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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

The research described in this report was prepared for the Office of the Secretary of Defense (OSD). The research was conducted within the RAND National Defense Research Institute, a federally funded research and development center sponsored by OSD, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community under Contract W74V8H-06-C-0002.

Library of Congress Control Number: 2012942069

ISBN: 978-0-8330-7619-9

Published 2012 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
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Preface

For various reasons, including the commander's priorities and expected mission requirements, U.S. Marine Corps amphibious lift requirements—that is, the space needed on ships to transport equipment for a given mission—may exceed the U.S. Navy's lift capacity. Thus, Marine Expeditionary Units (MEUs) afloat generally do not have all their support personnel and equipment on board. What is the impact of this shortfall on a MEU's ability to complete the tasks associated with its mission, especially when the mission includes reconstruction and stabilization operations? Close examination reveals that, in general, MEUs do not fail as a result of these equipment shortfalls; Marine Corps commanders are able to make use of the equipment they have in innovative and creative ways to accomplish the tasks at hand. However, equipment shortfalls do force shortcuts and sometimes sacrifice the quality and speed of task completion. This report describes the development of an automated tool for allocating both equipment and personnel to complete the tasks associated with 15 MEU missions, highlighting the associated equipment implications.

The RAND-developed Marine Air-Ground Task Force (MAGTF) Equipment Structural Assessment (MESA) application software CD is included with printed copies of this report. The application also accompanies the online version of this report as a separate downloadable file at http://www.rand.org/pubs/technical_reports/TR1253.html.

This research was sponsored by the U.S. Marine Corps Combat Development Command and conducted within the International Security and Defense Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

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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.

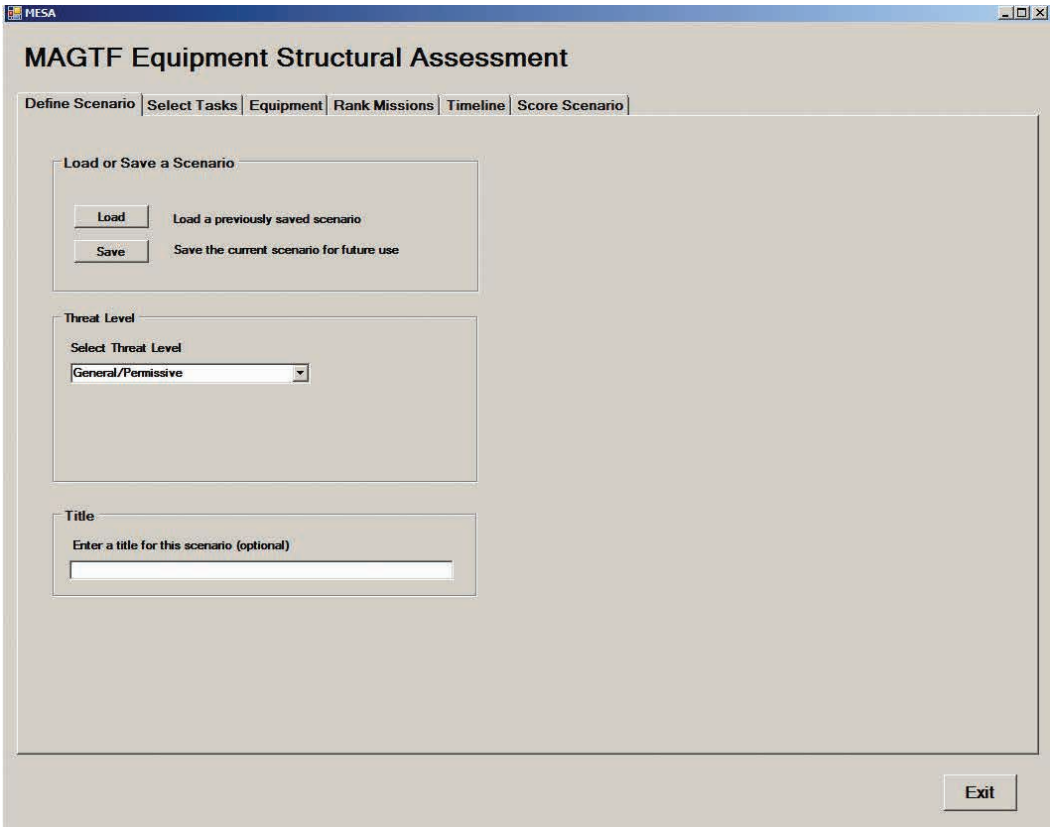
The second key issue is that of equipment packages. While certain tasks, such as personnel transport, can be completed with a single type of equipment, others require several types of equipment. In these cases, we defined packages of equipment that are considered sufficient to complete a specific activity 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.

Acknowledgments

We wish to acknowledge the invaluable assistance provided by Robert Bovey, the study point of contact. He and his team spent considerable time reviewing our mission deconstructions; they also provided us with equipment lists and helped arrange a workshop designed to validate the mission tasks, subtasks, and the equipment associated with performing the tasks. The workshop was very helpful in correcting errors in the initial worksheets. We would also like to recognize the Marine Corps personnel who agreed to spend a day participating in the workshop, held in RAND's offices in Arlington, Virginia, in August 2011: Maj. Michael Aldriole, 1stLt. Samantha Megli, Maj. Chris Ray, Maj. Larry Warfield, Maj. Pete Forsythe, Maj. (ret.) Scott Boisvert, Maj. Bradley Hausmann, LtCol. Chris Fears, and Maj. David Rooney. We also wish to thank RAND colleague Anthony Atler, a former marine, who provided helpful information on MEU and MAGTF structures and operations. Finally, we are grateful to John Yurchak and RAND colleague Derek Eaton for their thoughtful reviews of this report. Their comments and suggestions greatly strengthened the presentation of our findings.

