amphibious operations. Exploitation of gaps, seams, and the employment of the joint force under a single battle operational framework offers the best possibility for forcible entry scenarios. The execution of a "Tarawa II" scenario – a surface assault into the teeth of prepared enemy defenses, is probably off the table.[7] U.S. sentiment typically does not seem to favor solutions that are liberal with American blood.

The amphibious roots of the Marine Corps are reaffirmed within *Expeditionary Force 21*. The expeditionary framework envisioned in the document sees a full one-third of Marine Corps operating forces forward deployed at any one time. Their presence can serve to tamp down rising threats through direct military action or partnered training exercises to bolster the indigenous security forces. The concept offers opportunities to ground based maneuver systems that offer a lower perceived footprint but greater mobility and highly communicative technology that can integrate with other systems including unmanned vehicles.

To counter a higher level kinetic threat during forcible entry and ground combat operations, disbursing forces throughout the battlespace to reduce the ability of enemy actors to acquire, target, and engage friendly forces is a viable solution; this idea is called distributed operations. This type of operations plays directly into the need for highly maneuverable, mobile, and independent ground mobility systems capable of operating in uncertain environments far from supporting assets. Those assets ability to self-deploy from amphibious shipping and achieve operational reach is going to be of great importance in disbursing the force throughout the area of operations.

Today, the Marine Corps relies upon a triad of amphibious systems to effectively move Marine Corps forces from ship to shore and support subsequent expeditionary operations inland. This triad includes the MV-22 Osprey tilt-rotor craft, the Landing Craft, Air Cushioned (LCAC), and the Assault Amphibian Vehicle, AAVP-7A1. The current AAV was designed to move the surface assault elements of the landing force from ship to shore in a single seamless movement and to support their subsequent combat operations ashore with armored mobility and organic firepower.[8] A tracked vehicle, the AAV (then designated the LVTP-7) was conceived originally in the 1970's by FMC Corporation, and was a departure from previous AAV in that it possessed

greater ground mobility than its predecessor, the LVT-5.[9] The AAV-7 has since been upgraded and modified over the ensuing four and a half decades, but its useful life as an amphibious armored personnel carrier is rapidly coming to a close. The AAV has become a vehicle of last resort for the infantry, especially in any sort of theatre security cooperation mission, due to its heavy footprint, as well as during major combat operations. Additionally, the lack of reliability, poor blast protection characteristics, and less than optimal lethality brings with it questionable value to the ground force commander.

The current AAV is optimized as a waterborne assault amphibian. Subsequent operations ashore were not its primary mission, but as the situations have dictated, AAV were present and effective in major theatre operations including Operation DESERT STORM and Operation IRAQI FREEDOM. In those operations, the AAV served as the primary ground mobility enabler for the infantry, a mission it performed with a workmanlike quality. The introduction of the improvised explosive device (IED) in the Iraqi theater spelled the end of AAV operations in Iraq in 2008, due to the vulnerability of the flat underside and thin aluminum armor. Nonetheless, the AAV remains the primary armored personnel carrier for the Marines as of today.[10]

Operations with the current amphibious enablers lead to shortfalls in light of the movement of the Marine Corps to operations in support of *Expeditionary Force 21*. The EFV was designed to fill the void of surface mobility by rapidly bridging up to 25 miles of ocean and delivering Marines to the beach, and beyond, in a single and rapid lift. Within the idea of distributed operations, the EFV would have provided protected mobility and organic firepower to squad and platoon sized elements, coupled with networked fire support assets, creating smaller

but more effective task forces and units. The EFV was a hinge around which the concept "Ship to Objective Maneuver" was to have swung.

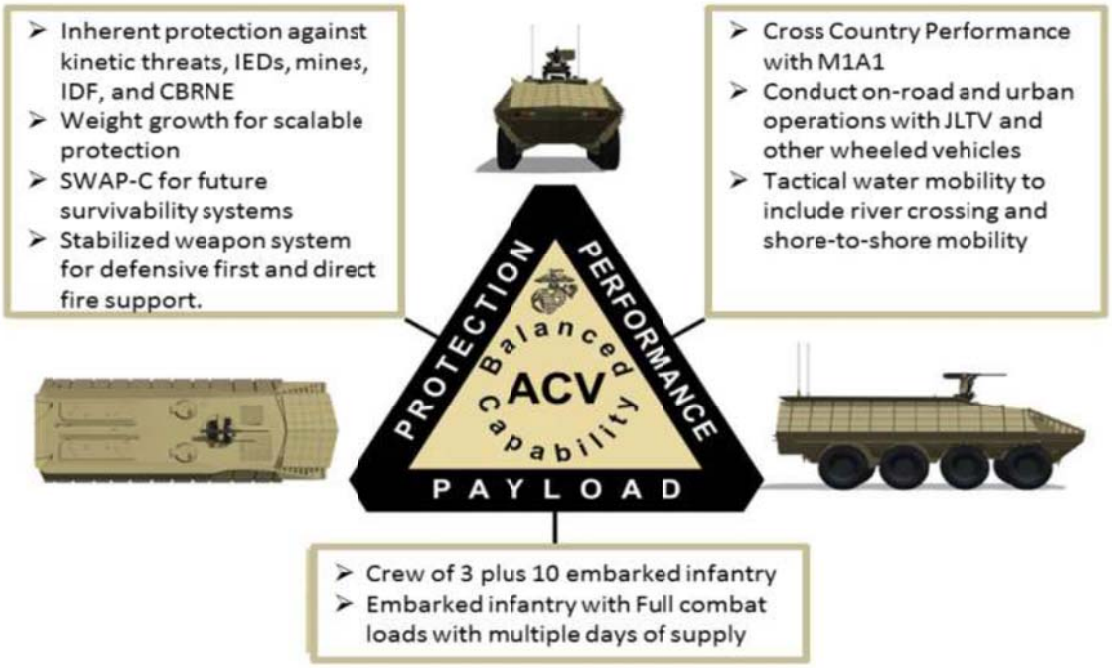
Instead, the Marine Corps will certainly be acquiring the ACV, a departure from the past in that the vehicle is a wheeled, vice tracked, platform. While the vehicle itself has yet to be purchased, the requirements have been defined, certified, and published. The extensive technical requirements delineate both threshold and objective requirements – the attainment of the threshold objective gets the Marine Corps just enough capability to get the job done while a vehicle that meets the objective requirement attains a much higher level of operational utility.

The general ACV requirements from the Marine Corps can best be described from the Concept of Employment Document:

> "The ACV will be an advanced generation eight-wheeled armored personnel carrier that can operate effectively in GCE based maneuver task forces (mechanized and motorized formations). ACV will provide a balanced set of performance, protection and payload attributes within the ground combat tactical vehicle (GCTV) portfolio (see Figure 2). The ACV will be fielded with sufficient design reserve to be readily adaptable over its service life….The ACV possesses a shore-to-shore swim capability to negotiate water obstacles common to the littorals such as light surf, bays, inlets, estuaries, and rivers. The ACV will have sufficient speed, control, stability, and water propulsion to enter/exit littoral surf zones and steep river banks. The ACV will be capable of rapid preparation for water operations while the crew remains within the protection of the vehicle."[11]

Graphically depicted below are some of the general characteristics of the ACV 1.1 in order to set the stage for more completely describing potential vehicle itself.

