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ANALYSIS OF MATERIAL HANDLING EQUIPMENT FOR MARITIME PREPOSITIONING SHIPS (MPS) INSTREAM OFFLOAD

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August 1992

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ANALYSIS OF MATERIAL HANDLING EQUIPMENT FOR MARITIME PREPOSITIONING SHIPS (MPS) INSTREAM OFFLOAD

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ABSTRACT

The Maritime Prepositioning Force (MPF) program enables the United States Marine Corps to globally project rapid and sustainable combat power. The instream method of offloading equipment and supplies from the Maritime Prepositioning Ships (MPS) provides the flexibility needed to respond to a broader range of contingencies dictated by the increasingly dynamic geostrategic environment. In this paper, we develop a simulation model of an MPS instream offloading operation to provide Marine Corps commanders with a decision support tool for best allocation of material handling equipment to rapidly achieve fully operational capability ashore.

Subject Terms: Maritime Prepositioning Ships (MPS), Simulation, Logistics, Military Applications, Material Handling Systems, Decision Support System

1 INTRODUCTION

The Maritime Prepositioning Force (MPF) enables a rapid and sustainable military response to short-warning global contingencies. To minimize response time without overtaxing available sealift and airlift assets, the entire complement of weapons, equipment, and supplies required for three Marine Expeditionary Brigades (MEB) was prepositioned aboard three squadrons of Maritime Prepositioning Ships (MPS), a total of thirteen ships. The strategic forward basing of this fleet provides a flexible global response capability for each MEB. Figure 1 depicts the strategic reach of the three-squadron MPS fleet. Normal operating areas of the three MPS squadrons are indicated on the map by the smallest concentric circles, while the larger circles represent maximum closure times of 7 and 14 days respectively. Each MPS squadron (MPSRON) is spread-loaded with weapons, equipment and supplies sufficient to sustain a MEB for thirty days of sustained combat (Auditor General of the Navy, 1989).

Because the MPF is such a recent development, the topic is largely unexplored, and doctrine is still being developed. The preliminary MPF planning efforts proved prophetic when on August 2, 1990, Iraq invaded Kuwait and threatened Saudi Arabia. Within two weeks, the Indian Ocean based MPSRON-2 arrived at the Port of Al Jubail and offloaded three ships simultaneously within 36 hours (Evans, 1991). The MPS-established 7th MEB provided the first credible deterrent capability in the region. Since then, the MPS operation has received more attention.

The offload and marriage of prepositioned equipment with the airlifted combat troops is required to establish an operationally ready Marine force ashore. Each MPS is capable of offloading either pierside or instream in an area which is devoid of significant enemy threat.

The pierside offload is preferred due to its speed and safety. Containerized cargo is lifted off the ship directly to the pier. All rolling stock is driven or is towed off the stern ramp of the ship. Additionally, most ports have equipment assets and an infrastructure which facilitate rapid offloading and organization of the MEB's assets. However, port facilities may be sabotaged or mined to deny access. A highly urbanized area surrounding the port may impede vehicle movement, impose space restrictions, and favor terrorist actions.

