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THE U.S. MARINE CORPS CONCEPT FOR the projection of naval power ashore is known as "Operational Maneuver from the Sea," or OMFTS. Like the Navy–Marine Corps white paper "Forward . . . from the Sea," it emphasizes the world's littoral regions as areas of potential conflict, and in turn the role of naval expeditionary forces in such conflicts. The services recognize that the availability to potential adversaries of inexpensive, advanced weapons and sensors will make traditional amphibious methods of ship-to-shore movement and lodgment ashore more risky than in the past. To reduce this vulnerability, OMFTS calls for movement from ships at sea directly to objectives inland, without pausing to build up on a beachhead. If they are to accomplish this, assault forces must be lighter and faster than they are now, and a great deal of their command, control, communications, computers, and intelligence (C4I), combat service support (CSS), and fire support (naval surface and close air) must be sea based.[1]

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One OMFTS concept under development envisions small, highly mobile teams dispersed over a battlefield up to two hundred miles across as well as deep. These "reconnaissance assault platoons," or RAPs (the teams are referred to by several different names), would cover an area, identify critical targets, and engage particular targets by calling in precision fires. The idea is to achieve the combat power of a large force spread over the entire battlefield without offering a large, fixed target against which the enemy can retaliate. Most of the support for these RAPs—command and coordination, fires, and sustainment—will remain at sea.[2]

The RAP concept is an approach to one of the fundamental goals of OMFTS, reducing the buildup of forces and equipment ashore. To that end, delivery and sustainment of ground forces is to come directly from the sea, primarily by air. That in turn demands that naval logistics assets remain close enough to the shore to allow aircraft (such as CH-53E helicopters and MV-22 tilt-rotor platforms) to resupply the battlefield directly. An implication of this is that Navy ships may have to sacrifice operational and perhaps tactical mobility to sustain the Marine operation.

The objective of this article is to offer a pragmatic and quantitative measure of the degree to which Navy ships would in fact be constrained, under a wide variety of circumstances, by this new form of expeditionary warfare. Specifically, it determines the distance from the coastline that sea-based CSS assets will be able to stay and still support OMFTS operations of the size of a Marine Expeditionary Unit (MEU), involving either traditional forces or RAPs. The paper focuses on combat service support—specifically the time, distance, weight, and volume relationships involved, taking into account such factors as aircraft availability and capacity, and the effects of attrition. It does not, however, address the validity of the RAP concept itself, of C4I and fire support, or other such broader issues.

It must be remembered that if Operational Maneuver from the Sea is adopted, the Marine Corps will continue to prepare for traditional amphibious operations, sustained operations ashore, and operations other than war. Nonetheless, some aspects of OMFTS represent drastic departures from previous doctrines with respect to the demands placed on logistics, C4I, and fire support—in return for the greatly expanded area of influence of a Marine air-ground task force. For this reason, OMFTS is the focus of this paper. Since, as one writer cautioned, "A campaign plan that cannot be logistically supported is not a plan at all, but simply an expression of fanciful wishes," this article helps to determine the supportability of the concepts outlined in Operational Maneuver from the Sea.[3]

Understanding OMFTS. The primary conceptual and programmatic underpinning of OMFTS is known as "ship-to-objective maneuver," or STOM, the goal of which is to "apply the principles and tactics of modern land maneuver to amphibious battlefields. Specifically, we will conduct combined arms penetration and exploitation operations from over the horizon at sea directly to the accomplishment of objectives ashore, without stopping to seize, defend, and build up beaches, landing zones, or other penetration points."[4] Traditional amphibious maneuver from the sea is a three-step process: maneuver in ships, transition to the shore, and maneuver ashore. During the first phase, the naval force has much more flexibility of movement than does the defending force ashore; as long as the assault force is at sea, able to choose where and when to attack, the defender must cover all possible avenues. The second step, the movement of land combat units ashore, requires a lodgment on the beach from which to operate inland. Historically, the time required to establish such a beachhead has often nullified the advantage that had been gained in the approach phase. By the time sufficient combat power is on the beach and a support area has been secured so that units are ready to commence maneuver on land, the enemy is likely to have been able to prepare a defense or counterattack.[5] It is the transition ashore that OMFTS, by means of STOM, seeks to eliminate by means of technological advances in mobility, fire support, and C4I.