Figure 1: Projected ACV 1.1 Characteristics[12]



The most important requirements involve the triad of performance, protection, and payload. Threshold mobility requirements of the ACV describe a land mobility capability that would allow the ACV to maneuver with a mechanized task force while the objective requirements ask for increased overall sustained speed, greater vertical obstacle clearance, and increased range. Water mobility requests the ability to ford inland waterways such as streams and lakes, while the objective increases significantly to the ability to traverse 12 NM of open ocean. Protection thresholds are rigorous but classified; at a minimum, it can be assumed that the ACV will have protection comparable to a Mine Resistant Ambush Protected (MRAP) vehicle coupled with an organic heavy machinegun. Objective requirements call for the ability

to upgrade to a 30mm cannon in the future. The most important threshold requirement regarding payload is personnel carrying capacity. Threshold requests 10 embarked infantry while objective asks for 13.[13]

Each competing vendor appears to meet at least the threshold requirements at this time, including the demonstrator vehicles from Lockheed Martin/Patria, SAIC, General Dynamics, and BAe. Each competitor is very similar, each essentially a modern, 8-wheeled armored personnel carrier with amphibious characteristics that can mount standard U.S. remote weapons stations.[14] As designed and tested, each has excellent ground mobility characteristics that will prove beneficial for all ground units working either with or for ACV equipped Marine Air Ground Task Forces (MAGTFs). They have demonstrated their ability to outperform the current AAV, as well as the M1A1 Main Battle Tank (MBT), in all types of terrain, from hard roads to soft sand and mud.[15] Of particular note, the mission profile of the ACV is based upon a mix between on-road and off-road performance of 30% on-road to 70% off-road. This ratio is directly opposite to the Stryker family of armored vehicles, a visually similar vehicle fielded by many U.S. Army brigades.[16]

The ability of the ACV to conduct open ocean amphibious operations is something that is still under study and evaluation. The stated threshold requirement of the program is for the vehicle to conduct only shore-to-shore amphibious operations. Based upon currently demonstrated test vehicle performances, there may be a greater inherent waterborne capability. Should that capability prove to be germane to the vehicle, the implications are significant. The ability of the ACV to 'self-deploy', that is, the ability to launch and recover on board an 'L' class amphibious ship as well as transit 4 to 6 miles in around one hour on the open ocean, would

prove to be a game changing asset.[17] This potential amphibious ability could put the vehicle more in line with the ideas espoused in *Expeditionary Force 21*.

On the current and future battlefield, information drives decision making. The combatant with the timeliest, most relevant, and accurate data can orient on a problem, decide on a course of action, and act faster than their opponent. To ensure Marines retain the initiative will require modern, effective, and user-friendly technology and interfaces. The ACV will be a fully networked vehicle with a complete suite of modern communications equipment to facilitate independent operations far from a centralized main unit. For example, the ACV will integrate the fully encrypted Joint Battle Command – Platform, be able to enter and be managed on the Tactical Voice Network as well as the Tactical Internet Network, and access precise location providing services.[18] The ability to act and operate in smaller sized units while still connected to all of the data gathered from the complete complement of intelligence gathering assets will serve to impart advantage to friendly forces.

Lethality lies at the heart of the effectiveness of combat systems. The ACV will reap benefits from the inclusion of technological advances in remote systems. The vehicle weapon station will contain either an M2 .50 heavy machine gun or a Mk 19 40mm automatic grenade launcher mounted on a Remote Weapons Station (RWS) that is common to many other American combat vehicle systems. This RWS will be stabilized in three axes, include a laser range finder and ballistic solution computer, as well as be fully electric.[19] The RWS will, most importantly, be served by a dedicated gunner. The inclusion of a gunner stands as the first truly evolutionary shift in the family of armored vehicles employed by the assault amphibian community since the replacement of the LVTH-6 armored amphibian in the early 1970s. The

primary purpose of the weapon system will be able to fully support the infantry assault with first round impacts on target in an offensive scenario.[20]

The LVTH-6 armored amphibian, crewed by six Marines, had a fully stabilized turret containing a 105mm cannon and .30 caliber coaxial machine gun, served by a dedicated team. The current AAV-7 is crewed by three Marines, and the vehicle commander also serves as the gunner. This arrangement is extremely detrimental to combat effectiveness, as the amount of work imposed on the vehicle commander under combat conditions is overwhelming.[21] Separating the two positions will allow for employment closely approximating a true fighting vehicle. The vehicle commander will be able to maintain situational awareness throughout engagements while the gunner concentrates on locating, engaging, and destroying threats from under the protection of armor. The ability of the gunner to focus completely on his job can increase the likelihood of first hit probabilities and add overall lethality to the vehicle system. The change in mindset that will be required is real and employment characteristics that define this combat vehicle will impart an increase in overall effectiveness to the mechanized force in total. While this description is similar to the employment schema used for the current Marine Corps Light Armored Vehicle (LAV), the difference is in the mass and accuracy that can achieved across the entire mechanized force.

The ACV will have excellent mechanical and performance characteristics that compliment the operational realm it is going to operate in. The operational availability of the ACV is to be 20% better than the legacy AAV.[22] This is due to several factors including the newness of the vehicle, modernity of the equipment, and the fact that anecdotally, wheeled vehicles take less of a pounding than tracked vehicles. Range will hover somewhere in the realm of 300 to 400 miles at road march speed, comparable to or in excess of complementary tactical

and combat vehicles. A range of 400 miles would be an increase of 100% over the legacy AAV, resulting in a whole order of magnitude increase.[23] Fuel efficiency will also go up in the ACV. In that vein, the logistical trail needed to refuel a platoon of ACV as opposed to a platoon of AAV will be roughly the same, therefore the calculations will be roughly the same in regards to supportability by the Marine Logistics Group and any "L" Class ship the vehicles are embarked upon. The chart listed below demonstrates the above information as derived from a comparison of the test demonstrator, the AAVP7A1, and the Expeditionary Fighting Vehicle conducted by the National Automotive Test Center in Nevada and is a good comparison of current reliability and fuel economy.

