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TECHNICAL
REPORT

Allocating Marine Expeditionary Unit Equipment and Personnel to Minimize Shortfalls

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Prepared for the Office of the Secretary of Defense

NATIONAL DEFENSE RESEARCH INSTITUTE

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Summary

To successfully accomplish their missions, Marine Expeditionary Units (MEUs) must have both the right personnel and the right equipment, as well as *access* to that personnel and equipment.[1] However, in many cases, the U.S. Navy's lift capacity—that is, the space available on the ships that make up the MEU—falls far short of what is needed to transport the full set of equipment required for the MEU to complete its missions with maximum effectiveness and efficiency.[2] This is especially true when the MEU must be prepared for stabilization, humanitarian, and contingency operations. As a result, when the MEU departs, some equipment is left behind. Several factors affect which equipment ultimately ends up aboard the ship and which remains behind. The risk preferences of the commander, expectations about the nature of the deployment or previous MEU experience, and equipment readiness and repair schedules all play a role in equipment selection. Thus, the MEU commander must make choices between pieces of equipment and is not able to deploy with an optimal or ideal equipment set. What is the impact of this shortfall on the MEU's ability to complete the tasks associated with its mission, especially when the mission includes stabilization operations?

As a consequence of this limited lift capacity, MEUs afloat generally lack some support personnel and equipment. Even if these shortfalls do not prevent the MEU from accomplishing its mission, and even if the MEU receives supplemental support from other sources, equipment shortfalls do affect mission performance and efficiency. In many cases, the first responders to disasters and postconflict operations are MEUs afloat. Hence, they are often called upon to initiate stabilization and reconstruction missions in the absence of civilian leadership and direct support.

The objective of this report is to assess the overall impact of equipment shortfalls on selected mission performance for MEUs afloat. To this end, it aims to address the following research questions:

- What is the typical MEU mission set?
- What are the component tasks and subtasks of each of these missions?
- What equipment is available to the MEU to accomplish mission tasks and subtasks?
- What measures and metrics should be used to assess the capability of selected equipment?
- What tasks cannot be accomplished immediately because of a lack of equipment?

[1] In this report, the notion of "mission accomplishment" refers to delivering the equipment needed to complete all tasks associated with a mission. It does not refer to how well the tasks are performed or, in the case of combat missions, the degree of combat effectiveness.

[2] *Required equipment* is the equipment that Marine Corps planners feel is needed to complete all tasks associated with a mission.

MEU Mission Set

As a rapidly deployable force, a single MEU may be involved in several diverse missions. The question, then, is what equipment is needed to support all these missions, and what are the effects of shortfalls on mission accomplishment? First, however, the appropriate missions must be identified. Fifteen MEU missions are addressed in this report:

- amphibious raid
- amphibious assault
- maritime interdiction operations
- advance force operations
- noncombatant evacuation operations (NEOs)
- stability operations
- humanitarian assistance (HA) operations
- tactical recovery of aircraft and personnel
- joint and combined operations
- aviation operations from expeditionary shore-based sites
- theater security cooperation
- direct action operations
- airfield seizure operations
- special reconnaissance
- foreign internal defense.

Common Tasks

Missions generally share many common tasks and activities (e.g., planning, establishing the command center, area and road clearance). Because the implementation of even common tasks will vary depending on the mission, we offer generic descriptions of the common tasks and then highlight some of the specific operational and environmental characteristics that are most likely to affect their execution. Table S.1 summarizes the tasks common across some or all of the 15 missions.

Mission Deconstruction

One way to identify the equipment and numbers of units needed for a given MEU mission is to deconstruct that mission into its component tasks and subtasks and then determine the equipment needed to complete each task. The first step in our approach was to deconstruct the 15 MEU missions into tasks, subtasks, and activities and to identify some of the characteristics of each mission that may affect equipment requirements. The main text of this report describes the deconstruction of all 15 missions. Here, however, we focus on one: humanitarian assistance, which was selected for a more detailed analysis.

All HA operations share certain common tasks, but the nature of an HA mission also depends on the nature of the precipitating crisis, the type of aid provided, and the operational environment. An average or typical HA mission consists of the tasks listed in Table S.2.