These vital advances—innovative, even high-risk concepts to support OMFTS—are the province of a structured developmental effort known as "Sea Dragon." In October 1995 the Commandant of the Marine Corps established an activity (the Commandant's Warfighting Laboratory, since 13 June 1997 known as the Marine Corps Warfighting Laboratory, or MCWL) to field-test leading-edge technologies and approaches in order to identify those having promise. It was this project that proposed dispersed, lightly armed teams, moving on foot but having access to sophisticated C4I and remote, on-call fire. To survive and be effective, such teams would have to be stealthy and agile, requirements that also apply to their means of delivery and support. The MCWL is exploring methods of resupply by air that do not compromise the location of the supported units.[6]

A final preliminary necessary to an understanding of OMFTS is the nature of the littoral operating environment itself. In the restricted waters off a defended shore, naval forces face particularly challenging threats, all of which point to the advantages of deeper and more open waters farther from shore.[7] The difficulty, in waters under continual surveillance by a coastal defense system, of preventing or rapidly detecting the laying of mines, and of clearing them, forces ships to move to seaward. Further, ships have very little time to defend themselves against low-observable, high-speed antiship missiles when they are fired at the short ranges likely in the littoral. Even with such advanced defensive systems as "cooperative engagement capability," depth of fire is required for safety. Another threat, of course, is diesel submarines, which are very difficult to detect and engage when operating close to shore in shallow water. Additionally (and this list is not exhaustive) there are small but heavily armed combatant craft, to which the U.S. Navy, with its large amphibious ships, may have considerable vulnerability.

As a result of all these threats, where traditional amphibious operations require assault shipping to approach within ten thousand yards of the beach, STOM envisions a minimum standoff of twenty-five miles when advanced assault amphibian vehicles (AAAVs) are to be used, forty miles for air-cushion landing craft (LCAC) operations, and fifty miles or more for aircraft.[8] Ideally, the aircraft carriers, assault ships, and the proposed arsenal ship would remain more than a hundred nautical miles from shore.

Assumptions, Scope, and Methodology. This analysis is broken into two main components: support requirements, and ability to satisfy those requirements. It envisions a landing force composed of a Marine Expeditionary Unit, Special Operations Capable (a MEU [SOC]); the Navy ships and aircraft that are present in a typical amphibious ready group (ARG); and a fifteen-day operation with no external support. Only the logistical aspects (that is, combat service support) of OMFTS are considered. CSS, in turn, has six functional areas (supply, maintenance, transportation, general engineering, health services, and other services), but we are concerned here primarily with the supply and transportation functions, with some consideration for the transportation requirements of health services.[9] The other functions are assumed to remain at sea, and they are not addressed. The time frame is the years 2010–2015, by when the required advances in C4I and fire support are assumed to have been achieved.

What Is to Be Supported, and How?

There are three steps in the determination of logistical requirements for OMFTS operations. The first is to establish what forces are to be supported, and the second, to find what assets (with what characteristics) are available with which to do so. On that basis, logistical support requirements can be characterized and calculations performed.

The Marine Corps deploys as Marine air-ground task forces (MAGTFs), combined-arms formations consisting of a command element, an air combat element, a ground combat element, and a combat service support element. The smallest MAGTF is the MEU(SOC). Its command element comprises a force reconnaissance company, a radio battalion, an air and naval gunfire liaison company, a communications battalion, and an intelligence company. Its air combat element, which includes a reinforced helicopter squadron and a Marine air control group detachment, contains twelve CH-46E medium-lift, four

CH-53D or E heavy-lift, three UH-1N light utility, and four AH-1W light-attack helicopters; six AV-8B vertical-takeoff-and-landing, fixed-wing, light-attack aircraft; two KC-130 tankers (on standby in the United States); and at least five Stinger hand-held antiaircraft missile teams. The ground combat element is a battalion landing team, that is, a reinforced infantry battalion. In that battalion are three rifle companies, a weapons company, an artillery battery of six M198 155 mm howitzers, a light armored reconnaissance platoon with seven light armored vehicles (LAVs), an assault amphibian platoon with twelve assault amphibian vehicles, and a combat engineer platoon.

The MEU(SOC)'s support principally resides in the amphibious ready group in which it deploys. An ARG has three or four ships: usually one amphibious assault ship of the LHD or LHA type, and at least one each of an amphibious transport dock (or LPD) and a dock landing ship (LSD). Table 1 summarizes the LCAC and aircraft-carrying capacities of these ships.[10]

Table 1
ARG LCAC and Aircraft Capacities

Ship/Class	Aircraft*	LCACs
LHD	45	3
LHA	42	1
LPD 17	6	2
LSD 41	0	4
LSD 49	0	2

* CH-46 equivalents

The LHA or LHD carries the command element of the MEU and is the primary aviation ship, with the LHD offering slightly more space for aircraft than does an LHA. The LPD has both a well deck and a limited aircraft capability. The developmental LPD 17 type will be more survivable and stealthy than current amphibious ships and therefore will be the member of the ARG best suited to go in close to shore, if needed. The LSD is primarily valuable for its well deck, from which assault amphibian vehicles (AAVs, formerly known as LVTs)—or their successors, advanced assault amphibian vehicles (AAAVs)—deploy.