Table 1: ACV/MPCTD versus AAV/EFV Reliability and Fuel Economy Survey[24]

Automotive Maintenance Summary

	MPCTD	AAVP7A1	EFV
Total Miles	**5,752**	**1,531**	**825**
Total Engine Hours	909	198	244
Total Fuel (gal)	2,875	1,560	1,155
Hardware Mission Failures 1/	None	1	5
Hardware Mission Faiure Systems	NA	Engine	Port Track Separation Replace Hydraulic Pump Starboard #3 Hub Failures Port HSU #7 Hydraulic Leak Port HSU #7 Hydraulic Leak
Preventative Maintenance Man-hrs	275	77	396
PrevMaint Ratio (hr/miles)	0.048	0.050	0.480
Unscheduled Maintenance Man-hrs	105	81	259
Unsched Maint Ratio (hr/miles)	0.018	0.053	0.314
Unscheduled Maintenance Actions	11	6	22
Unscheduled Maintenance Systems	Rear Steer Shaft	T-157 Track Pad (170)	T-161 LW Track Pads (2,040)
	Alternator Belt	T-157 Track Block (170)	T-161 LW Track Block (170)
	O-Rings	Road Wheel (3)	Road Wheel (52)
		PDA Harness (2)	Replaced Fuel Pump
		Remove Heater Pump	PTM Oil Line Replace
			Port Side Final Drive Replaced
			Hydraulic Pump Class III Leak
			Replace Hydraulic Attenuator Ball
			Port HSU #4 & #7 Hyraulic Leak
			Repair Transmission Mount Bolts

1/ Defined as failures where the vehicle could not complete test event & also could not return to Maintenance Area under own power

33

FOR OFFICIAL USE ONLY

Protection will be comparable to currently fielded MRAP vehicles. The overall mobility of the ACV will outstrip even the M1A1 MBT in both its ability to operate on road as well as on extremely broken and rugged terrain.[25] Taken together, these capabilities present an opportunity for exploitation by Marine Corps mechanized ground forces.

In addition to a shift in ground mobility and performance parameters, an evaluation of the necessity for a high speed assault amphibian is important to consider. In the *Marine Corps Gazette*, Lieutenant Colonel Howard Hall puts forth a very compelling case for the continuance of the search for a high speed amphibian. In particular, his contention is that the ability to self deploy is of vital importance, lest the ground combat element (GCE) of the Marine Corps be reduced to a "commuter status."[26] While that is a truly concerning proposition, current thinking and proposed technological solutions provide some relief to the self-deploying requirement. For example, tenants of *Expeditionary Force 21* advocate exploiting the seams in the enemy's defenses. Hitting surfaces simply does not make any sense in today's highly lethal battlefield, especially if a conflict was between near peer competitors. Additionally, the advent of potential individual surface connectors for each ACV is an ongoing process and holds much promise. While the acquisition process will be another costly proposition, alternatives do exist.[27] Finally, taking amphibious assault theory as a joint concept, not simply as a Marine Corps endeavor, is important in understanding forcible entry operations. Combinations of aerial platforms that can penetrate enemy air space and disrupt kill chains coupled with joint shaping actions such as special operations forces conducting covert actions to degrade enemy intelligence gathering assets will allow access to defended geographic spaces in the near to mid-range future. Additionally, leveraging the long range strike capability of the U.S. Navy will prove to be important in opening up avenues of approach at a time of our choosing. The key is to achieve

local aerial and maritime superiority for a specific and defined period of time in order to conduct operations.

The ACV is undergoing testing to determine if it will have the ability to self deploy. Vendors that are competing for ACV 1.1 have done some independent testing and anticipate their vehicle will exceed threshold values for ACV 1.1 in the water and may meet objective values. Additionally, even if the test vehicles prove to be incapable of self deploying, the venerable AAV-7 is to remain in the fleet for the foreseeable future, perhaps until 2035.[28] Finally, while the development process continues for the ACV, study and research into the viability of the procurement of a high speed amphibian continues until a decision point is reached around 2025.[29]

While even just the threshold requirements define a very capable vehicle, there are challenges that must be dealt with to capitalize upon the strengths of the new vehicle. Of significance, not having completed the acquisition process forces conclusions based upon conceptual ideas, prototype demonstration vehicles, and existing "near-off-the-shelf" vehicular solutions. Additionally, the lack of true, open-ocean amphibious mobility requirement, fiscal realities, organizational issues, and potential training and integration concerns are relevant. Dealing with these factors will be critical as the new ACV is procured, fielded, and placed into assault amphibian battalions by the Marine Corps.

The introduction of a new vehicle is an extremely complex operation requiring years of planning. There are significant issues associated with integrating a new vehicle with new performance, employment, and related capabilities. At first blush, the doctrine to employ the vehicle sits at the top of the hierarchy of issues needing definition. Additional items for discussion and decision include the organization of the units to 'own' and employ the vehicle,

how to train individuals and units to employ the vehicle, and how to support the units equipped with the new item with all of the material required. Other considerations include ways to prepare the leaders of the units, how to staff the units and determinations as to the correct requirement of personnel for each unit, and finally, questions of facilities required for optimum operations.

Of primary concern to the assault amphibian community, and Marine Corps leadership at large, is the lack of real open-ocean amphibious mobility threshold requirement that could enable ship-to-shore capability.[30] Without this capability, the AAV will remain in the fleet until a suitable high water speed connector is designed and fielded. While this may be an anticipated risk, the challenges inherent with relying upon a vehicle originally fielded in the 1970s are problematic for the high-threat environments that can be foreseen in the future of an anti-access and area denial (A2AD) environment. The challenge of integrating a vehicle that may only have comparable water mobility as the legacy AAV leads to the concerns of stagnation within the acquisition community as challenges for high water speed connectors and vehicles mount. It is possible that there will be a period of over a decade where the waterborne mobility of the amphibious mechanized force will continue to rely upon the legacy AAV or other waterborne connectors to move the ground-based elements of the assault echelon.[31]

Fiscally, there are concerns about the number of vehicles that must be purchased to move the required number of embarked Marine infantrymen. This concern is predicated upon the fact that replacement of the AAV by the ACV will not be an even one-for-one swap, but instead a twenty-one-vehicle platoon replacing a twelve vehicle platoon. With the anticipated unit cost of each production ACV being in the neighborhood of five to six million dollars, every extra vehicle required to lift an infantry company is a significant investment of Marine Corps dollars.[32] While there are inherent advantages to more vehicles in each platoon or unit – firepower,

maneuver, and mutual support – the financial burden on the Corps in general can become prohibitive. It appears, however, that the ACV is priority procurement item for the Marine Corps, and that the money required to field the needed amount of vehicles is already programmed and budgeted for.[33] Additionally, due to the problems of past amphibious vehicle programs exceeding projected costs, one can assume that the vehicle will come in on cost.