Abbreviations

AAV	assault amphibian vehicle
AHP	Analytic Hierarchy Process
DA	direct action
DoD	U.S. Department of Defense
FID	foreign internal defense
HA	humanitarian assistance
IED	improvised explosive device
IMET	international military education and training
JTF	joint task force
LAV	light armored vehicle
MAGTF	Marine Air-Ground Task Force
MESA	Marine Air-Ground Task Force Equipment Structural Assessment
MEU	Marine Expeditionary Unit
MIO	maritime interdiction operation
MTVR	medium tactical vehicle replacement
NEO	noncombatant evacuation operation
NGO	nongovernmental organization
RSOM	reception, staging, and onward movement
SAR	search and rescue
SRFA	Stabilization and Reconstruction Force Allocator
TACSATCOM	tactical satellite communication
TAMCN	Table of Authorized Materiel Control Number
TOW	tube-launched, optically tracked, wire-guided missile

TRAP	tactical recovery of aircraft and personnel
TSC	theater security cooperation
UAV	unmanned aerial vehicle

CHAPTER ONE

Introduction

As a rapidly deployable force with capabilities for ground, naval, and amphibious operations, the U.S. Marine Corps is responsible for missions that are both diverse and numerous. A single Marine Expeditionary Unit (MEU) may be involved in amphibious raids and assaults, covert reconnaissance carried out by special forces, humanitarian assistance following interstate conflicts and natural disasters, and the tactical recovery of displaced personnel. In many cases, MEUs afloat are the first responders to disasters and postconflict operations. Consequently, they are often called upon to initiate stabilization missions in the absence of civilian leadership and direct support. Facing this wide range of missions, MEUs must have both the right personnel and the right types of equipment to successfully accomplish their objectives. Creating a stable environment requires the use of security forces, whereas reconstruction requires skills that are quite different from those needed in combat. The lack of such skills and equipment on board can mean significant delays or forgoing the completion of some tasks altogether.

However, the MEU is often forced to operate without its ideal or optimal set of equipment. In most cases, the U.S. Navy's lift capacity, or the space available on the ships that make up the MEU, falls short of what is needed to transport the MEU's full set of equipment. As a result, when the MEU departs, some equipment is left behind—considered cargo left on the pier—leaving the MEU less than ideally equipped for certain missions. This is especially true when the MEU must be prepared for stabilization, humanitarian, and contingency operations.[1] Several factors may 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 ideal equipment set. What is the impact of this shortfall on mission accomplishment, especially when the mission includes stabilization operations?

[1] A critical component of mission accomplishment is the MEU's ability to access the equipment deemed necessary to accomplish all tasks associated with the mission. 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.

When we refer to *required equipment* in this report, we mean the equipment that Marine Corps planners feel is needed to complete all tasks associated with a mission.

Research Objective

This report and the accompanying RAND-developed Marine Air-Ground Task Force (MAGTF) Equipment Structural Assessment (MESA) application are intended to provide a systematic framework and approach that can be used to evaluate the effect of equipment shortfalls on the performance of specific missions. As described in this report, the approach used to develop planning factors for a complex MEU mission and the MESA application, which uses these planning factors to prioritize and assign equipment to tasks, provides a framework that MEU commanders can use to develop mission plans and understand where equipment shortfalls are likely. It does so by defining a set of simple steps that translate mission requirements into tasks, subtasks, and military activities, each of which is linked directly to the types of equipment needed for completion. It also highlights key parameters that may affect the types of equipment needed for the execution of key tasks, including terrain, threat level, infrastructure quality, and host-nation support. The MESA application supports this same objective by asking the user to define mission-specific characteristics and allowing the user to tailor equipment lists, equipment priority, and task priority as appropriate.

This report and accompanying MESA tool should be considered primarily as a proof of concept and demonstration of a general method or approach. Both have value in that they provide an analytic method that can be used to estimate equipment requirements and shortfalls. They also highlight the importance of task sequencing and prioritization and equipment sequencing to mission planning, and they offer ways to address and overcome equipment shortfalls when they arise. This report is not intended to address the broader set of factors affecting the choices of which equipment deploys and which remains behind (such as mission priorities and where commanders choose to accept risk), nor does it examine the specific impact of equipment shortfalls across missions.

This report aims to address several specific research questions:

- *What is the mission set?* The sponsor provided a set of 15 kinetic and nonkinetic missions to be assessed. However, of the 15, we were asked to focus on just one: humanitarian assistance operations.
- *What are the component tasks and subtasks of the 15 missions?* Answering this question required a thorough deconstruction of all 15 missions with a particular emphasis on the humanitarian mission.
- *What equipment is available to the MEU to accomplish mission tasks and subtasks?* A diverse set of factors will affect the types of equipment aboard a MEU, including space available, risk trade-offs made by commanders, and expectations about the nature of the deployment. This report does not focus on the factors or decisionmaking processes used to determine which pieces of equipment actually end up with the MEU. For the purposes of this study, the sponsor provided the RAND team with a loading list.
- *What measures and metrics should be used to assess the capability of selected equipment?* In addition to the loading list of available equipment, we used equipment manuals and sponsor input to define the capabilities of each piece of equipment in performing designated tasks.
- *What tasks cannot be accomplished immediately because of a lack of equipment?* A solution to the problem of a lack of equipment might be to reallocate equipment that is not neces-

sarily designed to accomplish the task but could do so in an emergency. Such an arrangement would resolve the shortfall impact assessment question.

Approach

This study drew on unpublished RAND work conducted in support of Marine Corps Combat Development Command's Operational Analysis Division. RAND developed a computer-based system to allocate Marine Corps units to stabilization and reconstruction tasks in a way accounted for changing situational factors. The finished system was called the Stabilization and Reconstruction Force Allocator (SRFA). It includes an index scoring system that reflects the capabilities of Marine Corps units with respect to stabilization and reconstruction operations. The index focuses on a narrow set of missions that are persistent in postconflict operations, including security missions (enabling kinetic activities) and stability and reconstruction missions (nonkinetic activities). The index scoring system measures a unit's capabilities in each of the mission areas selected, and it is used to allocate units to mission tasks. In this study, instead of allocating units to tasks and assuming that equipment that is organic to the units was available, we assigned equipment to tasks and assumed that the personnel to operate the equipment were available.

Central to this work was the development of a software system—loosely based on the previously developed SRFA. Inputs to the system consisted of the loading list provided by the sponsor, the tasks identified through the mission deconstruction process (described in Chapter Two), the measures and metrics used to define equipment capabilities, and the set of linkages between tasks and equipment.

The research answered the questions posed earlier in three phases: (1) we conducted a thorough review and deconstruction of the 15 missions focusing, in particular, on humanitarian assistance; (2) we identified the equipment needed to accomplish the tasks identified; and (3) we identified the measures and metrics, or "planning factors," needed to assess the capability of each piece of equipment on the loading list. This last phase also included identifying which alternative equipment might accomplish a task (albeit not as effectively). The software development proceeded in parallel with these activities.

Challenges

Several methodological challenges affected the research approach and placed some constraints on the MESA application and its outputs. First, there was ambiguity associated with the definition of subtasks within each mission. Although it is possible to provide some general description of the military activities involved in a generic MEU mission, the specific requirements are highly variable and difficult to predict. This report and the MESA application attempt to provide as much detail as possible about the activities involved in each subtask and the environmental or situational factors that may affect these activities.