Table S.1
Common Tasks

Task	Description
Mission planning	Define objectives and mission phases. Relies on reconnaissance activities to identify threats, characteristics of the operating environment, and status of infrastructure.
Establishing the command center	Insert or designate command center facility and command element, establish connectivity, and develop and implement intelligence and logistics plans.
Amphibious assault and raid	Phase I: Prepare beach landing site. Phase II: Move main force ashore. Phase III: Land and disembark (unload personnel and equipment). May require combat operations.
Road and area clearance	Prepare air or beach landing sites, create transport routes, create evacuation sites, equipment repair, medical care, demine roadways.
Assaults, raids, and infiltrations	Insert or move a force to the area of operations. Relies on advance intelligence and preparatory fires. Includes offensive action to seize control of assets or information, eliminate targets, or carry out sabotage.
Reconnaissance	Ground or air operations to gain intelligence.
Civil control	Enforce cease-fire, eliminate remaining insurgents, provide security, ensure freedom of movement, and conduct information operations, public affairs, psychological operations, and civil-military operations.
Evacuation of personnel	Transport personnel to evacuation point and process evacuees. In extreme cases, provide critical medical or humanitarian aid.
Force protection operations	Use of weapons against hostile forces and erection barriers or checkpoints. Neutralize external threats posed by the adversary and the environment. Includes hazmat procedures.
Transition to host-nation control	Shift provision of emergency services, governance, and security operations to host nation. Initial transition may be from the Marine Corps to nongovernmental organizations (NGOs) rather than directly to the host nation.
Withdrawal	Withdrawal of personnel and equipment involves equipment maintenance, provision of medical care to the wounded, planning withdrawal, maneuver to extraction or departure site, and defensive operations, if required.

Mission Nesting

In many cases, a MEU is asked to complete not a single mission from the mission set but a more complex operation that involves several overlapping missions that must be completed sequentially or nearly simultaneously. We refer to this as *mission nesting*.

Deconstruction also illustrates how the boundaries between missions are often blurred. Nesting has implications for planning in that it can be exploited to streamline the process. Planners may be able to supplement the HA mission plan with a NEO "module" based on past experience, rather than starting from scratch. A given mission may include a combat portion and a stability operations portion.

Available Equipment

The equipment available to perform the tasks associated with a mission consists of the equipment on board the MEU. The sponsor of this study specified the equipment available. However, as we explain later, the Marine Air-Ground Task Force (MAGTF) Equipment Structural

Table S.2
Humanitarian Assistance Tasks

Task	Description
Mission planning	The mission plan defines the objectives and mission, including the key tasks and associated requirements, using information collected through surveillance and reconnaissance. The plan is shaped by the nature of the disaster or crisis, the level and duration of assistance needed, the local conditions, and the security threat.
Establishing command center	The command center serves as the operational center for the mission. Establishing the command center (or centers) includes setting up communication lines and planning logistics and intelligence operations. The number, size, and location will depend on the conditions listed in the mission plan.
Road and area clearance	Transportation routes are cleared of obstacles and hazards to facilitate the movement of personnel and essential cargo.
Establishing and securing sites for assistance provision[a]	HA provision sites are used to supply emergency medical care, food, and water. The sites must be cleared and secured. The MEU is likely to work with NGOs and partner forces to establish provisioning. The scope of this task depends on the number of people requiring assistance and the number of sites needed.
Providing assistance at central sites or with mobile units[a]	The MEU may provide emergency HA assistance or support NGOs in this activity. HA assistance may include medical care, food, water, and sanitation.
Restoring the provision of critical services[a]	The MEU may assist in the restoration of critical services, such as power, water, and rule of law, until the host nation or NGOs can assume control.
Transition to host-nation control	The transition to host-nation (or NGO) control signals the end of the mission. It may include the transfer of service provision, the training of security personnel, and (in some cases) support for new elections.

[a] Mission-specific task.

Assessment (MESA) application we have developed can accommodate equipment lists that differ significantly in size and scope from what we use as a baseline. For example, if certain equipment is not available to support a given plan, the quantities in the application can be set to zero.