In 2010–2015 the medium-lift aircraft will be the MV-22 tilt-rotor, which will have replaced the CH-46E and CH-53D. It doubles the speed of the CH-46 and quadruples its range. The MV-22 has an internal capacity of ten thousand pounds at a radius of up to five hundred nautical miles.[11] While the MV-22 has a substantial external lift capability (fifteen thousand pounds, versus four thousand for the CH-46E), it comes at the expense of speed; the MV-22 cruises at 240 knots with an internal load, but at 150 knots or less with an external one.[12]

In the air combat elements projected for 2010–2015, the CH-46Es have been replaced one for one by MV-22s, resulting in forty-eight CH-46E-equivalent flight-deck spots. This equals the maximum available in an LHA-based ARG, and it leaves only three extra spots in an ARG having an LHD instead. The Marine Corps heavy-lift helicopter is and will be the CH-53E. With an external load capacity of thirty-two thousand pounds, it is the only helicopter that can transport the LAV or the M198 155 mm howitzer. The CH-53E also allows a forward refueling capability for aircraft or ground vehicles, by airlifting a tactical bulk fuel delivery system. That system, which can be quickly installed and removed, can provide up to 2,400 gallons of fuel.[13] Table 2 summarizes the characteristics of the MV-22 and CH-53E.

Table 2
Aircraft Characteristics

Type	Radius (NM)	Internal Load Airspeed (kts)	External Load Airspeed (kts)	Troops	Payload (pounds)	Average Availability	Spot Factor*
MV-22	500	240	150	24	15,000	85%	1.7
CH-53E	250	150	130	55	32,000	60%	2.5

Source: Janet R. Magwood, H. Dwight Lyons, and John F. Nance, Jr., *Project CULEBRA: Sea Based Combat Service Support for Ship-to-Objective Maneuver (Supply and Transportation Analysis)*, CRM 95-144 (Alexandria, Va.: Center for Naval Analyses, 1995).

* An arbitrary measure used in shipboard flight-deck management.

The primary surface logistical asset is the LCAC, designed to carry wheeled or tracked vehicles, artillery, and heavy equipment. An ARG will have six to eight LCACs, which can lift up to sixty tons at more than forty knots and have a range of three hundred nautical miles at thirty-five knots.[14] Although fast and highly mobile, the LCAC is both large and unarmored; it could be difficult to use in the face of opposition and will generally have to come ashore only after the AAAVs.

The AAAV, which will enter service around 2006, offers a capability much greater than that of the AAV7A1, which it replaces. It will travel in water at twenty-five knots (versus the six to eight knots of its predecessor), providing a true over-the-horizon capability. Over land it will move at more than forty-five knots, which gives it the mobility of the MlA1 tank. The AAAV will carry eighteen fully equipped Marines or up to five thousand pounds of cargo, and it will be armed with a 25 mm Bushmaster gun and a 7.62 mm machine gun.[15] A typical MEU will have twelve AAAVs.[16]

Having pictured the MAGTF units to be supported and the assets available in the ARG, we need next to understand how this team will operate. Three schemes of employment are envisioned for a MEU(SOC) conducting OMFTS, two based upon ship-to-objective maneuver and one using the Sea Dragon concept of reconnaissance assault platoons. Let us begin with an air and sea-borne assault. The air component will insert two of the battalion landing team's three rifle companies by MV-22. In the sea component, a light armored reconnaissance platoon will deploy by LCAC, and an AAAV platoon will lift the remaining rifle company. Each of the three rifle companies will be augmented by two weapons company HMMWVs ("humvees"), inserted by air. A notional deployment scheme for this force mix will have the main body of the ARG close the shore to forty nautical miles to deploy LCACs and aircraft, while an LPD goes as far in as twenty-five miles to deploy the AAAVs. Once the LCACs are recovered, the ARG can withdraw another ten miles or more offshore, possibly leaving an LPD or another ship with a flight deck as a forward arming and refueling point. The artillery battery will remain at sea, to be inserted and extracted by CH-53E for raids as needed.