One of our first steps was to deconstruct the mission into its component tasks and subtasks, using as guidance Marine Corps documents, joint publications, and other relevant information. The MESA application similarly attempts to capture requirements at the subtask level by providing screens for each subtask and allowing the user to tailor the predefined scenario

as necessary. However, the mission task and subtask discussions remain relatively general and are unlikely to support detailed mission planning. However, this ambiguity does not affect the value or generalizability of the approach used to develop inputs for the planning tool. Mission deconstruction, prioritization of tasks and equipment, and task sequencing are still the relevant steps that planners must take to develop mission plans and estimate equipment requirements, even if, in reality, deconstruction must occur at a more granular level.

A second challenge and limitation of the method is associated with the planning factors used in the study. Planning factors link equipment or military units to military tasks and activities, defining in relevant units what a given piece of equipment or specific type of unit can do in a set period of time if properly used. MEU commanders and marines involved in MEU operations typically have relatively clear ideas about the planning factors for specific units and pieces of equipment. However, the MEU does not have a written set of planning factors that it uses to develop mission plans or to guide what it brings aboard its ships. This lack of written planning factors meant that we were forced to develop alternative ways of defining equipment capabilities as they related to specific mission tasks.

As a second-best alternative, we relied on equipment manuals that provided details on the capabilities of pieces of equipment, such as payload, maximum speed, and lift capacity. These metrics provide estimates of the relative capabilities of different pieces of equipment and their ability to complete a given task, but they may not provide planning factors that are meaningful in an operational environment. The MESA tool links these planning factors to specific military tasks and activities and allocates equipment accordingly. The limitations inherent in our planning factors make it difficult to consistently match equipment to military activities, especially when these activities are themselves fairly broadly defined. The quality of the planning factors does not affect the value of the method or the MESA application. Furthermore, the quality of the planning factors will be easily addressed once better information is available. Updating the tool involves a simple data-entry change.

Limitations

In deconstructing the missions and developing the MESA application, we considered only the tasks and equipment involved in operational activities. This includes the movement of personnel and equipment to an area of operations but not the sustainment of these personnel and equipment or the tasks involved in reception, staging, and onward movement (RSOM).

Sustainment of personnel and equipment may include everyday logistics, routine maintenance and repair to equipment, and basic personnel support activities. RSOM is similarly focused on logistics and organization of personnel. Specifically, it describes the process through which personnel, materiel, and equipment are received and cleared through the point of debarkation (reception); assembled and organized into units and forces (staging); and moved from reception and staging areas to the area of operations (onward movement).

Although sustainment and RSOM tasks fell outside the scope of our research effort, these activities are central to the successful completion of MEU missions. They also often have additional resource implications, requiring specialized repair or communication equipment, additional personnel, and basic commodities, such as food, water, and gasoline. Users

of the MESA application must keep these additional requirements in mind when translating the MESA application's output from hypothetical to real operational plans.[2]

About This Report

This report records the tasks associated with the set of 15 missions defined in the Marine Corps Task List, the specific pieces of equipment that may be necessary to complete these tasks and the capabilities of this equipment, and the software system developed to assess the impact of equipment shortfalls. Chapter Two describes the deconstruction process, focusing on the humanitarian assistance mission, the prototype used for this report and the MESA application, as well as tasks that are common across missions. Chapter Three describes the analytic process used to identify and link equipment to tasks and to assess equipment capability. Chapter Four describes the MESA application and its utility in assessing equipment shortfalls and their impacts. Chapter Five presents some conclusions concerning this process and possible extensions. The report concludes with three appendixes: Appendix A presents planning factors for 14 of the 15 deconstructed missions; Appendix B lists the planning factors associated with all the equipment included in the equipment list provided by the sponsor, followed by a series of tables that describe the equipment needed for each of the tasks associated with the humanitarian assistance mission; Appendix C is a detailed user's guide to the software.

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[2] U.S. Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Joint Reception, Staging, Onward Movement, and Integration*, Joint Publication 4-01.8, Washington, D.C., June 13, 2000.

CHAPTER TWO

Mission Deconstruction

As a rapidly deployable force, the missions that a single MEU is expected to complete vary in complexity, length, and risk and often have very different personnel and equipment requirements. Each mission also involves distinct tasks that are shaped by the mission's unique goals and operating conditions. However, MEU missions also share many common tasks and activities: for example, planning, establishing the command center, area and road clearance, and surveillance and reconnaissance.

To be successful, MEUs must be able to identify the pieces of equipment needed to complete each task. One way to accomplish this is to deconstruct the mission into its component tasks and subtasks and then determine the equipment and personnel needed to complete each task. This chapter represents the first step in this approach. First, it discusses the common tasks and subtasks that are involved in many different MEU missions. Then, it deconstructs the humanitarian assistance (HA) missions into a set of tasks, subtasks, and activities—including both common tasks and unique tasks—that could be linked to equipment in a planning exercise. Importantly, although the HA mission shares common tasks with other mission types, it is the unique tasks and subtasks that are likely to have the most direct effects on equipment needs and be most severely affected by equipment shortfalls.

The mission description presented in this chapter is intended to be generic. In practice, each mission may have several different variants, depending on the prevailing conditions and location where the mission is to be executed. The discussion of the HA mission in this chapter also identifies some of the factors that affect the demands of specific missions, but it cannot account for every variant. Although only the HA mission is addressed in full in this chapter, Appendix A provides a similar deconstruction for 14 additional MEU missions, all from the Marine Corps Task List. For context, we provide a brief overview of the types of missions in the mission set, as shown in Table 2.1.