As the new ACV is fielded, it will be necessary to integrate the vehicles into an assault amphibian battalion. With the drawdown that the Corps is anticipated to endure, perhaps even to a low point of 175,000 total active duty personnel, ensuring that there are enough operators and maintainers to man and service the ACV is going to be an issue. Preliminary research and analysis shows a deficit of personnel, especially on the operator side. This initial research points to a ~202 man deficit for operators and a ~6 man maintainer deficit for the operating forces and does not include the supporting and training establishment.[34] Additionally, this is only taking into account the introduction of the initial buy of totaling 204 vehicles. With the addition of another ~400 ACV 1.2s, the deficit will triple to a minimum of ~606 operators alone. As the Marine Corps gets smaller, where these individual Marines will come from is unknown. A solution to claw back personnel lost in the reapportionment of forces out of the assault amphibian community is one possibility, but from where remains the question.[35]

Part of the challenge that may come from integrating a new vehicle into the assault amphibian battalion will come from the support requirements for a mixed fleet. Training maintainers to support both vehicle types – the ACV and the AAV - will require one of four schemes: Marines trained for both platforms, vehicle specific maintainers, a combination of the two techniques, or a maintenance program that is heavily contractor centric. With the fiscal issues facing the nation at this time, the contractor centric option seems to be less than optimal.

In addition, dual supply chains will increase the amount of parts required, increasing overall costs through quantity alone. Volume in a more practical sense can cause issues in a deployed environment as well. In a major contingency operation, the use of both the AAV and ACV will require two blocks of parts increasing both space and weight on any mode of transport providing the needed logistics to the force.

Finally, training and personnel integration issues will surface with the introduction of the new ACV. As the ACV is fielded, it will create two training pipelines for the operator and maintainer to travel down – the AAV or the ACV line. Questions will surely arise as to whether or not the pipelines are able to be crossed or if the AAV/ACV Marine will remain in that MOS for the entirety of his enlistment. Each option has advantages and disadvantages, but one scheme will have to be determined. Risks for denying flexibility could lead to a stagnated population of operators and maintainers requiring extra effort to keep motivated and proficient as promotions and opportunities for advancement dry up.

To employ the vehicle to its utmost potential, the supported force must trust in the capabilities of the vehicle, as well as understand its limitations. In training for tactical employment, the challenge will be in convincing Marine infantry that the vehicle is worthy of rigorous integration into the ground combat element to the point that the Marine Corps at large accepts more of a mechanized infantry construct when so equipped, as opposed to a light infantry concept, but simply carried on vehicles. As shown above, there are significant advantages to the vehicle itself. The advantages can only be realized, however, if the infantry, the maneuver unit commanders, take the time and make the effort to develop training schemes that thoughtfully and completely integrate the vehicle. The solution revolves around the early and successful demonstration of the inherent advantages of dealing with an advanced wheeled amphibious

armored personnel carrier. The ability to train on any surface, to shoot and communicate on the move and with modern networked equipment, and the inherent reliability of the vehicle will have to be demonstrated to entice continued and relevant training, resulting in effective employment across the range of military options in a forward deployed environment.

Even if all of these problems are surmounted, the critical deficiency of the program still appears to be the lack of EFV-like amphibious capability. Nonetheless, there is still hope that the ACV can bring a significant capabilities to bear in maneuver warfare. Possibilities for improved performance versus the current AAV vis a vis the mechanized infantry force center on the following categories: increased firepower, operational scalability, vehicular protection, joint and combined interoperability, international familiarity, and finally, operational reach.

The amount of firepower that can be brought to bear on a target at any one time is very important to the effectiveness of a combat vehicle. With the legacy AAV, each vehicle mounted a turret containing two heavy machine guns, of which the vehicle commander could employ only one effectively at any time. Of the twelve vehicles in a standard platoon, three vehicles are essentially out of the fight. One vehicle lifts a fire support team and the command element, one vehicle typically supports the mortar section, and one vehicle supports the logistics needs of the platoon, leaving nine vehicles for fire support. Of those nine vehicles, there are only six available to provide fire support at any one time; an additional three vehicles are required to support the three infantry platoon leaders. The vehicle commander (VC) of the AAV that the individual platoon commander rides in is far more concerned about the maneuver and movement of his platoon than he is in employing his weapon system. In the end, of a twelve vehicle platoon, only six are able to employ their weapons in a dedicated offensive action.

In contrast, the ACV platoon will be comprised of twenty-one vehicles, each mounting a single heavy machine gun served by a dedicated gunner.[36] Of these vehicles, fifteen to eighteen will be dedicated to embarking infantry Marines as well as maneuvering on the enemy. This will increase the effective fires placed upon targets will by somewhere in the vicinity of a factor of three (18 ACV vs. 6 AAV vehicles available for fire support). Additionally, the fact that the weapons stations will be stabilized, include a laser range finder, and be served by a dedicated gunner will increase combat effectiveness in a way that is a leap ahead in Marine Corps mechanized infantry warfare. The weight of shell – in this case, either .50 caliber bullets or 40 mm grenades - that can be delivered effectively is a defining characteristic of the ability of a military force to successfully prosecute a target and thereby achieve an objective and seize ground. The increase in this case is quite possibly a game changer in that greater firepower allows for more rapid and efficient seizure of ground and new fire positions.[37]

As stated earlier, the vehicle lift that is required to move the same amount of infantrymen in AAV increases dramatically when using the ACV. The increased vehicle requirement results from the reduction in available personnel seats in the ACV when compared with the legacy AAV. This leads to an organizational decision that amphibious assault vehicle battalions will have to make, and that is how to organize the individual platoon. To reap the most advantageous benefits from the vehicle, the maintenance of the 'rule of thee' method of organization is paramount. Additionally, the increased vehicle requirement will force commanders of mechanized amphibious units to make difficult decisions about load plans for amphibious ships. There will not be easy solutions as square and cubed footage aboard ship is a finite resource and must be husbanded carefully by commanders and embarkation officers. Decisions will have to be made about what vehicles will be included in a load plan, and what will be left on the pier; the

greater amount of ACV required to lift an infantry company could be a detriment to an amphibious unit. Finally, logistical management will become even more important as the 75% increase in total vehicles will require more material support, newness of the vehicle and reduced fuel requirements notwithstanding.

When organizing a platoon of ACV, the individual infantry platoon should be lifted by a section of six ACV. Each individual squad should have a two vehicle team apportioned to it. This construction results in advantages for both the ACV platoon and the infantry company. Employment considerations for vehicle movement will parallel current AAV standard operating procedures and dictate that an ACV should rarely, if ever, operate alone. While today's AAV platoon operates with sections of three vehicles, the ACV should implement a 'team' construct of two vehicles similar to the doctrinal tank "wingman" concept. This construct will facilitate several things. First, individual infantry squads will possess a multi-vehicle maneuver element that can increase the range of the individual squad maneuver while under armored protection, thereby increasing the amount of ground for which a squad can be assigned responsibility. While the increase will not be any more than the effective range of the mounted heavy machine gun, it is greater nonetheless. Second, the individual squad will be supported by twice the amount of vehicle mounted and stabilized heavy firepower. The ability of the squad to maneuver dismounted under the cover of this fire will change the calculus of what is achievable by a squad; for example, larger forces may be able to be engaged; stronger defenses can be suppressed for longer periods of time. In the extreme, destruction of certain positions could be considered without dismounting. These factors, coupled with the armor protected mobility of the part of the squad mounted in an ACV, the utility of a squad of infantrymen and a team of ACV becomes impressive.