For this type of operation—that is, for a landing force of battalion landing team size or less—no combat service support area will be established on a beachhead. Accordingly, the LCACs, with their heavy-lift capacity, cannot be used to sustain the forces already deployed ashore; there will be no "beachmasters" to offload the stores and forward them. Almost all such material will have to be delivered by air. In addition, while one infantry company is in AAAVs, sufficient airlift to move one of the other two companies up to twenty-five miles a day will be required. The daily support requirements of this force, then, will be sustainment for three rifle companies and two armored units, and transportation for one rifle company.[17] The high speed and mobility of the AAAVs will allow them to operate much like helicopters; forward arming and refueling points will support both.[18] Since fuel and other combat service support will not be based ashore for a landing force this size, sustainment for AAAVs and LAVs will be delivered directly to the units. Aircraft fuel and ammunition will come from the LHA or LHD, or from a sea-based arming and fueling point.

The second force-mix scheme is an entirely air-inserted assault. Here, three rifle companies will arrive by air, with no mechanized component or HMMWVs.

This technique could be necessitated by a lack of safe surface routes or by an objective requiring too great a standoff from the beach. As in the first scheme, artillery will remain at sea and be delivered by CH-53E on demand. The logistical requirement will be to sustain the three individual companies and provide airlift to move at least two of them every day.

The third case is the most drastic departure from traditional operations and makes most use of the new Sea Dragon concepts. In this case we postulate that the BLT will consist of twenty-seven reconnaissance assault platoons with a mobile combined arms company (MCAC) made up of LAVs, AAAVs, and HMMWVs as required. The RAPs, squad-sized units, will engage critical targets with remote fires in the form of naval surface fire support, close air support, or artillery raids. Nine of these units will be ashore at any time, with the remainder either preparing for insertion or returning from the field. The MCAC will generally remain at sea, going ashore as needed and then quickly returning to the ARG. The support requirements for this force are such that each of the nine teams will require one MV-22 resupply daily.[19]

Calculating Support Requirements

Each unit requires supplies from what is known as Class I (food and water), Class III (petroleum, oil, and lubricants), and Class V (ammunition). Table 3 summarizes the supply requirements for each of the ground combat elements components, as specified by the AAAV program office and the Center for Naval Analyses. Food figures are based on three "meals, ready-to-eat" per Marine per day, each MRE weighing 1.46 pounds. Water is required at the rate of five gallons per Marine per day.

The primary means for moving and sustaining troops in an OMFTS environment will be the MV-22. Its preferred method of resupply in the field is to carry cargo externally, which allows easy pickup and drop-off (unless materiel-handling equipment or a large landing zone is available, large internal cargoes are time-consuming to unload) and minimizes the time the aircraft is vulnerable to enemy fire. External loads, however, and as noted, require the aircraft to fly slower than it could otherwise, more so than can be offset by the greater speed of loading and unloading. The MV-22's speed penalty for external loads, ninety knots, is much larger than that of the CH-53E (twenty knots). In this setting, only the small cargoes for the Sea Dragon RAPs are internal payloads, all others are external;[20] food, water, and ammunition are packaged on pallets, and fuel is transported in five-hundred-gallon bladders, of which the MV-22 can carry two at a time.

In addition to the required sustainment and troop movements, MV-22s will also be used for decoy missions; deception is a significant component of

Table 3
Daily Sustainment Requirements for a MEU(SOC) GCE
(in pounds)

Unit	People	Class I (Food)	Class I (Water)	Class III (POL)	Class V (Ammo)	Total Wgt.
Rifle Co.	182	806	7,644 (910 gals.)	230 (30 gals.)*	842	9,292 9,522*
LAR Plt.	35	154	1,470 (175 gals.)	3,430 (409 gals.)	2,243	7,297
AAAV Plt.	47	205	1,974 (235 gals.)	14,280 (2,040 gals.)	3,259	19,718
RAP	13	57	546 (65 gals.)	0	60**	663

Source: Adapted from Magwood, Lyons, and Nance; and Ashinhurst.
* Rifle company augmented with two weapons company HMMWVs.
** At rifle-company rates; RAPs would ordinarily avoid direct combat.

OMFTS.[21] This analysis looks at two cases: no deception missions, and one deception for every three logistical sorties. The former gives an indication of upper logistical limits, while the latter represents a realistic operational support pattern.

As for the CH-53Es, due to their small numbers (four to eight) and their relatively low operational availability (about 60 percent), they will be assigned to move the artillery battery and respond to emergent heavy-lift requirements (such as recovering a disabled LAV). The helicopter's tactical forward-refueling capability is not considered in this analysis, since the needs of artillery movement will make it practically unavailable.