Although diverse, the set of missions listed in Table 2.1 can be categorized into a smaller set of mission types, based on the primary, unique activities involved. This framework may be useful for planners who can exploit similarities between missions in each category to estimate and project personnel and equipment requirements. For example, there are "evacuation" missions that involve the evacuation of noncombatants or isolated individuals, such as noncombatant evacuation operations (NEOs) and tactical recovery of aircraft and personnel (TRAP). There are "assistance" missions, such as HA, foreign internal defense (FID), security cooperation, and even stability operations. Another category of missions includes short-duration missions with limited objectives, such as direct action, advance force, or special reconnaissance. Finally, MEUs engage in amphibious missions, including amphibious raids and assaults, as well as maritime missions and aviation operations. The MESA application will eventually

Table 2.1
Missions Deconstructed in This Report

Mission Type	Description
Amphibious raid	Short-duration, small-scale deliberate attacks from the sea, involving a swift penetration of hostile or denied battlespace
Amphibious assault	Attack launched from the sea by naval and landing forces, embarked in ships or craft involving a landing on a hostile shore
Maritime interdiction operations (MIOs)	Operations to intercept commercial, private, or other nonmilitary vessels and conduct visit, board, search, and seizure activities
Advance force operations	Operations to shape the battlespace in preparation for the main assault, including reconnaissance, seizure of supporting positions, minesweeping, underwater demolitions, and air support
Noncombatant evacuation operations (NEO)	Evacuation of noncombatants from countries when their lives are endangered by civil unrest or natural disaster to safe havens or to the United States
Stability operations	Operations that encompass various military missions, tasks, and activities conducted outside the United States in coordination with other instruments of national power to maintain or reestablish a safe and secure environment, provide essential government services, emergency infrastructure reconstruction, and humanitarian relief
Humanitarian assistance (HA) operations	Operations that respond to manmade and natural disasters and include tasks such as providing personnel and supplies and a mobile, flexible, rapidly responsive medical capability for acute medical care
Tactical recovery of aircraft and personnel (TRAP)	An operation conducted to locate and extract distressed personnel and sensitive equipment from enemy-controlled areas during wartime or contingency operations to prevent capture
Joint and combined operations	Operations that include two or more military departments, are commanded by a joint force commander with a joint staff, and incorporate military forces from two or more nations
Aviation operations from expeditionary shore-based sites	Marine aviation units operate from expeditionary shore-based sites (in line with unit/platform capabilities), including forward operating bases, expeditionary airfields, forward arming and refueling points, austere forward operating sites, tactical landing zones, and helicopter landing zones
Theater security cooperation (TSC)	Bilateral and multilateral military noncombat activities conducted with allies and other potential partners to build partner capacity and support interoperability and cooperation with U.S. forces
Direct-action (DA) operations	Strikes and small-scale offensive actions conducted as special operations in hostile, denied, or politically sensitive areas using specialized military capabilities
Port/airfield seizure operations	Offensive operations to occupy or defend airfields or ports for use by friendly forces
Special reconnaissance[a]	Reconnaissance and surveillance actions conducted as special operations in hostile, denied, or politically sensitive areas to collect information of strategic or operational value
Foreign internal defense (FID)[a]	Participation by civilian and military agencies in any program undertaken by another government or other designated organization to free and protect society from subversion, lawlessness, and insurgency

SOURCES: Definitions from OPNAV Instruction 3500.38B/Marine Corps Order 3500.26A/U.S. Coast Guard Commandant Instruction 3500.1B, *Universal Naval Task List*, January 30, 2007, MCTL 2.0 (September 1, 2010); U.S. Joint Chiefs of Staff, *DoD Dictionary of Military and Associated Terms*, Joint Publication 1-02, Washington, D.C., November 8, 2010, as amended through January 2012; and U.S. Joint Chiefs of Staff, *Joint Operations*, Joint Publication 3-0, Washington, D.C., August 11, 2011.

[a] Definition from Marine Corps Order 3120.9C, *Policy for Marine Expeditionary Units (MEU) and Marine Expeditionary Units (Special Operations Capable) MEU(SOC)*, August 4, 2009, p. 6.

make use of these overlaps, using similar modules to specify the requirements of common tasks in multiple missions.

MEU Organization

Central to this discussion is the MEU itself. It will be tasked with carrying out the missions, subtasks, and activities described here and in Appendix A. For this reason, we include a general discussion of its organization. Figure 2.1 presents an overview of the MEU structure.

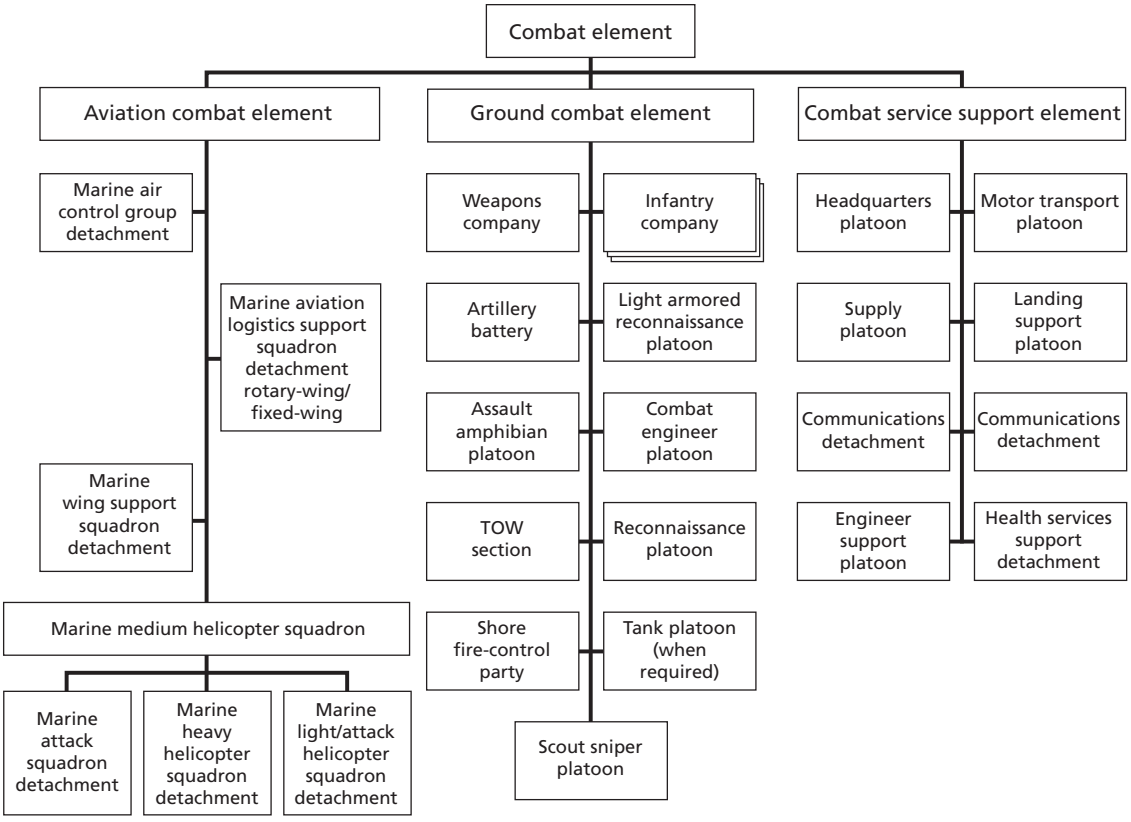
The Marine Air-Ground Task Force

A MEU is structured along the task-organized concept of the Marine Air-Ground Task Force (MAGTF). As such, each MEU comprises four core elements: command element, a ground combat element, an aviation combat element, and a logistics combat element (formerly referred to as a *combat service support element*). A MEU may be task-organized for specific missions. The composition and functions of each MEU core elements are as follows:

- A command element is the MEU headquarters and is commanded by a colonel. It may include additional assets and responsibilities, such as command and control, a force reconnaissance company, and signals intelligence capabilities provided by the radio battalion. The command element provides the command, control, communication, computer, and intelligence capabilities necessary for effective planning, direction, and execution of operations in a joint or combined environment.
- A ground combat element consists of an infantry battalion reinforced with artillery, reconnaissance, engineer, tank, light armored reconnaissance, and assault amphibian units, as well as other attachments as required. In a MEU, this element is also referred to as a *battalion landing team*; it consists of approximately 1,200 personnel. It is task-organized to conduct combined arms, ground operations in support of the MEU's mission.
- An aviation combat element consists of a combat assault transport helicopter squadron reinforced with utility and attack helicopters, vertical/short-takeoff and -landing fixed-wing attack aircraft, air refuelers or transport aircraft, and other detachments, as required. The aviation combat element conducts offensive and defensive air operations and is task-organized to perform six aviation functions required to support the MAGTF mission: assault support, anti-aircraft warfare, offensive air support, electronic warfare, control of aircraft and missiles, and aerial reconnaissance.
- A logistics combat element is task-organized around a combat logistics battalion, formerly called a *service support group*. This element has engineering, supply, transportation, landing support, medical, and maintenance capabilities.[1] The logistics combat element provides a full range of combat service support functions necessary to accomplish assigned missions and provides 15 days of sustainability through its supply detachment.

[1] Headquarters, U.S. Marine Corps, *Marine Corps Operations*, Marine Corps Doctrinal Publication 1-0, Washington, D.C., September 27, 2001.

Figure 2.1
MEU Organizational Structure



SOURCE: Headquarters, U.S. Marine Corps, *Organization of Marine Corps Forces*, Marine Corps Reference Publication 5-12D, Washington, D.C., October 1998, p. 2-4, Figure 2-3.
NOTE: TOW = tube-launched, optically tracked, wire-guided missile.
RAND *TR1253-2.1*

The addition of a task-organized element from Marine Forces Special Operations Command creates a MEU (Special Operations Capable), or MEU(SOC).[2] Each MEU's equipment and approximately 2,200 personnel are typically embarked aboard three Navy ships that make up an amphibious ready group (see Figure 2.2).[3] This combination of forces allows a MEU to maintain the desired characteristics of a forward presence with operational flexibility, rapid response capability, task-organization for multiple missions, and a sea-based, strategic reach with organic force protection.[4]

The four elements are coordinated by the command element, which can exercise operational command and control from ship or ashore. The MEU elements participate in an intensive training program before the MEU is certified for deployment. Leaders in each element

[2] Headquarters, U.S. Marine Corps, *Concepts and Programs*, Washington, D.C., 2010a.

[3] Marine Corps Order 3120.9B, *Policy for Marine Expeditionary Unit (Special Operations Capable) (MEU[SOC])*, September 25, 2001.

[4] Marine Corps Order 3120.9B, 2001.

Figure 2.2
Ships of an Amphibious Ready Group

SOURCE: U.S. Navy photo by Chief Mass Communication Specialist John Lill.
NOTE: The photo shows the Makin Island Amphibious Ready Group, composed of the USS *Pearl Harbor* (LSD 52), USS *Makin Island* (LHD 8), and USS *New Orleans* (LPD 18), off the coast of California in 2011.
RAND *TR1253-2.2*

coordinate their activities along the six warfighting functions: command and control, maneuver, fires, intelligence, logistics, and force protection.[5]

Common Tasks

In this section, we focus specifically on the tasks that are common to more than one mission, listed in Table 2.2. Because the implementation of even common tasks will vary depending on the mission, we offer generic descriptions and then highlight some of the specific operational and environmental characteristics that are most likely to affect execution—for example, external threat or host-nation support.

Mission Planning

Mission planning is the first step of most Marine Corps missions.[6] It involves defining mission objectives and outlining the mission's distinct phases. Mission planning relies heavily on reconnaissance and surveillance activities to define the level of the external threat, the physical

[5] Headquarters, U.S. Marine Corps, 2001.

[6] This section draws on Headquarters, U.S. Marine Corps, *Infantry Training and Readiness Manual*, Navy/Marine Corps Manual 3500.44, Washington, D.C., September 16, 2008b, and OPNAV Instruction 3500.38B, 2007.

Table 2.2
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 (communication and data processing facilities), 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 of 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 force protection operations, if required.

characteristics of the operating environment (e.g., terrain, weather), and the status of existing infrastructure. A completed mission plan should define the number and types of personnel needed, potential transit routes and landing sites, primary sources of threat, the pieces of equipment that will be used, the tasks that must be accomplished, and the lines of operational control. Chapter Three describes in detail one method that can be used to match equipment and personnel with tasks.

Establishing the Command Center

A second core task in most Marine Corps missions is establishing the command center from which mission operations are controlled, monitored, and directed.[7] The command center can take many forms and range in size from a single combat operations center to a more established facility, depending on the level of external threat, the complexity and expected duration of the mission, the status of existing infrastructure, and the level of support provided by host-nation,

[7] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b) and OPNAV Instruction 3500.38B, 2007.

partner, or joint forces. Importantly, certain missions may have multiple command centers, some operated jointly with allies or partner forces. In more hostile environments, the command center may include only a single armored vehicle in a remote location. Regardless of its form, the establishment of the command center (or centers) involves establishing communication lines and data processing facilities and subsequently using these facilities to implement intelligence and logistics plans.

Amphibious Assault and Raid

The amphibious assault, which involves forces and equipment from sea to the shore to complete a ground operation, is one of the most fundamental Marine Corps missions (see Figure 2.3).[8] The amphibious assault acts as the first phase of many other operations, including reconnaissance, seizing ports or airfields, recovery of personnel or equipment, and establishing sites for humanitarian aid provision. Importantly, it is also its own independent mission, as shown in Table 2.1. The amphibious assault involves a preparatory phase in which an advance team prepares the landing site, supported by preparatory naval or air fires. The amphibious

Figure 2.3
Offloading a U.S. Navy Landing Craft

SOURCE: U.S. Air Force photo by Staff Sergeant Jerry Morrison.

