XXIV. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

Our project used a top-down, bottom-up approach to engineer an architecture and overarching system requirements for a system-of-systems to conduct expeditionary operations in littoral regions, exploring interfaces and system interactions; and comparing current, proposed, and conceptual Sea Based platforms against these requirements. Our conclusions are summarized below.

B. EXTEND™ MODEL RESULTS

A cornerstone of this analysis was the large-scale, high-resolution model written in EXTEND™. This model enabled us to compare the capability of the Conceptual architecture we defined through our top-down analysis, against the capability of the Current and Planned architectures comprised of the programs of record.

The major results of the comparison between these architectures' capability to project Marine combat power ashore were:

- The Time To Build Up The Advance Force (TAF) for each architecture was insensitive to the effects of weather, mines, and distance from the objective for all three architectures.

- The proximity of the ships to the objective and weather conditions are the main influences on the Time To Build Up To The Desired Force Level (TBU) for all three architectures.

- Using the Planned or Conceptual architectures under good weather conditions and commencing the MEB assault from a greater distance at sea does not increase TBU significantly.

- Aircraft combat survivability is critical for successful sustainment of the objective, particularly in the Planned and Conceptual architectures, where a greater proportion of supplies travel by air. Combat survivability can be improved through a combination of threat suppression, use of escort aircraft, and/or the incorporation of robust aircraft combat survivability into their initial design.

- The Current Architecture, with the accompanying Iron Mountain, while it takes the longest time to build up forces ashore, is the most robust in sustaining the objective, if the operational commander is willing to accept the accompanying operational pause and the threat conditions permit. This is primarily the result of the Iron Mountain's large overland transportation capacity, which was not affected significantly by weather or the attrition modeled in our scenario.

- Sea Basing appears to be a viable operational concept, since the model showed the Planned Architecture was able to sustain the objective through the Sea Base as well as the Current Architecture, but only under good weather conditions. The reduced surface craft sea keeping, loading capacity, and speed reduction caused by heavy weather meant a Sea Base comprised of the Planned Architecture had difficulty maintaining the required flow of supplies in inclement weather. Additionally, the Planned Architecture's combat force projection was distance limited, based on planned transporter capabilities, to approximately 175 NM from the Sea Base.

- Under all conditions, the Conceptual Architecture was able to project forces ashore in the shortest time, since its increased number of MV-22 and conceptual long-range, heavy-lift air assets were better able to project forces up to the 275 NM from the Sea Base required by doctrine.

- In the Conceptual architecture, longer transport ranges and larger numbers of aircraft required to sustain the forces ashore lead to very high fuel consumption rates, which demand more frequent fuel deliveries to the Sea Base.

- While large numbers of aircraft are required to implement STOM and re-supply from a Sea Base over the long distances envisioned in the doctrine, there remains a need to retain an effective surface craft transport capability to project high volume and weight loads, such as the M1A1 tank, ashore.

The data collected from the series of experiments conducted on the Expeditionary Warfare EXTEND™ model indicated that in order to achieve the elements of speed, rapid power projection, and indefinite sustainment for the force projected ashore, it would be necessary to use more air assets to transport the light combat elements to the Objective, while reducing the susceptibility of the sea transports to poor weather effects. In addition, the use of an Iron Mountain would also reduce the effects that weather has on the re-supply process.

Notwithstanding that, the experiments have also shown that the Sea Base concept, using the planned assets, is indeed able to support the Objective fully without establishing another logistics depot ashore in good weather conditions. Poor weather will, however, decrease the throughput from the Sea Base to the Objective, and consequently, the resource level held at the Objective will be affected. This can be overcome by either increasing the stockpile held at the Objective prior to the onset of the bad weather, by improving on the design of the transporters to make them more robust to the effects of poor weather (for example, to design sea crafts with better sea keeping ability), by moving the Sea Base closer to the Objective, by establishing a small logistics depot ashore to supplement the Sea Base, or a combination of these options.

The use of HSVs to replenish the logistics depot was shown to have reduced the variability in the resource levels. The high transit speed and relatively short loading and unloading time of the HSV allowed for multiple trips to be made in the time taken for the LMSR ships to complete one replenishment run.

C. EFFECT OF SPEED EXCURSION

1. Conclusions from Scheduling Model Analysis

The results from the Scheduling Model Analysis have quantitatively determined the numbers of each type of ship (FSS and HSV) required at various distances. From these results, the following were deduced:

a. The maximum cost effective distance that the HSV should be utilized for re-supply runs based on the current HSV to FSS cost ratio of 6:1, and given the current HSV speed and payload capability.

b. The cost ratio of HSV and FSS required at each distance.

Sequentially, the speed and payload requirements to fulfill the 6:1 cost ratio at a pre-set distance of 1,765 NM (distance between Offshore Base and Sea Base in the scenario) were also determined using the same methodology.

2. Recommendations from Scheduling Model Analysis

	RECOM.	REMARKS
Maximum Distance for Re-supply Runs (Speed and Payload fixed)	250 NM	At the lowest possible HSV to FSS cost ratio of 7:1
	2,250 NM	If HSV to FSS cost ratio is halved to 12:1
Cost Ratio Required at Various Distances (Speed and Payload fixed)	Varies	Nil
Speed Required to Fulfill Current Cost Ratio of 6:1 (Distance set at 1,765 NM, Payload fixed)	> 55 knots	Cost ratio at 55 knots is 8:1 Higher speeds not investigated
Payload Required to Fulfill Current Cost Ratio of 6:1 (Distance set at 1,765 NM, Speed fixed)	3.5 DOS per Squadron	Approximately 1.5 times of current payload

Table XIX-9: Summary of Recommendations

From the summarized recommendations, it is apparent that at its current cost, speed, and payload, the HSV is not an effective replacement for the FSS for re-supply missions. To be an effective replacement, either one of the following has to be implemented for future HSV designs:

a. Reduce the cost of the HSV relative to the FSS. The exact cost requirement varies according to the distance that the HSV would be utilized for.

b. Increase the speed of the HSV. Again, the exact speed requirement varies with distance involved. At 1,765 NM, the speed required is beyond 55 knots, which may render the HSV unstable or significantly reduce its practical payload capability.

c. Increase the payload of the HSV. The exact payload requirement varies with distance the HSV is utilized for. At 1,765 NM, the payload required is approximately 1.5 times the current payload.