Tables 4 and 5 show the insertion and daily sustainment requirements for each of the force mixes. In the first three, at least two aircraft are required per mission. It is coincidental but fortunate that the insertion and sustainment requirements are so similar across the three scenarios; the extra two sorties required to insert the "air" mix have a negligible effect on the results of the overall analysis.

Supportability Calculations

What is the maximum distance offshore from which logistical support requirements can be satisfied? Formulas can be written to determine the

Table 4
MV-22 Sorties Required for MEU (SOC) Insertion

Force Mix	Internal Cargo	External Cargo	Troop Movement	Deception	Total Sorties
Air/Sea					
3 Rifle Companies 1 AAAV Platoon 1 LAR Platoon	0	4	16	8	28
Air					
3 Rifle Companies	0	0	24	8	32
Sea Dragon					
9 RAPs (Two aircraft/mission)	0	0	18	6	24
Sea Dragon					
9 RAPs (One aircraft/mission)	0	0	9	3	12

Table 5
MV-22 Sorties Required for Daily MEU (SOC) Sustainment

Force Mix	Internal Cargo	External Cargo	Troop Movement	Deception	Total Sorties
Air/Sea					
3 Rifle Companies 1 AAAV Platoon 1 LAR Platoon	0	10	10	8	28
Air					
3 Rifle Companies	0	6	16	8	30
Sea Dragon					
9 RAPs (Two aircraft/mission)	0	0	18 (includes resupply)	6	24
Sea Dragon					
9 RAPs (One aircraft/mission)	0	0	9 (includes resupply)	3	12

maximum separation between units ashore and their sea-based sources of logistical support. The basic equation to determine this distance is

$$D = \frac{(H - T) \times V}{S} \qquad (1)$$

where $D \equiv$ round-trip distance in nautical miles,

$H \equiv$ operational aircraft hours per day,

$T \equiv$ total unusable time (on deck, loading, unloading, or refueling) in hours,

$V \equiv$ aircraft speed in knots, and

$S \equiv$ number of sorties.[22]

We modify this basic form to take into account the number of aircraft assigned, aircraft operational availability, the number of aircraft held in reserve, differing sortie types (including external loads, internal loads, troop movement, and deception sorties), differing airspeeds of particular sortie types, air-crew flight hour limitations, and indirect flight-path routing.

For the resulting set of equations, we use a number of "baseline inputs," some of which have been referred to. First, we assume the MEU(SOC) operates MV-22s, and that their average operational availability is 85 percent (which is the anticipated operational rate).[23] Further, a maximum of two aircraft are held in reserve. At present, most MEU(SOC) operations do not hold back any for such contingency missions as tactical recovery of aircraft and personnel, medical evacuation, or emergency extraction of ground combat units. A section (usually two aircraft) is designated for tactical recoveries, but it goes about its normal operations until a requirement arises. The distances involved in OMFTS, the lack of ground transport or facilities for casualty evacuation and treatment, and the vulnerability of small, dispersed units provide some justification for dedicated, on-call aircraft.[24] This analysis looks at two cases, one with two aircraft in reserve, the other with none.

For any mission, the MV-22's expected operational refueling time is ten to fifteen minutes, external load pickup or release takes approximately one minute, internal cargo handling extends from five to thirty minutes, and troop loading and unloading require about two minutes. We therefore assume a notional thirty minutes "on deck" for turn-around. The maximum daily flight time per aircraft is eight hours, a limit based primarily on the aircrew endurance but also on aircraft maintenance requirements. As noted above, for deception sorties such as feints we examine two variants: no deception missions, as a baseline, and one deception mission for every three real sorties.

Table 6 summarizes the results for the different force mixes. The distances shown are the total separations possible between supporting ships and supported units. Figures were calculated for three cases in each mix: using all available aircraft for troop movement and sustainment; holding two aircraft in reserve for tactical recovery or medical evacuation; and both flying deception missions and holding two aircraft in reserve.