NOTE: LAV-25s (eight-wheeled, amphibious, light armored vehicles) and high-mobility, multipurpose wheeled vehicles are offloaded from a U.S. Navy landing craft at Samesan Royal Thai Marine Base, Thailand, May 26, 2002. In a combat situation, this equipment would support amphibious assault and raid missions.

RAND *TR1253-2.3*

[8] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and U.S. Joint Chiefs of Staff, *Amphibious Operations*, Joint Publication 3-02, Washington, D.C., August 10, 2009b.

landing and disembarkation phase of the assault involves unloading personnel, moving essential equipment from land to shore, and, often, force protection operations. The amphibious raid follows a pattern similar to the assault but also includes a short-duration ground operation and a rapid amphibious withdrawal. The amphibious raid or assault will be shaped by the level of external threat, the status of existing infrastructure, weather or terrain, and the number of personnel and amount of equipment involved.

Road and Area Clearance

Because most missions require MEUs to be able to move through the operating environment or set up sites for evacuation, assembly, or provision of humanitarian assistance, area and road clearance are also tasks that span missions.[9] Area and road clearance may be conducted to prepare air or beach landing sites, to create transport routes for supply convoys or personnel, or to create sites for evacuation, equipment repair, or medical care. Clearance activities involve removing obstacles, such as trees, rocks, or other debris from roadways or other areas; defusing improvised explosive devices (IEDs) and other potential threats; repairing roadways where necessary; and securing roadways or assembly areas using force protection measures, such as establishing a perimeter or barriers. Importantly, road security and repair provided by MEUs are intended primarily to allow the safe passage of personnel and do not involve permanent rebuilding. The clearance activities required will depend on the level of threat, the status of existing infrastructure, and the road-miles or area to be cleared.

Assaults, Raids, and Infiltrations

Assaults, raids, and infiltrations occur as part of ground operations or direct action, advance force, or special reconnaissance missions.[10] Assaults, raids, and infiltrations all involve the insertion or movement of a force into the area of operations and rely on advance intelligence collection and preparatory fires. The three tasks also share similar objectives and often include some type of offensive action to seize control of land, assets, or information; to eliminate adversary targets; or to carry out some other act of sabotage against the adversary force. Infiltrations and raids tend to be covert and involve the insertion of a small forward element into enemy territory to carry out a limited objective (for example, target elimination, reconnaissance, or sabotage). An assault implies a longer-duration attack or offensive operation against an enemy target, often with the intent of seizing control of some area or facility.[11]

All three tasks are shaped by mission-specific factors, such as the level of external threat, the status of existing infrastructure, and the extent of support from local or partner forces. Force protection operations and civil control may be necessary when the external threat is high and no local support exists, but they may be easier when the adversary is weak and when the forward element can rely on local security for preparatory and civil control operations. The nature of follow-on tasks and objectives determines the number of personnel involved and the types of equipment required.

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[9] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b) and OPNAV Instruction 3500.38B, 2007.

[10] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and Headquarters, U.S. Marine Corps, *Aviation Training and Readiness Manual*, Navy/Marine Corps Manual 3500.14, Washington, D.C., July 3, 2007.

[11] See Navy/Marine Corps Manual 3500.14 (Headquarters, U.S. Marine Corps, 2007).

Conducting Reconnaissance

Many missions also rely heavily on reconnaissance and intelligence gathering, either to supplement mission planning or to support the ongoing mission.[12] Much reconnaissance activity relies on ground-based assets, with information gathered and processed by teams of marines in the field. As a result, reconnaissance requires the transport of personnel to and through the area of operations. The appropriate mode of transport depends on the level of external threat and the status of existing infrastructure. Air reconnaissance may also be important, since aircraft can often cover more territory more quickly and with less risk than ground assets. However, ground vehicles may still be used for close reconnaissance and surveillance. Both types of reconnaissance operations may be armed, especially in hostile areas. The level of threat, the status of local infrastructure, and the types of information being collected will shape reconnaissance missions by determining the likely need for weapons, force protection operations, and armored vehicles.

Civil Control

Many Marine Corps missions also involve civil control operations conducted to prevent riots or public disturbances, as well as to neutralize the threat to mission completion or the security of the force posed by the local population.[13] Civil control may involve any number of specific activities, depending on the environment (urban or rural), the level of threat, the size of the population, and the extent of local security support. For example, it could simply consist of neighborhood patrols, or it could involve the provision of security at key buildings and the administration of checkpoints on important roadways. If local police are cooperative and strong, civil control responsibilities may fall to them alone. Civil control may involve enforcing a cease-fire, eliminating insurgents, providing security at key buildings and businesses, ensuring freedom of movement, and conducting information operations.

Evacuation of Personnel

Evacuation is another task that appears in several different Marine Corps missions.[14] Evacuation of noncombatants is the primary objective of NEOs, while recovery and evacuation of isolated individuals is the key activity of a TRAP mission. Evacuations will be influenced by such factors as the level of the operational threat, the number of individuals to evacuate, the number and types of injuries, and the mode of evacuation (air, ground, or amphibious transport). A typical evacuation involves the transport of personnel to the evacuation point, the processing of evacuees (if necessary), and, in extreme cases, the provision of critical medical or humanitarian aid, including food and water. When included, the provision of food, water, and emergency medical care to the local population is important from a planning perspective because it has

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[12] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012); and Marine Corps Order 3120.9B, 2001.

[13] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and U.S. Joint Chiefs of Staff, *Interorganizational Coordination During Joint Operations*, Joint Publication 3-08, Washington, D.C., June 24, 2011b.

[14] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and U.S. Joint Chiefs of Staff, *Noncombatant Evacuation Operations*, Joint Publication 3-68, Washington, D.C., January 22, 2007a.

significant implications for the type and amount of equipment needed to complete the evacuation. Force protection may be needed in particularly hostile environments.

Force Protection Operations

The MEU always prepares for force protection, even when the threat appears low.[15] Force protection operations may include the use of weapons to repel enemy forces, the erection of barriers or fences to secure a perimeter, the use of checkpoints to monitor the entry and exit of personnel, and hazmat responses to nuclear, biological, or chemical weapons. The types of operations conducted in a given mission depend on the operational environment, the level of threat, the characteristics of the area that must be secured or defended, and the size of the force. Force protection operations will be extensive when the threat is high and when the MEU is required to hold territory for long periods. However, other than vehicles and weapons, the equipment requirements for force protection activities may be relatively minimal.