At the ACV section and infantry platoon level, the benefits becomes even more apparent. Unique and creative task organizations can be devised to allow for units smaller than a platoon to move rapidly on the battlefield to exploit opportunities. The individual ACV teams and sections can become maneuver units themselves, commanded by a staff noncommissioned officer, capitalizing on the speed and maneuverability of the vehicle. One of the factors that makes this opportunity possible is the inherent reliability of a new vehicle, coupled with the fact that wheeled vehicles are not as prone to breakdown as tracked vehicles.[38] This can engender greater confidence in the vehicle from both the ACV crews and the embarked infantry to exploit opportunities farther from the base unit.

In current operations, IED pose a serious threat to an AAV. The use of the AAV in Iraq was faced with significant obstacles due to the presence of large IED. On 3 August 2005, an attached to Third Battalion, Twenty-fifth Marine Regiment was destroyed by a large IED. The blast killed fourteen Marines that were embarked on the vehicle.[39] This incident was a contributing factor to the eventual withdrawal of all AAV from operations in Iraq in the spring of 2008.[40] The combination of thin aluminum armor, a flat bottomed hull, and low ground clearance made the AAV a vulnerable target in operations that generally centered on route security in the Al Anbar province. While intentionally canalized onto main supply routes, especially Main Supply Route Mobile, the AAV proved that it had the ability to complete the mission but at a reduced level of effectiveness due to the IED threat.[41]

The ACV brings a dual solution to the IED threat. The vehicle has been designed with the ability to protect its occupants from a significant blast through the integration of a “V”-shaped double hull, higher ground clearance, blast-attenuating seats, more significant armor, and specialized wheel and suspension systems to enable the vehicle to egress a ‘kill zone’ even when

damaged, among others.[42] These characteristics open up avenues of advance that may have been closed to mechanized Marine forces with the AAV; nonetheless, risk will always have to be accepted in any military plan.

A second remedy to the IED threat comes from the mobility profile of the vehicle itself. A Stryker Infantry Combat Vehicle (ICV), as mentioned earlier, is a similar system to the ACV. The Stryker was designed with a mobility profile that required it to operate off road for thirty percent of the time, while operating on road for seventy percent of the time. The ACV will turn that ratio on its head; the mobility profile requirement defines a seventy percent off road and thirty percent on road mix.[43] The overall focus of the ACV mobility profile to operate in places that had been inaccessible to the Stryker or AAV can reduce the IED threat by introducing uncertainty into the enemy mind as to from where and when the mechanized force will appear. This will also increase the options for maneuver unit commanders as the force will not feel as restricted to the road as in the past. Finally, the flexibility that it offers keeps the battlefield fluid and allows for inclusion of courses of action that do not necessarily view the future operating environment as simply a counterinsurgency with a high IED threat, but one that can have numerous possible threats including major combat operations.

The decision to select a future combat vehicle for the Marine Corps that is not tracked but instead wheeled opens up avenues for interoperability that have been closed in the past. Many nations from Europe, the Middle East, and Africa use wheeled fighting vehicles. The Patria Armored Personnel Carrier, an option competing for selection as the future ACV, is based on a design produced under license by Lockheed Martin. It is currently present in the fleets of Finland, Poland, Sweden, Slovenia, Croatia, the United Arab Emirates, and South Africa.[44] Additionally, another system competing for selection as the ACV is the Singaporean Terrex

vehicle which is used by both Singapore and Turkey.[45] With the fiscal constraints imposed on many militaries, especially in the developing world, many nations are only able to afford wheeled vehicles. The potential to capitalize on the familiarity of those nations' militaries with wheeled vehicles in conjunction with partnered, bilateral, or other training opportunities plays directly into the tenants espoused in the concept document *Expeditionary Force 21*. By offering training opportunities with nations more familiar with wheeled vehicles, the Marine Corps is more likely to gain access for mechanized or motorized training opportunities than with a tracked vehicle that can be perceived as a 'tank.'

Within the United States itself, the prevalence of the Stryker ICV provides opportunities to capitalize on joint operations. While the mobility profiles are very different, amphibious capabilities diverge, armor packages are not parallel, and the personnel lift capacity is different by between one to four personnel, wheeled system familiarity and technological similarities between the two platforms offer possibilities for collaboration in tactics, techniques, and procedures. Additionally, co-opting the deployment schema used by Army units could provide insights into better ways of doing things related to rapid deployment and future Marine Corps concepts; there is no need to 're-invent the wheel.' Finally, should a vehicle be chosen that has parts in common with the Stryker, functions of efficiency could be gleaned in the supply and maintenance chains, as well as in personnel training.

Whichever vehicle is finally chosen as the contract winner for the ACV, the threshold requirements ensure that range will be significantly greater than the legacy AAV. Should the objective requirements be met, an on-road range of upwards of 400 miles becomes possible. More importantly, however, is that the operational availability is increased over the standard now set with the AAV by around twenty percent.[46] This increase, while not astronomical, may be

enough to change the calculus in determining what missions are possible for the mechanized force and which are not.

Operational reach – the distance and duration over which a military can successfully deploy credible forces – increases in the case of the ACV.[47] When the ability to communicate across multiple domains, be it via voice, type, or other graphic means, is combined with the range and operational availability of the vehicle, total operational reach is increased. The ACV can provide commanders with greater confidence that their mechanized force can reliably operate for a greater amount of time and farther from supporting forces than in the past with the AAV.

With the summation of the projected capabilities, challenges, disadvantages, and advantages inherent in the soon to be introduced Amphibious Combat Vehicle 1.1, conclusions can be drawn as to the potential effectiveness of the future mechanized amphibious Marine task force. There is a possibility for increased operational maneuver on the battlefield by an organization mounted in the wheeled ACV. The reliability, mobility, and communicative characteristics of the vehicle make it possible. The increased lethality present in a remote weapons station manned by a dedicated gunner can provide greater effectiveness in any kinetic combat operation. The lower perceived psychological impact to a civilian observer of a wheeled vehicle vice a tracked one facilitates the introduction of forces into more numerous areas to conduct partnered and joint training. Additionally, the commonality of the wheeled APC construct can encourage more common tactics and doctrine within the American ground forces as it seeks to employ in the future as a more joint force. The challenges incumbent in the vehicle, however, have serious drawbacks for furthering the future Marine Corps concepts of employment under *Expeditionary Force 21*. The inability of the ACV to transit 4 to six miles of

open ocean complicates the connector problem for the Marine Corps as well as the U.S. Navy. Personnel shortfalls can also serve to derail effective integration into the ground combat element.

Transformative vehicles and techniques are regularly touted, perhaps for the ability of the phrase to turn more customers in one direction or another. In this case, transformative could be defined as the wholesale change in the character of the mechanized Marine amphibious task force. With this established as the definition, a comparative review of the various capability requirements of a Marine amphibious vehicle is illuminative.