These figures all assume a "permissive" air defense environment—that is, the aircraft movements are unopposed. What would be the effect on maximum

Table 6
Supportable Offshore Distances
(Permissive Air Environment)

Force Mix		Distance (NM)
Air/Sea	Using all available aircraft	289
[1]	Holding 2 aircraft in reserve	182
	2 reserve + 1 deception / 3 actual missions	129
Air	Using all available aircraft	192
[2]	Holding 2 aircraft in reserve	188
	2 reserve + 1 deception / 3 actual missions	132
Sea Dragon	Using all available aircraft	327
[3]	Holding 2 aircraft in reserve	201
	2 reserve + 1 deception / 3 actual missions	201
Sea Dragon	Using all available aircraft	711*
[4]	Holding 2 aircraft in reserve	331
	2 reserve + 1 deception / 3 actual missions	331

[1] 3 Rifle Companies, AAAV Platoon, LAR Platoon
[2] 3 Rifle Companies
[3] 9 RAPs (Two aircraft/mission)
[4] 9 RAPs (One aircraft/mission)

*Distances over five hundred nautical miles require aerial refueling

support distance if aircraft were being lost to enemy action? To measure the impact of a non-permissive environment and of aircraft attrition, we model the aircraft as circulating between the supported unit and the ARG, subject to attack on both the inbound and outbound legs. We assume a constant probability of an aircraft being shot down for every hundred miles flown over land, a probability that does not change with distance or time; that is, its chance of being shot down is the same crossing the beach as it is two hundred miles inland, and the same on the first day of the operation (D+1) as it is on D+15. Extra missions required to recover downed air crewmen are not taken into account. We assume further that the MEU(SOC)'s operations do not fundamentally change as a result of the loss of aircraft. The aircraft losses are independently, identically, and binomially distributed, as:[25]

$$p_s = 1 - (1-p)^{D_s}. \qquad (2)$$

where p_S = probability of shootdown per sortie,

p = probability of shootdown per hundred miles traveled over land (assumed to be .01), and,

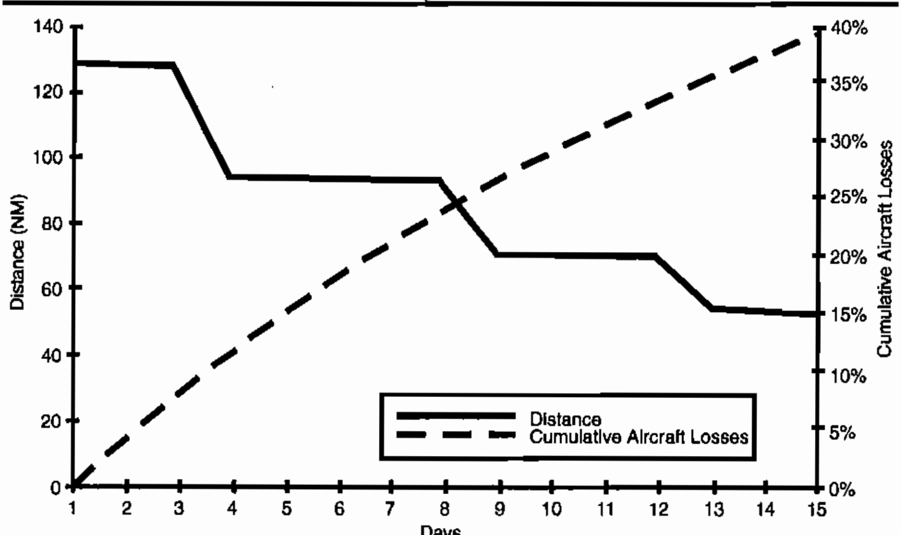
D_S = average distance flown (in hundreds of nautical miles, with fractional values when appropriate) over land per sortie.

When n is defined as the total number of aircraft sorties per day, then the expected losses (E) of all types of operating aircraft each day are given by

$$E = np_S. \quad (3)$$

To determine attrition over the course of an operation, expected losses are calculated for the end of each day, with the number of aircraft available for each following day duly decreased. (The decrement may be a fractional number.) With this number we recompute the distance calculations discussed above, and new maximum separation distances are determined. The results are presented in Figure 1, which shows the decrease in operating distance as aircraft losses increase. Table 7 summarizes the supportable distances for the different force mixes, at days one, seven, and fifteen of an operation.

Figure 1



Maximum Supportable Range in a Non-Permissive Environment
(Air/sea force mix using deception and holding aircraft in reserve)

For illustration, let us work through an example, choosing as one whose aptness cannot be doubted a situation the Marine Corps itself posited as an example in its 1996 doctrinal paper, "Operational Maneuver from the Sea." (This paper defined the Marine Corps' future operational concept.) In that illustration, a hypothetical amphibious force conducts a ship-to-objective maneuver against the eastern seaboard of the United States. The force's objective is Richmond, Virginia, and the Marines attack that city directly from the sea. However, the potential movements of the Navy ships in twenty-four hours at sea are such that the forces ashore must defend beaches from South Carolina to New Jersey.[26]