Transition to Host-Nation Control

The transition from Marine Corps to host-nation control varies with the specific mission.[16] In humanitarian operations, it will involve a shift to host-nation provision of emergency services, such as electricity and water. In other cases, it involves the return of operational control to the host nation following a raid, port or airfield seizure, or assault on an adversary target. The initial transition may be from the Marine Corps to NGOs rather than directly to the host nation. Transition may also involve training host-nation security forces and will conclude with the withdrawal or extraction of Marine Corps forces, often through an amphibious withdrawal. The level of threat, the status of local infrastructure, and the capacity of the host nation will shape the transition stage and, importantly, the duration and nature of the MEU mission.

Withdrawal

The final cross-mission task is the withdrawal of personnel and equipment.[17] Preparation for withdrawal requires the completion of necessary equipment maintenance and repairs, along with the provision of necessary medical care to wounded personnel and reconnaissance operations to plan the withdrawal route. The extraction of personnel and equipment may occur by air or by amphibious operation, depending on the operational environment or the location. The withdrawal will be shaped by the external threat, the status of existing infrastructure, and the number of personnel and pieces of equipment to extract. Withdrawals that are conducted where the infrastructure is weak or destroyed are likely to involve route and area clearance or to rely on vehicles that can handle difficult terrain. Withdrawals also become more difficult when the force is large, when there are injured personnel, or when there are many pieces of damaged equipment.

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[15] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012); and Headquarters, U.S. Department of the Army, *Operations*, Field Manual 3-0, Washington, D.C., 2011.

[16] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and U.S. Joint Chiefs of Staff, *Counterinsurgency Operations*, Joint Publication 3-24, Washington, D.C., October 5, 2009c.

[17] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and Field Manual 3-0 (Headquarters, U.S. Department of the Army, 2011).

Deconstructing Humanitarian Assistance

As noted earlier, although Marine Corps missions do share the common tasks listed in Table 2.3, it is often the mission-specific activities that have the greatest effect on equipment and personnel needs and that are most immediately and severely affected by equipment shortfalls. In this section, we move from a discussion of specific tasks to a more careful deconstruction of the HA mission, focusing on the tasks and characteristics that make the mission distinct and that most directly affect the planning required for completion. We use the HA mission for this demonstration because it is the mission that we have considered in most detail and it serves as the prototype for the MESA application. Appendix A presents mission deconstructions for the additional 14 missions listed in Table 2.1.

Humanitarian Assistance

Humanitarian assistance is defined in joint publications and Army field manuals as follows:

> Programs conducted to relieve or reduce the results of natural or manmade disasters or other endemic conditions such as human pain, disease, hunger, or privation that might present a serious threat to life or that can result in great damage to or loss of property. Humanitarian assistance provided by US forces is limited in scope and duration. The assistance provided is designed to supplement or complement the efforts of the host nation civil

Table 2.3
Humanitarian Assistance Tasks

Task	Description
Mission planning	The mission plan defines the objectives and operational plan for the mission, including the key tasks and associated requirements, using surveillance and reconnaissance. Factors considered in the mission plan will include the threat level, terrain, nature and severity of the disaster, presence of local support, likely scope and duration of the mission, numbers of people requiring assistance, and the status of infrastructure.
Establishing the command center	The command center serves as the operational center for the mission. Its establishment involves setting up communication lines and planning logistics and intelligence operations.
Road and area clearance	Transportation routes must be cleared of obstacles and hazards to facilitate the movement of personnel and essential cargo. Obstacles may include debris from a manmade or natural disaster, IEDs, or other emplaced munitions.
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 of debris and secured. Marine Corps units may take a lead in security-related tasks and assist NGOs in essential repairs of facilities for aid provision.
Providing assistance at central sites or with mobile units[a]	The MEU may provide emergency HA assistance or support NGOs in this activity. MEU involvement is likely to include primarily transport and distribution of foreign aid, including food, water, and other supplies. It may also assist in search and recovery operations or evacuations, as necessary.
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, as well as the repair of essential infrastructure until the host nation or NGOs are able to 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, training of security personnel, and, in some cases, support for new elections.

[a] Mission-specific task.

> authorities or agencies that may have the primary responsibility for providing humanitarian assistance.[18]

In recent years, U.S. military personnel have found themselves taking on significant humanitarian responsibilities. All HA operations share certain common tasks, but the nature of the mission also depends fundamentally on the nature of the precipitating crisis, the type of aid provided, and the operational environment. For example, although an HA mission following a major earthquake and one that occurs during an ongoing low-intensity civil war are both likely to involve the transport and distribution of emergency food and water and road clearance, the mission following the earthquake is likely to include significantly more rebuilding, while the latter mission would maintain a security focus.

The basic approach to HA operations and the role of Marine Corps personnel and equipment will affect the equipment requirements. Marine Corps officers with whom we spoke were clear that marines do not typically participate in the actual provision of humanitarian aid, such distributing food, building shelters for refugees, or providing nonemergency medical care, leaving these tasks to local organizations and NGOs. However, necessity sometimes dictates that personnel become more involved in certain aspects of HA, participating directly in the distribution of food and potable water or assisting in local construction and engineering activities.

Mission Planning and Establishing Command Centers

A typical HA mission consists of the tasks listed in Table 2.3. It begins with mission planning and the establishment of a command center that oversees its execution. In an HA mission, the plan will be shaped by a basic assessment of the disaster or crisis that considers (1) the nature of the disaster or crisis; (2) the effect of the disaster on the local infrastructure, governance, and population; (3) the status of food and water supplies; (4) medical care demands; (5) the existence of host-nation or allied support; (6) the level of threat; and (7) duration of assistance needed. The plan may also consider or project the likely operational demands—for example, whether roads will need to be cleared, emergency assistance provided (and to how many people), or evacuations or search operations conducted. The size and nature of the HA mission will also affect the establishment of the command center (or centers), determining the number of sites requiring command centers and the command capabilities needed at each site.[19]

Road and Area Clearance

Once the command center and mission plan are in place, the next step in many HA missions will be accessing the areas in need of assistance. This may require extensive road and area clearance as well as critical road and infrastructure repairs, ranging from removing debris or IEDs to repairing bridges and dealing with flooded roads. In an HA mission, route clearance will be necessary to facilitate the transport of supplies to support assistance provision to local

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[18] Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012). This section also draws on U.S. Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Foreign Humanitarian Assistance*, Joint Publication 3-07.6, Washington, D.C., August 15, 2001; Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; Field Manual 3-0 (Headquarters, U.S. Department of the Army, 2011); and U.S. Joint Chiefs of Staff, *Foreign Humanitarian Assistance*, Joint Publication 3-29, Washington, D.C., March 17, 2009.