3. Conclusions from EXTEND™ experiment

The results obtained from the experiment using the EXTEND™ modeling analysis showed the effects of speed evolving from the interactions with the environmental and noise factors. The interactions showed that the model prefers payload to speed in the case of the specific HSV investigated, where the returns from increasing speed does not compensate for the loss of speed in the transporting platform.

4. Recommendations from EXTEND™ experiment

The model in this case, is unable to quantify the value of low survivability in reality, and hence unable to deduce what level of force protection is required for the HSVs to perform their mission. A separate study on how the level of protection interacts with the payload and speed of the HSV is recommended to derive a force protection degree of measurement for the HSV.

5. General Conclusions Recommendations

The Replenishment model analysis quantitatively showed the effects of speed versus payload and its relevant cost relationship based on the comparison between a conventional FSS and a conceptual employment of a HSV. The recommendations resulting from this analysis allows the decision maker to possess an overview of the relationships between these three factors, thus allowing a decision to be crystallized anchoring on either one or more of the three factors.

The EXTEND™ experiment was aimed at examining the interactions with environmental and noise factor, which was not factored into the Replenishment model to concentrate on direct impact between speed, payload, and cost. However, the results from the EXTEND™ experiment were only able to identify a distinct relationship between speed and payload, with the other environmental and noise factors deemed statistically insignificant.

Other than the above investigated key and environmental factors, other operational cost effectiveness issues like quantifying the holding cost for resources held above the target value at the Sea Base, penalty cost for using the safety stock, and operating cost for delivery of resources to the Sea Base are recommended for further investigation to achieve a more detailed trade-off analysis.

D. IMPLICATIONS OF SEA BASING RESULTS

In this study, we examined the Sea Base using various analytical tools and methodologies, and concluded that Sea Basing is a viable option for the future of Expeditionary Warfare provided a robust aerial throughput capability and a capable force protection package exists. The following summarizes our conclusions using EXTEND™, EXCEL, ARENA™, and EINSTein.

1. Conclusions Resulting from EXTEND™ Analysis

- The distance from the Sea Base to the Objective is critical to the overall sustainment effort.
- Greater distances create more variability and difficulties in maintaining a desired level of days of supplies at the Objective.
- Air re-supply is more robust in adverse weather, but it is highly dependent on survivability during transit.
- Air re-supply is more responsive and expedient, but it consumes a significant amount of fuel.

2. Conclusions Resulting from EXCEL™ and ARENA™ Simulations and Analysis

- Planned aviation assets cannot meet the sustainment needs of a MEB beyond 175 NM.

- Conceptual aviation assets with 24 HLAs and 96 MV-22s operating from the X-ships can surge and sustain a MEB up to 275 NM from the Sea Base.
- Conceptual aerial throughput capability has a surge capacity of 4 times the daily sustainment requirements at 225 NM; 3 times at 250 NM and 2 times at 275 NM (12-Hour Operating Time).
- Conceptual Architecture can accept up to 50% attrition or diversion of assets to other missions and still sustain a MEB ashore up to 275 NM daily (A_o = .75).

3. Conclusions Resulting from EINStein™ Simulations

- The Conceptual Sea Base did not perform better than Current or Planned in terms of survivability.
- A less distributed Sea Base becomes less survivable.
- Mobile land-based ASCMs (Anti-Ship Cruise Missiles) pose a threat to the Sea Base.
- The defense capabilities of the ships need to be increased.
- The simulations indicate the MOE for the Conceptual architecture can be achieved with 16 LCS; 3 CG, 3 DDG, and 3 FFG; or 3 DDG and 12 LCS.

E. IMPACT OF REDUCED FOOTPRINT ASHORE

As part of our analysis we also examined the impact of a reduced footprint using various analytical tools and methodologies, concluding that, while the. The following summarizes our conclusions using EXTEND™, EXCEL, ARENA™, and EINSTein.

- A reduced MEB-sized force with equivalent, if not better, collective firepower, operating with lighter and more efficient equipment, as well as lower fuel, spare parts, and ammo consumption will contribute to a flexible, more maneuverable and responsive fighting force.

- Building and developing a force with a lower footprint that will be a crucial component in making STOM at 275 NM from the Sea Base a reality.

- Water and fuel account for approximately 85% of the logistical re-supply requirement for a MEB-sized Landing Force.

- Reducing the number of personnel by an increment of 1,000 reduces the daily re-supply requirement by 16.4 to 56.4 tons, depending on the environment and the use of a minimum or maximum sustainment rate.

- Reliability and availability of equipment are key factors to ensuring a much leaner and more effective MEB force ashore.

- Shifting fire support to the Sea Base can reduce the daily re-supply requirements by up to 21%. But the more important benefit is the significant reduction of the footprint ashore associated with the initial assault on the objective, whereby more lift assets can be freed to project the key troops and fighting equipment ashore faster.