Table 7
Supportable Offshore Distances
(Non-Permissive Air Environment)

Force Mix		Distance (NM) Day 1	7	15
Air/Sea [1]	Using all available aircraft	296	184	93
	Holding 2 aircraft in reserve	186	127	69
	2 reserve + 1 deception / 3 actual missions	131	95	54
Air [2]	Using all available aircraft	203	138	99
	Holding 2 aircrafr in reserve	201	137	73
	2 reserve + 1 deception / 3 actual missions	139	75	43
Sea Dragon [3]	Using all available aircrafr	327	200	98
	Holding 2 aircraft in reserve	201	136	72
	2 reserve + 1 deception / 3 actual missions	201	99	55
Sea Dragon [4]	Using all available aircraft	711*	330	327
	Holding 2 aircrafr in reserve	331	329	200
	2 reserve + 1 deception / 3 actual missions	331	203	138

[1] 3 Rifle Companies, AAAV Platoon, LAR Platoon
[2] 3 Rifle Companies
[3] 9 RAPs (Two aircraft/mission)
[4] 9 RAPs (One aircraft/mission)

*Distances over five hundred nautical miles require aerial refueling

If we apply the preceding calculations, we find that to attack Richmond, which is ninety-five miles inland, an ARG would have to stay within forty-five miles of the Delaware-Maryland-Virginia coastline if it is to conduct ship-to-objective maneuver, while Sea Dragon RAPs could be inserted from a distance of more than a hundred miles at sea. These distances apply only for a permissive air environment. In the face of air defenses, however, neither of the STOM force mixes could be supported even from the beach itself after one week of operations. The only option that could be sustained is Sea Dragon, and then only if the units are supported by individual aircraft instead of the conventional flights of two. To support the RAPs for an additional week the large amphibious ships would have to close from over a hundred miles from the beach to within forty-three.

"Influencing Events Ashore"

In Operational Maneuver from the Sea, as envisioned, there is no room for surface resupply. Logistical movement over land requires both ground transportation and secure lines of communication. Especially in view of the distances involved, these lines of communication require defense, just as a beach combat service support area would. For OMFTS the CSS must instead be provided by air. In this article we have measured the outer limits of airborne CSS of a MEU(SOC), based on the airlift assets future MEUs are now planned to have: twelve MV-22s, and CH-53Es for heavy lift support and special circumstances. Air-cushion landing craft and advanced assault amphibian vehicles will be used only for the original delivery of equipment and Marines—not sustainment.

In an OMFTS operation conducted using traditional ground forces (with light amphibious vehicles and AAAVs permanently ashore, but not the artillery), the envisioned amphibious ship stand-off of at least fifty miles will be difficult if any aircraft are diverted to deception missions or held in reserve. It will simply not be possible in a non-permissive air environment. Shifting to a non-mechanized landing force does not ease the problem, because of the increased requirement that results to move troops by air. Using reconnaissance assault platoons does help somewhat. However, because of the RAPs' small sustainment requirements, the current doctrinal practice of sending a two-aircraft section wastes a great deal of lift capability.

The distance at which the ARG can stand off shore could be increased by a number of measures having to do with increasing, or maintaining, the actual or effective number of MV-22s. If only one aircraft is sent to resupply or move a RAP (effectively doubling the available aircraft), there is a huge increase in range: even in an opposed scenario, after seven days (and the loss of a quarter of the aircraft) it would still be possible to conduct operations more than two hundred miles from the ships. (But this decreases by the fifteenth day to 138 miles.) Another approach is to increase the number of crews in the air combat element, which would allow the aircraft to be flown more than eight hours per day. However, it is likely that doing so would have negative, offsetting effects on operational availability of the aircraft or on required maintenance. A second possibility is to increase the number of MV-22s in the ACE. Making use of the spots on the LPD would allow three additional aircraft, and the three UH-1s could be replaced with one more MV-22, at the expense of light utility helicopters. Also, the need to replace MV-22 losses must be anticipated, if the original stand-off distance is to be maintained in OMFTS operations of more than a week.

A fundamentally different approach recognizes that whereas this article considers an amphibious ready group operating independently of a carrier battle group, the presence of a CVBG (whether formally part of the naval expeditionary force or not) would offer advantages. It could reduce attrition to the MV-22s by providing escort or suppressing enemy air defenses. Also, at least if there were MV-22s assigned to the carrier, the battle group might provide additional lift or reserve lift capability.