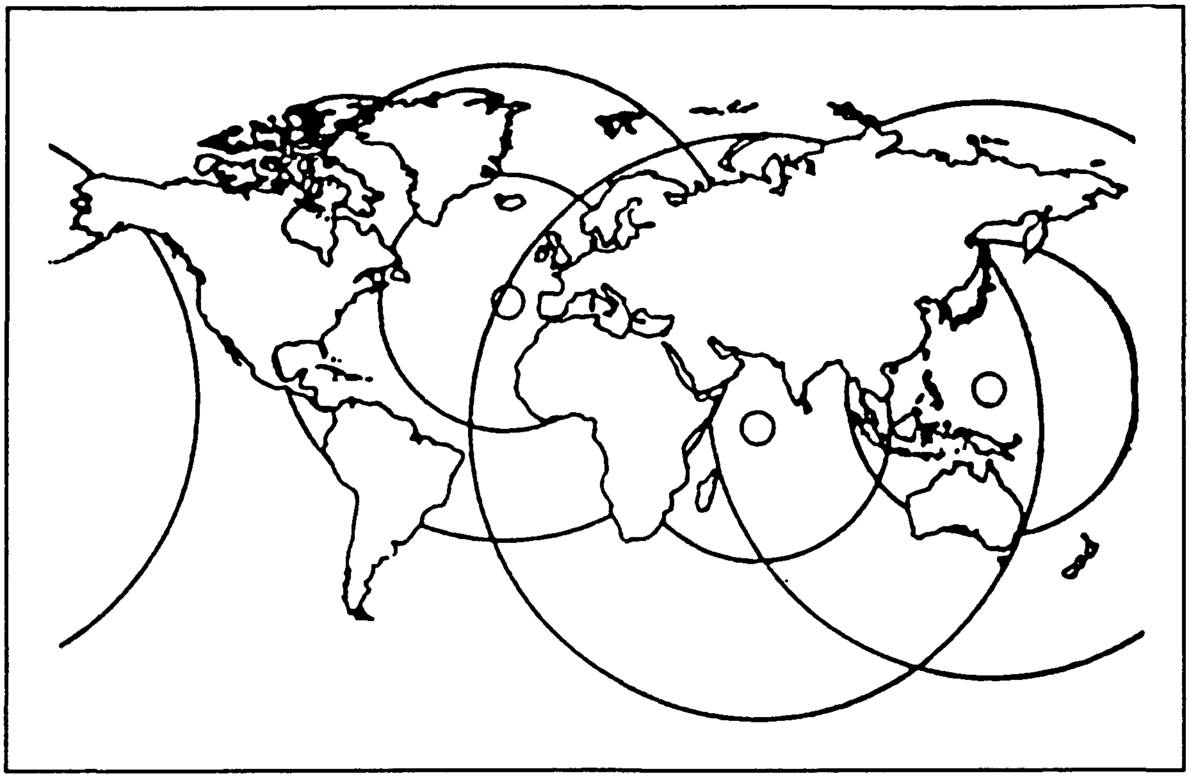

Figure 1: MPF Strategic Reach (Pernini and Eacott, 1988)

The instream offload provides strategic planning flexibility when a port is either unavailable or undesirable for offload. With the ship at anchor offshore, all vehicles and containers are lifted onto floating lighterage which shuttle the gear from ship to shore. This operation is slower, more dangerous, and sensitive to environmental and terrain factors. Congestion at the beach area must be minimized by the efficient allocation of material handling equipment. The distribution and operation of the material handling equipment ashore is the responsibility of the Marine Corps commander. Understanding the capabilities and limitations of the MPS offload process will enable the commander to best employ his assets to rapidly develop and achieve full operational capability ashore.

The objective of this paper is to provide the Marine Corps commander with a decision support tool to augment his sound situational leadership by indicating optimal allocation of scare resources, and material handling equipment, for rapid instream offloading. We develop a simulation model to analyze the flow of containerized cargo offloaded from the ship, across the beach, and delivered to the Combat Service Support Area

(CSSA) during a self-sustained two-ship instream offload. The goal of the model is not to simulate a particular scenario, but to give decision makers or commanders a feel for the impact of different policies regarding resource allocation. The simulation model is written in SIMAN (Pegden, Sadowski, and Shannon, 1990) with its enhanced modeling capability of material handling systems. Details of the program are available in Sumner (1991).

The structure of this paper is as follows. Section 2 describes the MPS instream offloading operation and the material handling equipment used during the operation. Section 3 includes the results and analysis of material handling resource allocation alternatives for various scenarios. Section 4 contains concluding remarks.

2 INSTREAM OFFLOADING OPERATION

Upon receipt of an alert order, the Survey Liaison and Reconnaissance Party (SLRP) is formed and deployed to the objective area. This small team's mission is to collect essential information concerning the suitability of the Arrival and Assembly Area (AAA) for the conduct of the offload. Simultaneously, the Offload Preparation Party (OPP) is flown to the MPSRON to prepare the equipment for offload while the ship is underway to the AAA.

Following the SLRP is the time phased arrival of the Fly-In-Echelon (FIE) of personnel and equipment coordinated with the offload of the MPS ships. The Marine Corps commander's objective is to attain a fully operational capability of the MPF within ten days from the time the MPS ships can begin offloading (Gerlaugh, 1989). This includes approximately five days for instream offloading operation.