To lift elements of the landing force, the ACV will require more individual units than the current AAV. Waterborne mobility is no better, but perhaps on a par with, its predecessor. Ground mobility, when compared with demonstrator vehicles, is on a par with the M1A1 MBT. Lethality, protection, and communications connectivity are certainly superior to the AAV. In total, it appears that qualitatively, the ACV will be a superior vehicle to that which it replaces, but with one potential shortcoming, that of water mobility. The Expeditionary Fighting Vehicle was to have been the transformative program that would have allowed the Marine Corps to conduct surface amphibious assaults from over the horizon.

Instead, the ACV represents only an evolutionary capability for the Marine ground combat element in the tactical and operational sense while engaged in ground operations. The tactics, techniques, and procedures that will prove possible with a modern, reliable, and lethal armored personnel carrier will expand the reach and effectiveness of any task force the vehicle supports. In that sense, the vehicle program lives up to its promise, that of focusing on the robustness of its ground capabilities with a relatively off the shelf program, while hedging on the transformative capabilities of the Osprey tilt-rotor aircraft to rapidly project power inland versus the A2AD threat.

The crux of the issue is with *Expeditionary Force 21* and the ability of the ACV to facilitate or at least complement the concept and operate in an A2AD environment. In order to facilitate the introduction of Marine forces onto a hostile shore, a redistribution of entry platforms may have to be developed. The MV-22 offers the greatest potential for success in this regard. The potential to seize an initial airhead with airborne Marine forces prior to the introduction of surface based forces may allow the naval amphibious force to stay beyond the range of many anti-ship systems and hence, protected. Upon the seizure of the initial foothold, a rapid neutralization of systems designed to interfere with surface assets could be undertaken to facilitate the approach of amphibious shipping to a range where the ACV could launch.

In keeping with the traditional surface based assault echelon, another solution already alluded to is the development of a revolutionary landing craft that can rapidly transport the ACV to the beach over an operational distance in a survivable manner. The mWAVE-SLED concept vehicle, a single space high speed semi-amphibious boat, offers an individual connector platform for each ACV. Able to be remotely piloted to and from the beach with the range, speed, and survivability required, it offers great potential for further study. Additionally, the amount of square footage within the amphibious ship well deck is not greatly increased.[48] If this vehicle is investigated more thoroughly, it may offer a solid chance for success in an A2AD arena.

Continuing to maintain or even enhance the ability of the LCAC to land surface forces is also a viable solution to the real problem of the lack of long range, survivable amphibious connector platforms. While the LCAC is not a combat vehicle in any sense of the word, it offers speed, flexibility, payload, and a proven track record of success in real world amphibious operations. With the ability to carry approximately sixty tons of equipment and vehicles at a speed of between 35 to 50 knots, it has a robust capacity to deliver forces from over the horizon

and provide some amount of security to the amphibious force.[49] The issue here is, of course, the inability of the LCAC to land on a defended beach. That fact continues to drive the requirement for an amphibious fighting vehicle.

However, the most practical, economical, and viable solution to all of the problems that are presented by the inevitable acquisition of the ACV is not one that falls into the old paradigm of acquiring a new piece of equipment. It does not advocate 'throwing more money at the problem' to modify or re-equip a current platform with a technological wonder that will solve the Marine Corps or Navy's ills. Instead, doctrine, tactics, techniques, and better thinking can ride to the rescue and make the ACV a program that can enhance the warfighting and amphibious capability of the Navy and Marine Corps team. In a sense, a change in mindset is that which is critical to solving the issues at hand. At its base, the amphibious and joint force must be resolved to fight and win in spite of an A2AD environment. The current tactics for launching amphibious vehicles includes a technique for a tactical in stream, underway launch; properly developed and supported by joint force, this provides the best solution.

To expound on the aforementioned thought, in current thinking, the amphibious force must remain a significant distance off shore to protect itself from the A2AD threat, as previously discussed. The change, again, must be one of mindset. Certain assumptions are necessary: each vessel in the U.S. Navy is a fighting vessel, equipped with at least some form of self defense, including amphibious ships; U.S. Navy cruisers and destroyers are the world's preeminent air defense platforms and capable of providing protection to a carrier battle group, an extremely valuable asset; finally, under a single battle concept, the Navy doesn't fight alone - it brings the entire capability set of the U.S. to bear, including Air Force and Special Operations assets.

Finally, the last assumption is that the ACV will be able to launch underway and recover aboard an 'L' Class amphibious U.S. Navy ship.

In the proposed concept, old is new, and the following actions would be necessary to land the landing force in ACV. First, local air and maritime superiority would have to be gained and maintained in the amphibious objective area. This requirement is by no means a new concept and is well within the joint forces capability set. It requires commitment to fighting, but it is possible. Next, the Landing Ship, Dock (LSDs) would launch their LCACs and LCUs with their pre-boated loads while approximately 25 NM offshore. These platforms could then proceed at speed to holding areas or directly to the beach, timed to arrive after the LSD. The LSDs, loaded with ACV, would then execute a high speed run into the launch area and, while underway at a significant speed of up to twenty knots, launch the ACV and retire at high speed to a "safe" distance. This technique is not new, but instead simply not considered possible in the risk adverse culture present today. The idea is to minimize exposure time of the ship to threats from the shore. It requires no new acquisition programs but instead a frank and professional discussion with relevant stakeholders about how to seize the required local superiority at a time of our choosing for approximately two hours and twelve minutes (44 nm covered at 20 kts by an LSD with an in stream launch of ACV).

It is impossible, however, for the ACV in and of itself to provide the transformative capability projected by the EFV program. The ACV is simply a highly capable personnel carrying vehicle with modern characteristics. To really 'revolutionize' or change the way that the Marine Corps conducts amphibious operations, especially in an A2AD environment, a high speed, combat capable connector, be it an individual platform to support an individual ACV, a heavy load capable surface craft, or a high-speed amphibious vehicle, would be required. The

vast majority of the Marine Corps landing force will still come across the beach, carried in Landing Craft, Utilities (LCU) or Landing Craft, Air-Cushioned (LCAC) craft. To seize a beachhead prior to their arrival, a force must arrive and actually do the seizing.

The most important potentiality for the ACV, however, is in its ability to allow the Marine Corps to practice ground maneuver warfare as espoused by Kenneth McKenzie in his 1993 article in the Marine Corps Gazette. The intense focus on fire that still permeates the Marine Corps could finally shift to the original concept of maneuver warfare – deep, thrusting actions focused on the enemy's will to fight, vice a focus on destruction of physical enemy systems.[50] The ability of the ACV to operate reliably and at long range with great operational mobility can facilitate this shift. The venerable AAV simply did not allow the commander to think as expansively as the ACV will. In order to fully optimize the ACV for Marine Corps amphibious and maneuver warfare, a great amount of focus needs to be put into the open ocean capability of competitors; the objective requirement for amphibious operations should weigh heavily on the final acquisition decision.