The implication of this quantitative analysis is essentially that to realize the full value of Operational Maneuver from the Sea, there must be either a shift to more lethal landing forces having smaller logistical demands, or a sizable increase in airlift capability. The figures suggest that to maintain a safe stand-off distance from shore, maintain operational flexibility, and still support OMFTS, the Navy will need to push development of inshore combat tactics, perhaps by means similar to those used at the Marine Corps Warfighting Laboratory. Influencing events ashore is more than being able to strike deep inland with precision weapons and aircraft. It is the ability to *affect* the campaign, deep inland, with forces on the ground. Until a lighter, more lethal Marine force is feasible, it appears that the Navy would be well advised to study the problem of supporting the Marines from close to shore. Correspondingly, both the Navy and the Marine Corps need to keep the laws of logistics in mind if they are to distinguish campaign plans from "fanciful wishes."

Notes

1. U.S. Marine Corps, *Operational Maneuver from the Sea* (Quantico, Va.: Marine Corps Combat Development Command, 1996), pp. 5–6.

2. Commandant's Warfighting Laboratory, "Technology Exploration and Exploitation Plan," 1997, <http://ismo-wwwl.mqg.usmc.mil/cwl-main/html/planch1.htm>.

3. John F. Meehan III, *The Operational Trilogy*, p. 15, quoted in U.S. Marine Corps, *Combat Service Support*, Fleet Marine Force Manual [FMFM] 4 (Quantico, Va.: Marine Corps Combat Development Center, 1993).

4. U.S. Marine Corps, *Ship to Objective Maneuver*, coordinating draft (Quantico, Va.: Marine Corps Combat Development Command, 1995).

5. H. Dwight Lyons and Janet R. Magwood, *Project CULEBRA: Mini Seminar*, CRM 94-53 (Alexandria, Va.: Center for Naval Analyses).

6. Commandant's Warfighting Laboratory.

7. For an encapsulated assessment of this threat, see Yedidia Ya'ari, "The Littoral Arena: A Word of Caution," *Naval War College Review*, Spring 1995, esp. pp. 8–13.

8. U.S. Marine Corps, *Ship to Objective Maneuver*.

9. For the components of combat service support, see FMFM 4.

10. Norman Betaque, Jr., et al., *Logistical Support of Operational Maneuver from the Sea* (draft) (McLean, Va.: Naval Studies Board, 1995).

11. Craig W. Turley, "An Analysis of the V-22 in the Carrier Onboard Delivery and the Vertical Onboard Delivery Roles" (master's thesis, U.S. Naval Postgraduate School, 1989).

12. This is due not to the flight characteristics of the MV-22 but to the behavior of non-aerodynamic external leads at high speeds.

13. U.S. Marine Corps, "USMC Factfile: Tactical Bulk Fuel Delivery System, CH-53E," 1997, <http://www.usmc.mil:80/factfile/213e.html>.

14. Naval Surface Warfare Center, "Landing Craft Air-Cushion," 1997, <http://lpd17_wr.nswc.mil:80/character/baseline/vehicle/lcac.html>.

15. General Dynamics Land Systems, "Advanced Amphibious Assault Vehicle," 1997, <http://www.gdls.com:80/programs/aaav.html>.

16. Telephone conversation with Joel Ashinhurst, Advanced Amphibious Assault Vehicle Program Office, Alexandria, Va., 12 February 1997.

17. Telephone conversation with Leonard A. Blasiol, Marine Corps Combat Development Command, Quantico, Va., 12 February 1997.

18. Ashinhurst.

19. This is a conservative estimate of RAP support requirements. These units are expected to be capable of operations for several days without resupply. Also, in certain scenarios some aircraft would resupply more than one RAP per sortie.

20. As a sensitivity analysis, supportability calculations were also performed with all sustainment except fuel transported internally. The results differed by less than 6 percent. While internal loading is preferable, it does not appear to be a critical factor for the forces analyzed.

21. U.S. Marine Corps, *Operational Maneuver from the Sea,* p. 6.

22. John E. Edwards, *Combat Service Support Guide,* 2nd ed. (Harrisburg, Penna.: Stackpole Books), 1993, p. 173.

23. Telephone conversation with Paul Morgan, MV-22 Program Office, Alexandria, Va., 4 October 1996.

24. In Vietnam, 8–10 percent of such small reconnaissance patrols required some form of emergency extraction. Telephone conversation with F.J. West, Gama Corporation, 10 October 1996.

25. Thus the effects of air defense "hot spots" and operational attrition due to sandstorms, torrential rain, snowstorms, and the like are disregarded, although in such cases p_s tends to be higher.

26. U.S. Marine Corps, *Operational Maneuver from the Sea,* p. 8.

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