The ships' cranes begin the instream offload cycle by lifting all containers and vehicles overboard to floating lighterage alongside the ship which then transit to the shore. At this point, all rolling stock drives or is towed to the CSSA or to other MEB elements located within the AAA. Containers, on the other hand, are individually removed from the lighterage by the Rough Terrain Container Handler (RTCH) which is akin to a huge forklift. The RTCH then loads the container on a Logistic Vehicle System (LVS) which is similar to a commercial flat bed truck. The LVS then transports each container to the CSSA to offload it there and complete the cycle. Container movement is the critical path of the operation due to the special handling required. The total offload time begins when the ships start offloading and ends when the last container arrives at the CSSA. Figure 2

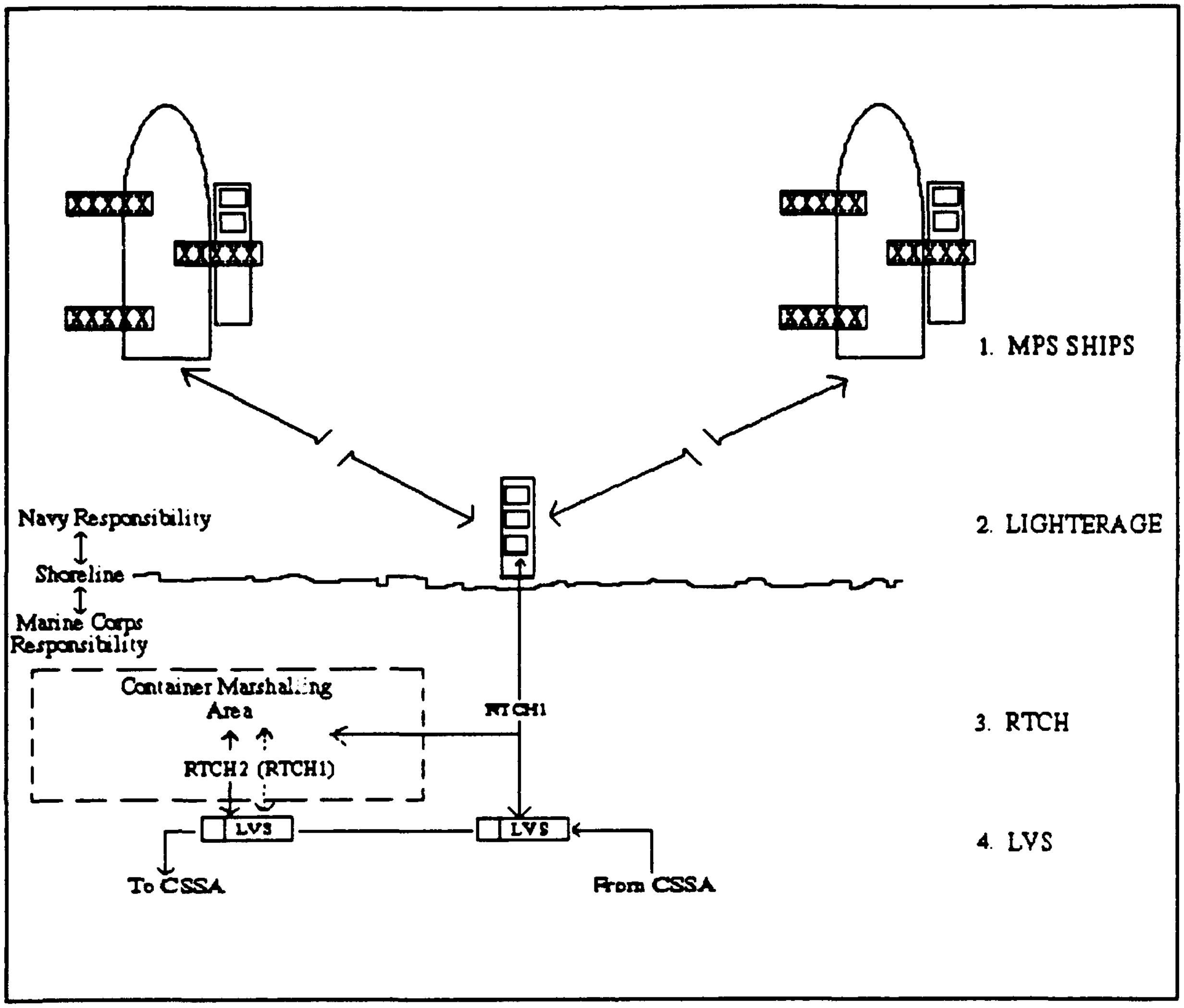

Figure 2: MPS Instream Container Offloading Operation

shows the offloading operation.