In total, the Amphibious Combat Vehicle 1.1 looks to be a very capable, tough, and effective vehicle, especially in light of its 'near off the shelf' nature, but it is surely not the leap-ahead in amphibious capability that the Corps so greatly wants and needs. In order to ensure future relevancy for the surface based amphibious assault, one of two things must happen. Either a change in mindset must be adopted by the Navy and Marine Corps team, one that encapsulates a realization that the joint force will have to fight for local superiority at a time of their choosing, or the Marine Corps must acquire an exquisite, expensive, over the horizon capable connector that can approach defended shores to deliver mechanized forces. All told, the ACV 1.1 will still

offer enhanced ground based mobility, lethality, survivability, and operational reach, thereby increasing options for the Marine mechanized force and its commander.

Notes

[1] LtGen J. M. Paxton, USMC, Assistant Commandant of the Marine Corps, Marine Corps Requirements Oversight Council (MROC), MROC Decision Memorandum 15-2014, 8 July 2014, slide 19.
[2] LtGen Kenneth J. Gleuck, USMC, "GOS Capability Development Update," (PowerPoint presentation, Marine Corps Combat Development Command, Quantico, VA, 22 October 2014).
[3] Headquarters U.S. Marine Corps, *Expeditionary Force 21*, (Washington, DC: U.S. Marine Corps, March 4, 2014), 4-11.
[4] Headquarters U.S. Marine Corps, *Expeditionary Force 21*, (Washington, DC: U.S. Marine Corps, March 4, 2014), 8.
[5] Department of the Navy, *Naval Operating Concept 2012: Implementing the Maritime Strategy*, (Washington, DC, 2010), 28.
[6] Headquarters U.S. Marine Corps, *Expeditionary Force 21*, (Washington, DC: U.S. Marine Corps, March 4, 2014), 18.
[7] "Corps Existentialism: Ensuring a Future for the Marine Corps," Nic Di Leonardo, *Center for International Maritime Security*, October 2014, http://cimsec.org/corps-existentialism-ensuring-future-marines/13373.
[8] LtGen Richard P. Mills, USMC, Deputy Commandant for Combat Development and Integration, memorandum for record, *AAV FOV Capability Baseline Document*, 8 February 2012, ii.
[9] Kenneth W. Estes, *Marines Under Armor: The Marine Corps and the Armored Fighting Vehicle, 1916*-2000 (Annapolis, MD: Naval Institute Press, 2000), 73-74.
[10] Maj Jacob Robinson, USMC (Executive Officer, 2d Assault Amphibian Battalion), interview by Aaron Lloyd, November 20, 2014.
[11] "Concept of Employment for Amphibious Combat Vehicle 1.1," 2 December 2014, Headquarters Marine Corps, Fire and Maneuver Integration Division, Capabilities Development Directorate, Quantico, VA, 5, 7.
[12] LtGen Kenneth J. Gleuck, USMC, "GOS Capability Development Update," (PowerPoint presentation, Marine Corps Combat Development Command, Quantico, VA, 22 October, 2014). Slide 8.
[13] Kurt Koch, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 15, 25, 26, 42, 65, 66, 85, and 85.
[14] MGySgt Chris Banus, USMC (Assault Amphibian Specialist, Plans/Policies/Operations, HQMC), interview by Aaron Lloyd October 31, 2014.
[15] Kurt Koch, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 27-35.
[16] Maj Victor Ruble, USMC (Requirements Officer, Capabilities Development and Integration Division), interview by Aaron Lloyd October 1, 2014.
[17] MGySgt Chris Banus, USMC (Assault Amphibian Specialist, Plans/Policies/Operations, HQMC), interview by Aaron Lloyd October 31, 2014.
[18] "Capability Development Document for Amphibious Combat Vehicle Phase 1, Increment 1," 29 April 2014, Headquarters Marine Corps, Capabilities Development and Integration, Quantico, VA, 10.

[19] Kurt Koch, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 66-69.
[20] "Concept of Employment for Amphibious Combat Vehicle 1.1," 2 December 2014, Headquarters Marine Corps, Fire and Maneuver Integration Division, Capabilities Development Directorate, Quantico, VA, 6-7.
[21] W. Blair Haworth, Jr., *The Bradley and How it Got That Way* (Westport, CT: Greenwood Press, 1999), 49.
[22] LtGen J. M. Paxton, USMC, Marine Corps Requirements Oversight Council (MROC), MROC Decision Memorandum 15-2014, 8 July 2014, 62
[23] Kurt Koch, USMC, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 119, 121.
[24] LtGen Kenneth J. Gleuck, "Mobility Characterization," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 12 August 2014). Slide 33.
[25] Kurt Koch, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 25-34.
[26] LtCol Howard Hall, USMC, "Ship-to-Objective Commuters," *Marine Corps* Gazette 98, no. 8 (August 2014): 76.
[27] Kevin Neprud, *Executive Summary Common Platform for High Speed Water Connectors and ACV 2*.0 (Wayland, MD: Kevin Neprud and Associates, September 24, 2014).
[28] LtGen Kenneth J. Gleuck, USMC, "GOS Capability Development Update," (PowerPoint presentation, Marine Corps Combat Development Command, Quantico, VA, 22 October, 2014). Slide 13.
[29] LtGen Kenneth J. Gleuck, USMC, "GOS Capability Development Update," (PowerPoint presentation, Marine Corps Combat Development Command, Quantico, VA, 22 October, 2014). Slide 8.
[30] LtGen J. M. Paxton, USMC, Marine Corps Requirements Oversight Council (MROC), MROC Decision Memorandum 15-2014, 8 July 2014, 5.
[31] LtGen Kenneth J. Gleuck, USMC, "GOS Capability Development Update," (PowerPoint presentation, Marine Corps Combat Development Command, Quantico, VA, 22 October, 2014). Slide 8.
[32] Andrew Feickert, *Marine Corps Amphibious Combat Vehicle (ACV) and Marine Personnel Carrier (MPC): Background and Issues for* Congress, CRS Report for Congress R42723 (Washington, DC: Congressional Research Service, July 16, 2014), i, https://fas.org/sgp/crs/weapons/R42723.pdf.
[33] LtGen Kenneth Gleuck, USMC, "ACV Phase 1.1 Capabilities Development Document: MROC Decision Document," (PowerPoint presentation, Combat Development and Integration Division, Quantico, VA, 29 April 2014). Slide 20.
[34] Tony Knight, "ACV 1.1 Manpower Study," (PowerPoint presentation, Program Manager Advanced Amphibious Assault, Stafford, VA, 15 October, 2014). Slide 8.
[35] Cynthia Cheek, "GCE DOTMLPF/C-P Executive Summary," (PowerPoint presentation, Headquarters Marine Corps, Washington, DC, 26 November, 2014). Slide 6.
[36] Maj Victor Ruble, USMC (Requirements Officer, Capabilities Development and Integration Division), interview by Aaron Lloyd October 1, 2014.
[37] J. A. English, J. Addicott, and P. J. Kramers, eds. *The Mechanized Battlefield: A Tactical* Analysis (Washington, Pergamon-Brassey's, 1985), 58.