Planning Factors

A planning factor links a task or military activity to the piece of equipment or number of military personnel needed to accomplish the mission. Planning factors form the backbone and foundation of the MESA application developed for this study. Once planning factors are defined, they can be combined with the mission task list to generate a list of required equipment. This list can be compared to equipment and personnel available on board to provide information about the tasks that can be completed and the areas that will require substitutions or compromises.

The process of defining planning factors requires several steps: (1) mission deconstruction, (2) linking military tasks with specific pieces of equipment, (3) developing relevant metrics, and (4) prioritizing pieces of equipment and unit types based on their relative capabilities. The first step was discussed in the previous section. Here, we describe the subsequent steps using the HA task as a specific example:

- *Linking tasks to equipment.* Each task and military activity must be attached to pieces of equipment with the requisite capabilities. Military planners can use this information to choose between pieces of equipment.
- *Developing metrics.* A *metric*, as used here, refers to the capability of a piece of equipment relative to a specified task or military activity. Examples include the range of a vehicle on a single tank of gas or the carrying capacity of a vehicle.
- *Prioritizing equipment.* After specifying the appropriate metrics for each task, the next step is to assign each military activity all the relevant pieces of equipment that can be used to complete the task and to rank the pieces of equipment based on how effectively they can be used to complete that task. In this study, our prioritization of equipment was informed by experienced Marine Corps officers who drew on their own experience to rank the efficacy of equipment for each task.

Fungibility and Equipment Packages

The use of planning factors to substitute between pieces of equipment with similar capabilities raises the question of fungibility. A set of trucks, for example, may be more or less fungible. Fungibility allows commanders to complete missions even when optimal equipment is not available. The prioritization of equipment and its integration into the MESA application ensures that the concept of fungibility is also incorporated into the MESA application.

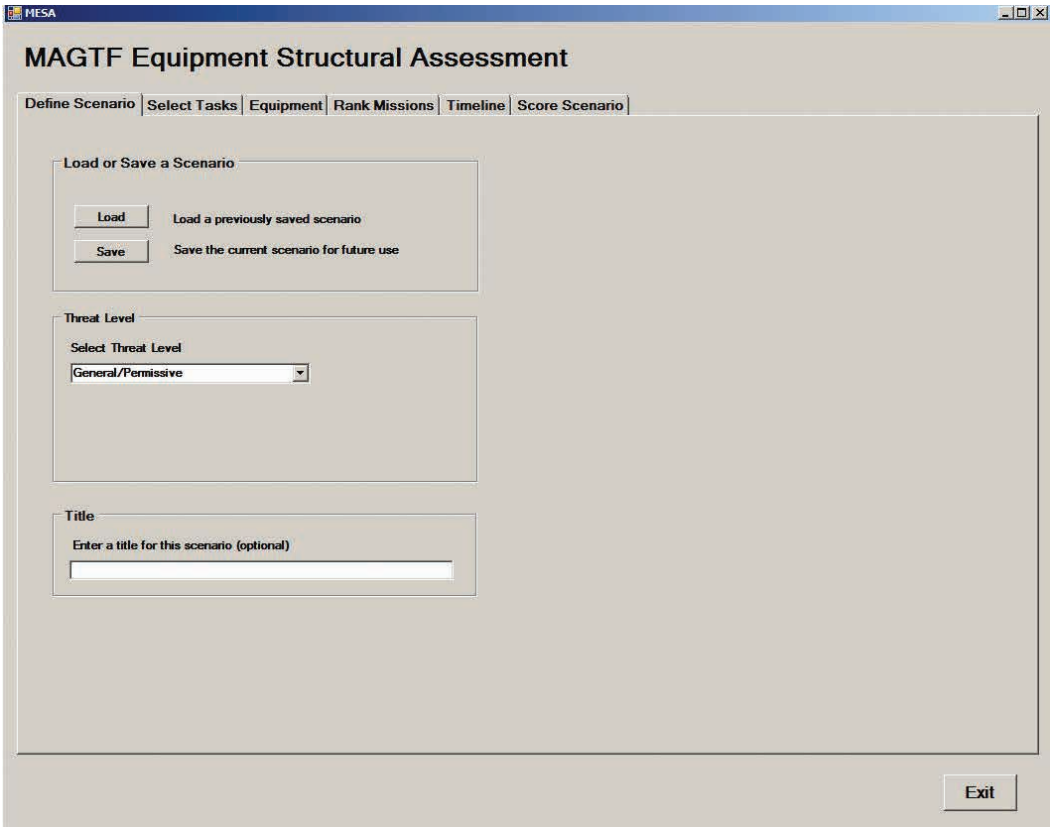
The second key issue is that of equipment packages. While certain tasks, such as personnel transport, can be completed with a single type of equipment, others require several types of equipment. In these cases, we defined packages of equipment that are considered sufficient to complete a specific activity or task only as a unit, with a single, integrated planning factor. Planning can also be more iterative and user-driven. For instance, the user could define the packages that must be allocated to complete a specific task.