Once offloaded ashore, the materiel must be moved to the location where it will be prepared for issue to the unit that will ultimately employ and have accountability for the items. Depending on terrain and distance factors within the AAA, this will require an additional two to three days.

In this paper, two Maersk class MPS ships offload instream continuously and concurrently with a fully-manned Navy Support Element (NSE) to achieve full operational capability of the ships. Loaded aboard each ship are 365 8'x8'x20' International Standards Organization (ISO) containers. The containers are primarily loaded on the weatherdeck of the ship and within the lower holds. Vehicles are loaded on the decks in between. The continuous and concurrent offload of both vehicles and containers is achieved through effective management of the material handling equipment including cranes, lighterages, RTCHs, and LVSs.

We now discuss the material handling equipment used for instream offloading operations. The model assists the Marine Corps commander in optimally allocating and employing those assets over which he has direct control.

2.1 Crane and Lighterage

Each ship is equipped with three twin-tandem cargo cranes which service three offload positions. The total offload time begins when the first container is lifted off of the weatherdeck of the ship to be lowered overboard. Each ship carries eight 75'x21'x5' causeway sections which are configured into three powered barge ferries. Each barge is called a *lighterage*. Although the configuration of the lighterages is flexible, the Center for Naval Analysis (CNA) study identified that three lighterages per ship was the most efficient configuration of the causeway sections. The model dedicates three lighterages to the container offloading while rest of the lighterages are used for vehicle offloading or other purposes (Avitzur et al. 1988). The six available cranes offload containers when one of the three lighterages is available. Once it is loaded with a batch of 16 containers, the lighterage transits to the shore. Lighterages will achieve about 8 knots and are designed to operate in sea conditions of up to sea-state 3, which is defined as five foot waves, 15 knot winds, and three knot currents (Brown, 1985). Once its containers are offloaded ashore, the lighterage returns to an open position at either ship for another load of containers.

2.2 Rough Terrain Container Handler (RTCH)

When a lighterage loaded with containers arrives at the beach it is offloaded by the RTCH. The RTCH is an enormous, rough terrain, 50,000 pound capacity forklift specially designed to handle containerized cargo. It is designed to operate in unimproved beachhead areas and is capable of wading in seawater up to 1.52 meters deep in order to board a causeway ferry and sequentially offload the containers (Jane's Military Logistics, 1990-1991). This capability allows the lighterage to beach anywhere in the vicinity of the RTCH. The RTCH is able to either load containers directly on LVS platform trucks, or stack them two-high in a marshalling area set up at the beach.

A total of five RTCHs from the two ships are available for this operation. Typically two RTCHs are dedicated to the CSSA destination for the final offload of containers from the LVS trucks, and three RTCHs for beach operations. RTCHs used for beach operations are categorized into two classes by task: RTCH-A and RTCH-B.

Upon the arrival of a lighterage at the beach, RTCH-A boards the lighterage and picks up a container. After backing off the barge with a container, RTCH-A checks to see if an LVS is available for loading. If so, it carries the container an approximate distance of 200 feet to the LVS from the lighterage. RTCH-A then releases the container on the LVS. The LVS departs and RTCH-A returns to the lighterage to complete the cycle.

If an LVS is not available for loading, RTCH-A carries the container to a marshalling area. At this point, if additional containers remain on a lighterage to be offloaded, RTCH-A returns to expeditiously complete offloading the lighterage thereby clearing and releasing it to return to the ship. If there are no lighterages to occupy RTCH-A, RTCH-A will assist RTCH-B in the marshalling area.

RTCH-B is tasked with clearing the containers from the marshalling area. Unlike RTCH-A which travels a given distance between the lighterage and LVS or marshalling area, RTCH-B travels varying distances depending on the location of the container within the marshalling area. RTCH-B is stationed in the marshalling area where it awaits the arrival of an LVS.