[38] Maj Victor Ruble, USMC (Requirements Officer, Capabilities Development and Integration Division), interview by Aaron Lloyd October 1, 2014.
[39] Sun National Staff, "14 Marines from One Unit Killed in Iraq," *Baltimore* Sun, August 4, 2005, http://articles. baltimoresun.com/2005-08-04/news/0508040089_1_western-iraq-marines-iraqi-insurgents.
[40] Maj Jacob Robinson, USMC (Executive Officer, 2d Assault Amphibian Battalion), interview by Aaron Lloyd, November 20, 2014.
[41] MGySgt Thomas Boore, USMC (Operations Chief, 3d Assault Amphibian Battalion), interview by Aaron Lloyd 20 November, 2014.
[42] Kurt Koch, USMC, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 83-98.
[43] Maj Victor Ruble, USMC (Requirements Officer, Capabilities Development and Integration Division), interview by Aaron Lloyd October 1, 2014.
[44] Patria, *Patria AMV: Armored Modular* Vehicle (Hameenlinna, Finland, 2014).
[45] Staff, "Singapore, Turkish Firms in Vehicle Project," *The Straits Times*, October 1, 2003, http://news.pseka.net/
index.php?module=article&id=4251&PHPSESSID=6329b7c60255e60718e9511a4f3cb63b.
[46] Kurt Koch, "ACV CDD Requirements Quads," (PowerPoint presentation, Capabilities Development and Integration Division, Quantico, VA, 15 April 2014). Slides 112-116.
[47] Headquarters Marine Corps Combat Development Command, *Operational Terms and Graphics*, MCRP 5-12A (Quantico, VA, U.S. Marine Corps, February 2, 2010), 1-139.
[48] Kevin Neprud and Associates, LLC., *Connector Concept #2 of 5: MWAVe-SLED Connector Next High Speed Sled* (Wayland, MA, 29 August 2014).
[49] Textron, *Landing Craft Air Cushion,*
http://www.textronsystems.com/capabilities/marine/landing-craft-air-cushion.
[50] Maj Kenneth F. McKenzie, USMC, "On the Verge of a New Era: the Marine Corps and Maneuver Warfare," *Marine Corps Gazette* 77, no. 7 (July 1993): 63-67.

Bibliography

Cheek, Cynthia. "GCE DOTMLPF/C-P Executive Summary." PowerPoint Presentation. Headquarters Marine Corps, Washington, DC, 26 November 2014.

Department of the Navy. *Naval Operating Concept 2012: Implementing the Maritime Strategy*. Washington, DC, 2010.

Di Leonardo, Nic. "Corps Existentialism: Ensuring a Future for the Marine Corps." *Center for International Maritime Security*, 17 October 2014. http://cimsec.org/corps-existentialism-ensuring-future-marines/13373.

Estes, Kenneth W. *Marines Under Armor: The Marine Corps and the Armored Fighting Vehicle, 1916-2000*. Annapolis, MD: Naval Institute Press, 2000.

Feickert, Andrew. Marine Corps Amphibious Combat Vehicle (ACV) and Marine Personnel Carrier (MPC): Background and Issues for Congress. CRS Report for Congress RL 42723. Washington, DC: Congressional Research Service, July 16, 2014. https://fas.org/sgp/crs/weapons/R42723.pdf.

Gertler, Jeremiah. *V-22 Osprey Tilt-Rotor Aircraft: Background and Issues for Congress*. CRS Report for Congress RL31384. Washington, DC: Congressional Research Service, December 22, 2009. http://fas.org/sgp/crs/weapons/RL31384.pdf.

Gleuck, LtGen Kenneth, USMC. "ACV Phase 1.1 Capabilities Development Document: MROC Decision Document." PowerPoint presentation. Combat Development and Integration Division, Quantico, VA, 29 April 2014.

Glueck, LtGen Kenneth J., USMC. "Mobility Characterization." PowerPoint Presentation. Capabilities Development and Integration Division, Quantico, VA, 12 August 2014.

Glueck, Kenneth J., LtGen, USMC. "GOS Capability Development Update." PowerPoint Presentation. Marine Corps Combat Development Command, Quantico, VA, 22 October 2014.

Grahm, D. S. *The Mechanized Battlefield: A Tactical Analysis*. 55-72. Edited by J. A. English, J Addicott, and P. J. Kramers. Washington, DC: Pergamon-Brassey's, 1985.

Hall, LtCol Howard. "Ship to Objective Commuters." *Marine Corps Gazette* 98, no. 8 (August 2014): 72-76.

Haworth, Blair W. Jr. *The Bradley and How it Got That Way*. Westport, CT: Greenwood Press, 1999.

Headquarters Marine Corps Combat Develop Command. *Operational Terms and Graphics, MCRP 5-12A*. Quantico, VA, 2 February 2010.

Headquarters U. S. Marine Corps. "Capability Development Document for Amphibious Combat Vehicle Phase 1, Increment 1." Capabilities Development and Integration, 29 April, 2014.

Headquarters U. S. Marine Corps. "Concept of Employment for Amphibious Combat Vehicle 1.1." Fire and Maneuver Integration Division, Capabilities Development Directorate, 2 December, 2014.

Headquarters U. S. Marine Corps. *Expeditionary Force 21*. Washington, DC: Headquarters U.S. Marine Corps, 4 March, 2014.

Kevin Neprud and Associates, LLC. *Connector Concept #2 of 5: MWAVe-SLED Connector Next High Speed Sled*. Wayland, MA, 29 August 2014.

Koch, Kurt. "ACV CDD Requirements Quads." PowerPoint presentation. Capabilities Development and Integration Division, Quantico, VA, 15 April 2014.

Knight, Tony. "ACV 1.1 Manpower Study." PowerPoint presentation. Program Manager Advanced Amphibious Assault, Stafford, VA, 15 October 2015.

McKenzie, Kenneth F., "On the Verge of a New Era: The Marine Corps and Maneuver Warfare." *Marine Corps Gazette* 77, no. 7 (July 1993): 63-67.

Mills, LtGen Richard P., Deputy Commandant for Combat Development and Integration. Memorandum for record, 8 February 2012.

Neprud, Kevin. *Executive Summary Common Platform for High Speed Water Connectors and ACV 2*.0. (Wayland, MD: Kevin Neprud and Associates, September 24, 2014).

Patria AMV. *Armored Modular Vehicle*. Hameenlinna, Finland, 2014.

Paxton, J. M., LtGen, USMC, Assistant Commandant of the Marine Corps, United States Marine Corps. Decision Memorandum, 8 July 2014.

Reardon, Mark J., and Jeffery A Charlston. *From Transformation to Combat: The First Stryker Brigade at War*. Washington, DC: Center of Military History, 2007.

Textron. *Landing Craft Air Cushioned*. Providence, RI, 2014. http://www.textronsystems.com/capabilities/marine/landing-craft-air-cushion.