The Planning Tool: MESA Application

The MAGTF Equipment Structural Assessment (MESA) application is a software tool that allocates equipment from a predetermined and potentially limited inventory to a set of missions and tasks selected by the user. Although the allocation is not optimal, it does provide the commander with an effective plan for completing the tasks associated with the selected mission. The MESA application incorporates the deconstructed missions and task-specific planning factors described earlier and produces as an output a set of equipment that could be used to accomplish a specific user-defined mission.

The application is organized as a series of tabbed input screens (see Figure S.1 and Table S.3). At the application's simplest level of implementation, the user moves from tab to tab, selecting specific tasks involved in the mission and the requirements for those tasks, defining key parameters (such as weather and threat level), determining timelines and priorities, and defining available equipment. Once the scenario is satisfactorily defined, the user can request that the application generate an allocation of equipment to the defined mission based on the equipment inventory and suitability ranking. If insufficient equipment is available to accomplish a mission, the application will display the percentage of each task that could be completed with the resources available.

Figure S.1
Main Screen of the MESA Application



RAND *TR1253-S.1*

Table S.3
Initialization Screen Tabs

Tab	Function
Define scenario	The user is presented with 15 missions and can select one or more. (In the current version, only the HA mission is fully operational.)
Select tasks	For each mission selected, the user is offered a series of tasks and subtasks and can choose those that are critical to the scenario.
Equipment	This tab shows the equipment available on the MEU.
Rank missions	The user is offered the opportunity to specify which missions and tasks are most important.
Timeline	The user can specify the start and finish date for each task.
Score scenario	This tab displays the results of the equipment allocation.

The MESA application is designed so that much of its appearance (e.g., the input screens) and the data inputs (equipment definitions, inventories, and rankings of preferred equipment) can be configured by the user. The application is largely data-driven and configured via spreadsheet interface. This is an advantage because it allows the user to tailor each scenario based

on expected operational constraints and conditions, ultimately producing more realistic and useful outputs.

The MESA application output tells planners and commanders which types of equipment will be essential to mission completion and identifies the key implications of equipment shortfalls. The application is extremely flexible: Not only does the user define the tasks involved and the operational conditions, but he or she can also reconfigure equipment inventories and rankings. The application is intended as a planning tool and models only generic MEU missions; it does not capture the full range of complexities and alternatives associated with a given MEU mission. What the application produces are useful approximations and guidelines, but it requires additional human input and vetting to translate these outputs into a viable operational plan.

Conclusions

The MESA application described in this report provides military planners and commanders with a means to estimate the equipment that will best complete a given set of tasks and to evaluate the sufficiency of available equipment to support mission completion. The output from the tool may also assist the commander in understanding likely equipment shortfalls and possible substitutions.

Lessons Learned

The processes of defining planning factors and developing the MESA application led us to several observations about the requirements for reconstruction and stability operations that commanders and military planners might consider:

- *Common tasks.* There is considerable overlap in the types of tasks and activities involved in the MEU's mission set. These commonalities are important to mission planning because they imply that similarities in equipment requirements may also exist. The MESA application assists commanders by identifying these possible substitutions.
- *Constrained allocation.* The MESA application allows the set of available equipment to be constrained, facilitating planning under suboptimal conditions. It allows planners to assess which pieces of available equipment can support task completion, if absolutely necessary, and to define the mission implications of equipment shortfalls.
- *Situation-dependent allocation.* The process of defining planning factors also underscores the important effect of operational conditions on equipment requirements. The MESA application allows the user to specify key parameters and to prioritize specific tasks over others within a single mission.
- *Task sequencing and timing.* If tasks are completed sequentially, equipment used in one task may be available for the next. However, if tasks overlap, then equipment required by multiple tasks may be available for only one activity, again forcing substitution and reallocation.
- *Relative task importance.* For any mission, especially those that are complex, certain tasks may be more important than others. Especially in constrained environments, prioritizing key tasks is one way that commanders can ensure that the most effective pieces of equipment are available to achieve the most important mission objectives. The MESA applica-