2.3 Logistic Vehicle System (LVS)

The LVS has a flat platform deck with standard container lashing points to carry the ISO container. Its unique design provides superior off-road capability for transporting individual containers to an inland destination (Jane's Military Logistics, 1990-1991). The model permits adjustment of the quantity of LVSs dedicated to

Table 1: The Effects of LVS Quantity and CSSA Location on Offload Time and LVS Utilization

LVS QUANTITY	RESULTS	ROUND-TRIP CSSA DISTANCE			
		10 KM	20 KM	40 KM	60 KM
20	Time	99.98 (3.09)	102.71 (1.10)	108.02 (0.08)	142.81 (0.31)
	Avg # of LVSs utilized	6.50 (0.17)	9.87 (0.27)	16.27 (0.22)	17.83 (0.05)
30	Time	99.98 (3.09)	102.71 (1.10)	104.44 (1.21)	109.40 (0.96)
	AVG # of LVSs utilized	6.50 (0.17)	9.87 (0.27)	17.15 (0.46)	23.21 (0.26)
40	Time	99.98 (3.09)	102.71 (1.10)	106.32 (0.66)	104.38 (1.62)
	AVG # of LVSs utilized	6.50 (0.17)	9.87 (0.27)	16.92 (0.28)	24.5 (0.46)

container throughput as well as the distance travelled to the container destination at the CSSA. Round trip travel times utilized in the model are based on a speed of 20 kilometers per hour. Such an average speed is not an unreasonable assumption for equipment operating over unimproved roads in a remote area (Strock, 1985).

When the LVS returns to the beach, it checks to see if there is a container aboard a lighterage. If so, it waits to be directly loaded by RTCH-A and travels to the CSSA. This logic minimizes the double handling and queueing of containers in the marshalling area. If there are no containers aboard a lighterage ashore, the LVS checks the status of the marshalling area. If there are no containers there, it awaits the next lighterage. If there are containers in the marshalling area, the LVS moves to the marshalling area where it is loaded by RTCH-B or sometimes by RTCH-A as described earlier. The total offload time ends when the last container is brought to the CSSA.

3 ANALYSIS

The twofold intent of this section is to promote an understanding of the simulated offload's characteristics for decision makers, and to investigate possible material handling resource allocation alternatives for various scenarios. A CNA research memorandum (Avitzur, et al. 1988) provided the primary source of data.

3.1 LVS Quantity and Location of CSSA

Due to the substantial acreage required to establish the CSSA, terrain and dispersion factors greatly influence the CSSA location decision. Although the AAA is considered a benign area, the dispersion of functional elements within the CSSA is required as a passive defense measure against missile, terrorist, or chemical attack (Dykstra, 1988). Knowing the approximate distance from the beach within which the CSSA could be located and still achieve the desired time goal provides flexibility in planning the location of the CSSA.

We examine the effects on offload time of various LVS quantities transporting containers over various distances to the CSSA. The maximum of 40 LVS' are available from the two ships. The CSSA distances are aimed at determining a CSSA location that will maintain desirable offload time goals. Table 1 illustrates this output data. Indicated values within the table are the averages of ten replications followed by the standard error in parentheses. Common random number technique (see e.g. Law and Kelton, 1991) was applied for variance reduction of simulation output. Times are in hours and utilization is the average number of trucks utilized for a given quantity. The RTCH allocation policy in this output is held constant at its most likely state with two servicing the lighterages (RTCH-A) and one servicing the marshalling area (RTCH-B).

The desired time goal for the instream container offload is within four and one-half days or 112 hours. The simulation model begins tallying the total time from the moment the first container is lifted. However, the actual offload time begins with the offload and assemblage of the lighterage which requires one day preceding the container offload. An offload time greater than five and one-half days then, including the preparation of lighterages, may impact the ability to achieve the ten day goal for the Marine Task Force to be operationally ready.

Table 2: The Effects of RTCH Policy and LVS Quantity/CSSA Distance Scenarios upon Offload Time and the Container Queue in Marshalling Area

POLICY		RESULTS	SCENARIO			
QUANTITY OF RTCH-A	QUANTITY OF RTCH-B		20LVS/ 10KM	40LVS/ 10KM	20LVS/ 40KM	40LVS/ 40KM
2	0	TIME	99.98 (3.09)	99.98 (3.09)	193.16 (0.40)	128.81 (26.11)
		QUEUE	0	0	271.15 (6.83)	126.13 (14.78)
2	1	TIME	99.98 (3.09)	99.98 (3.09)	108.02 (0.08)	106.32 (0.66)
		QUEUE	0	0	4.30 (2.16)	2.29 (0.50)
3	0	TIME	91.53 (1.40)	91.53 (1.40)	146.80 (0.28)	114.34 (0.84)
		QUEUE	.80 (0.47)	.80 (0.47)	167.58 (12.47)	69.79 (95.72)

At a round-trip distance of 20 km or less, the offload time falls within the desired goal and is unaffected by the employment of additional LVSs over 20. Beyond 40 km, variations in time and utilization are evident with additional LVSs. These times approach the 112 hour limit. When 20 LVSs must travel the 60 km round-trip distance to the CSSA, this amount is obviously insufficient for the distance. The commander must consider either a closer location, or the dedication of additional LVSs to achieve the time goal. A quantity of 30 LVSs appears sufficient at 40 km, however, at 60 km, the time is close to the 112 hour limit with a high utilization level. The employment of ten additional LVSs achieves an appreciable reduction in offload time for that location of the CSSA, but the utilization still remains high enough for concern. It appears necessary to employ all 40 LVSs at this distance.

These output results indicate that potential CSSA locations within a 40 km round-trip travel distance from the beach will meet the desired time goal without overtaxing the available LVSs. Engineering improvements to the road network may improve travel times and consequently extend this distance. On the other hand, even though the model assumes a conservative 20 km speed, the effect of foul weather on unpaved roads may further delay the travel time.

3.2 RTCH Allocation Policy

This section examines the effects of three different RTCH allocation policies upon offload time and container queueing in the marshalling area. With a maximum of three RTCHs possible at the beach, the first policy examines whether or not two beach RTCHs are sufficient. In the model, this policy labels two RTCHs as RTCH-A, therefore there are no RTCHs in the marshalling area. If containers are queued in this policy, the marshalling area queue is serviced only if the RTCH-A RTCHs are unoccupied with a lighterage. When RTCH-A contains two or more RTCHs, they alternate offloading containers from a single lighterage before proceeding to the next lighterage.

The second policy is the most intuitively logical employment of the three beach RTCHs. Two RTCHs are labeled as RTCH-A, and one is labeled as RTCH-B. Thus, both the lighterages and the marshalling area are serviced at the same time.

The third policy examines the effect of three RTCHs operating as RTCH-A. The CNA study stated that three RTCHs tend to interfere with each other somewhat when offloading a lighterage (Avitzur et al. 1988). The model does not account for this, therefore, the offload times resulting from this policy can be considered somewhat optimistic.

Two specific round-trip distances were chosen as scenarios representing likely close and distant CSSA locations of 10 km and 40 km respectively. Additionally, two LVS quantities were selected for evaluation at each distance for a given RTCH policy. At 10 km, the 40 LVS quantity results duplicated the 20 LVS results. Table 2 displays the effects of RTCH policy.

This output suggests the critical importance of the RTCH policy to the efficiency of the container system. At 10 km, due to the quick turnaround time of the 20 LVSs, RTCH-A is consistently able to directly load the LVS with a container from the lighterage. Given this LVS quantity/distance for the CSSA location, employing all three available RTCHs as RTCH-A achieves a significant time savings without the use of the marshalling area. Additionally, a total of two RTCHs appears sufficient to comfortably achieve the offload time goal with minimal queueing. The third RTCH may be held in reserve or employed elsewhere when the CSSA is closely located. This indicates that a close CSSA location will not require a RTCH dedicated to the marshalling area.

In order to achieve the best possible throughput rate in this scenario, all three RTCHs should be dedicated as RTCH-A. Thus, this is the preferred RTCH policy for this scenario.

The significance of container queueing is related to the space constraints imposed by the selected beach site. The smaller the area required for beach operations, the greater the planning flexibility in beach site selection. The space required for the container marshalling area can be substantial. For example, 100 containers stacked two-high and placed end-to-end in a 50 container long row extends 1,000 feet, or greater than three football fields! The physical configuration of containers within the marshalling area often parallels the beach. This allows sufficient access by the RTCH and maintains a separation between the containers and the high-water line on the beach. Container queueing not only limits planning flexibility, but also increases offload time due to the double handling required by the RTCHs. For the purpose of this analysis, the acceptable expected average number of containers in the marshalling area is established at ten containers. This low limit seeks to avoid the vulnerability to potential attack posed by large numbers of containers in a concentrated area.