tion allows users to specify which tasks in a mission are more important than others. The application uses the "analytical hierarchy process," discussed later, to translate pairwise importance selections into a formal ranking system. In cases in which such ranking is not needed, the user may bypass this step.

- *Mission nesting.* In some cases, a MEU is asked to complete not a single mission from the mission set but a more complex operation that involves several overlapping missions to be completed sequentially or nearly simultaneously. We refer to these as nested missions. In the current MESA application, this is not a problem because only one mission is addressed. However mission nesting will become an issue in subsequent versions. Mission nesting has implications for planners for two reasons. First, it complicates the allocation of equipment and increases the potential for equipment shortfalls because equipment must be spread across the tasks of several different missions. At the same time, however, it allows planners to exploit common tasks that may apply to all missions. Currently, the MESA application includes NEO and search and rescue as tasks within the HA mission.[3] A next step in the tool's development is to more fully integrate the notion of mission nesting, using linked planning modules that integrate equipment requirements across tasks and allow commanders to build more dynamic and complex mission plans.

Limitations

In its current configuration, the MESA application is able to account for only one mission at a time. However, we realize that, in practice, a MEU may be faced with a situation in which it must accomplish multiple missions or parts of multiple missions. Future versions of the application will allow for multiple missions and will therefore accommodate relative mission ranking as well as relative task ranking within a mission. It will also allow for common tasks to serve multiple missions.

Finally, the MESA application does not produce an optimal solution for allocating equipment to tasks. The RAND-developed Stabilization and Reconstruction Force Allocator (SRFA) system, discussed later in this report, is able to optimally allocate units to missions and can handle multiple missions. The MESA application allocates equipment to tasks based on the relative importance of the task, when the task must be completed, and the priority assigned to the equipment capable of accomplishing the task.

Next Steps and Challenges

The MESA application described in this report considers HA missions only and focuses on equipment-specific planning factors. Future work will expand the MESA application to include other Marine Corps missions and will include additions or the refinement of existing features—for example, the addition of a consistency test for relative task importance selection.

In accounting for multiple missions, we face two significant challenges:

- The first challenge is how to deal with common tasks when considering multiple missions. It may be the case that a single command center is all that is needed to accommodate multiple missions, but the equipment needed to support each mission may differ in some way. In other words, although the task is "common," there may be unique, mission-specific requirements for accomplishing it.

[3] The search and rescue mission is not one of the 15 missions discussed in this report, but it is included in the HA mission.

- A second challenge concerns sequencing the tasks and assigning relative importance at the task level as opposed to the mission level. A typical example might be transporting goods and personnel. If mission A is deemed more important than mission B, does that mean that all tasks associated with mission A have absolute priority? If not, how do we provide the user with the ability to designate exceptions at the task level?

The value of the MESA application and its contribution to mission planning could also be significantly advanced by developing more rigorous and accurate planning factors for the tasks and activities listed on the Marine Corps Task List. To be useful, these planning factors would need to link tasks from the task list to specific pieces of equipment that can be used to complete them.

Additional missions will require substantial augmentation of equipment capabilities and planning factors. Currently, the MESA application relies on a single dimension of capability (e.g., payload, range) in allocating equipment to tasks. In reality, multiple factors could be considered in allocating equipment. For example, when allocating trucks for transporting material, the current primary consideration is capacity in tons. However, speed and range, the ability to traverse varied terrain, and so forth, are equally important.

Similarly, a more sophisticated model of equipment performance would be helpful. For example, time and distance parameters are crucial to estimating the demand for transportation resources, yet, at present, the MESA application does not fully address this issue.

Finally, better documentation of the tasks involved in specific missions and better ways of capturing the experiences of past MEU commanders will also provide better data on unexpected equipment substitutions and will allow the application to collect additional performance data from real-world situations.