At 40 km, unacceptable offload times and amounts of container queueing result from both RTCH policies which do not utilize RTCH-B regardless of either LVS quantity considered. The large values of standard errors also indicate high variability of the output results. When the first policy is employed, with only two RTCHs total, their slow offload rate keeps them almost continuously occupied with the lighterage. This reduces the time that they can spend clearing the marshalling area.

The third policy with three RTCH-A and no RTCH-B is similarly undesirable. Although they offload the lighterage more quickly, they also fill the marshalling area quicker as a consequence. Once in the marshalling area, containers have a tendency to remain there due to the LVS loading policy which prioritizes the direct loading of containers from the lighterage. Considering the interference factor stated in the CNA study along with this extreme run value, even greater time and queueing values are likely.

Dedicating one of the three RTCHs to the marshalling area in the 40 km distance scenario achieves the most efficient throughput rate which comfortably meets offload time and average container queueing goals. Thus, this is the preferred policy for this scenario. The highest average number of containers queued in this scenario occurs when 20 LVSs are employed.

4 CONCLUSIONS

In this paper, we develop a simulation model for MPS instream container offloading operations to assist the Maine Corps commander in optimally allocating his assets. Results indicate that the throughput rate of containers is not only sensitive to the quantities of the material handling equipment and travel distance, but also to the operational allocation of the material handling equipment. This paper provides a foundation for understanding possible scenarios for future MPF deployment, and promotes a better understanding of system interrelationships.

APPENDIX: LIST OF ACRONYMS

AAA	Arrival and Assembly Area
CNA	Center for Naval Analysis
CSSA	Combat Service Support Area
FIE	Fly-In-Echelon
ISO	International Standards Organization
LVS	Logistic Vehicle System
MAGTF	Marine Air-Ground-Task-Force
MER	Marine Expeditionary Brigade
MPF	Maritime Prepositioning Force
MPFTF	Maritime Prepositioning Task Force
MPS	Maritime Prepositioning Ship
MPSRON	Maritime Prepositioning Ship Squadron
OPP	Offload Preparation Party
RTCH	Rough Terrain Container Handler
SLRP	Survey Liaison and Reconnaissance Party

REFERENCES

Auditor General of the Navy. 1989. *Logistics Planning for the Maritime Prepositioning Ships Program*, Audit Report (030-C-89), Department of the Navy.

Avitzur, T., P. A. Veling, D. Brenner, P.W. Hodes, G. E. Horne, J. D. Love, and W. F. Morgan. 1988. *Research Memorandum on Analysis of Exercise Freedom Banner 87*, Contract Study, Center for Naval Analysis, Alexandria, VA.

Brown, D. B. 1985. MPS: The Navy's crucial role, *Marine Corps Gazette*, March.

Dykstra, D. M.. 1988. Five principles for survival, *Marine Corps Gazette*, February.

Evans, D. 1991. *Desert Shield, From the Gulf*, Naval Institute Proceedings.

Gerlaugh, R. E. 1989. Doctrine and roles for MPF (Maritime Prepositioning Force): what have we learned?, Unpublished Research Paper, U.S. Naval War College, Newport, RI.

Jane's Military Logistics 1990-91, 11th ed., edited by Foss, C. F., and Gander, T. J., Jane's Information Group, Alexandria, VA.

Law, A. M. and W. D. Kelton. 1991. *Simulation Modeling and Analysis*, McGraw-Hill, Inc., New York, NY.

Pegden, C. D., R. E. Shannon, and R. P. Sadowski. 1990. *Introduction to Simulation: Using SIMAN*, McGraw-Hill, Inc., Highstown, NJ,

Pernini, J.K., and R. G. Eacott. 1988. Commander maritime prepositioning force - identify yourself, Unpublished Research Paper, U.S. Naval War College, Newport, RI.

Strock, J. N. 1985. The MPS reception-an analysis, Unpublished Research Paper, Marine Corps Command and Staff College, Marine Corps Development and Education Command, Quantico, VA.

Sumner, J.D. 1991. An analysis of the maritime prepositioning ships (MPS) instream offload: a decision framework for the Marine Corps commander, Master's thesis, Naval Postgraduate School, Monterey, CA.

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