[19] Joint Publication 3-29 (U.S. Joint Chiefs of Staff, 2009a); U.S. Agency for International Development, *Field Operations Guide for Disaster Assessment and Response*, version 4, September 2005.

populations, including food and other aid received from external donors, and radios and other materials that Marine Corps personnel need to carry out their responsibilities. The difficulty and extent of clearance activities will depend on the initial status of key roadways, the length of roadways, the type and number of obstacles that must be cleared, and the level of security required. Area clearance may also be part of an HA mission—specifically, clearing sites for the provision of assistance.

Establishing and Securing Sites for Assistance Provision

Before assistance can be provided, sites for aid provision must be established. The MEU is likely to work alongside NGOs and partner forces to establish sites for emergency or critical HA provisioning, but it is unlikely to undertake extensive new construction. The demands of this task depend on the number of people requiring assistance and the number of sites that must be established. The task may involve repairing existing buildings and facilities or using temporary shelters to house refugees and provide critical medical care, along with setting up communication lines and ensuring access to running water. It may also involve force protection and area security.

Providing Assistance and Restoring Critical Services

HA provisioning sites cannot function without medical supplies, food, water, and other essentials. Our interviewees indicated that these supplies come from external sources (e.g., foreign donors and aid organizations), but that MEUs are often involved in the distribution of foreign food aid, bottled water, or medical supplies. As a result, cargo transport of these supplies is an important HA task—perhaps one of the most important during the HA mission. The demands associated with this task will depend on the weight of the items to be carried, the distance, the number of sites, and the time available. Importantly, MEU commanders do not consider the food and water provided to local populations as part of their planning considerations when preparing for an HA mission because these provisions are not taken out of the MEU's own supplies. The same is true of medical care. However, commanders may still be interested in the amount of food and water required to assist local populations because these amounts will directly affect the transport demands associated with the HA mission.

Although in extreme situations, marines may carry out assistance provision on their own, it is more likely that, as mentioned earlier, the MEU will support and work alongside NGOs, host-nation organizations, and partner forces. The defining characteristics of the HA mission will be the number of individuals requiring assistance, the types and extent of assistance that they require, and the time over which assistance must be provided. Assistance may be provided in central locations only or in more widespread or remote sites. The types of emergency assistance that may be provided during an HA mission include medical care, food, water, shelter, and search and recovery operations. The MEU's central function in this phase of the mission will likely be transporting and distributing supplies, assisting in security operations, and providing emergency medical and other types of assistance. Vehicles for cargo transport and basic security operations, radios and other communication equipment, some medical equipment, and equipment to produce potable water will be most important in these tasks. The cargo transported will primarily include foreign aid as well as the supplies that the MEU needs to assist in essential emergency rebuilding activities.

Assistance provision may also involve related search and recovery or evacuation operations, depending on the nature of the mission and the disaster. In search and recovery opera-

tions, communication and personnel transport may be the most important categories of equipment. In rare cases, NEOs may be required to remove U.S. citizens or citizens of allied nations from a dangerous or unstable situation. Search and recovery operations and NEOs may overlap with the HA mission, but they will likely require their own mission plans. Although HA operations will not always include these overlapping missions, when they do, there can be important resource implications. As a result, a planning tool, such as the MESA application, should incorporate and account for such scenarios.

A MEU involved in an HA mission may also assist in essential emergency reconstruction activities, including the restoration of *essential* services, such as water, electricity, and rule of law, until local institutions and forces are able to assume responsibility. The nature of the mission, the size of the population, and the duration of the operation will determine the equipment and personnel requirements, as well as the demand for force protection and information operations. This phase of the HA mission is likely to be dominated by engineering activities, including well drilling, provision of potable water, clearing debris, and reestablishing basic utilities and public facilities. It may also involve the training of local personnel to undertake these tasks independently. However, while the MEU may assist in the restoration of basic services, it is unlikely to use its own generators or other equipment intended for personnel sustainment to permanently restore power and water to local populations.[20]

Transition to Host-Nation Support

The final stage of the HA task is the transition to host-nation control. As described earlier, the goal of this phase in the HA mission is to restore the local provision of key services, including not only electricity and water but also law enforcement and governance.

Conclusions

This chapter illustrated the process of deconstruction, first by defining a set of common tasks shared by many missions and then by deconstructing the HA missions in detail. This deconstruction is important because it facilitates the development of planning factors and the identification of metrics that can be used to link each task to the specific pieces of equipment and types of units needed to successfully complete it.

Why Humanitarian Assistance?

The HA mission is appropriate as a prototype for our interface and the MESA application because it is a fairly common mission, but it can also be complex, with many different tasks and subtasks, and that complexity depends on the operational environment, the type and extent of assistance required, and the availability of partner, NGO, or joint force support. The HA mission may also occur alongside many other MEU missions, including FID, NEOs, tactical recovery of equipment and personnel, stability operations, and even direct action or special reconnaissance, adding to the complexity of its resource requirements and raising concerns about task, mission, and equipment prioritization and sequencing.

[20] Joint Publication 3-29 (U.S. Joint Chiefs of Staff, 2009a; U.S. Agency for International Development, 2005.

Deconstruction

The deconstruction of the HA tasks suggests some interesting observations and themes that will be important throughout this report. First, it highlights the significant role that common tasks play in mission development and execution. Because these missions rely on common tasks, the initial phases are extremely similar to those of most other MEU missions considered in this project and described in Appendix A.

That said, the deconstruction also makes it clear that the mission-specific tasks are the ones that really define the mission and that determine the pieces of equipment that will be most essential to mission completion. Although road clearance is essential to many HA operations, it is the transport and distribution of supplies and the engineering or stabilization activities undertaken to restore local governance and services that really define the HA mission.

Deconstruction also highlights the importance of context. The specific operational environment, the threat level, terrain, and contributions of other organizations will all significantly affect the activities in which the MEU is expected to engage and the associated equipment requirements.

Mission Nesting

Finally, deconstruction suggests that the HA mission may overlap with other missions included in the broader mission set, such as NEOs and search and rescue (SAR) operations.[21] This overlap between missions, or "mission nesting," blurs the boundaries between missions and is important because of its implications for mission planners. In the case of the HA mission, even where overlapping SAR operations and NEOs have their own mission plans, all these missions may be able to make use of cleared roads and communication infrastructure that has already been established. Planners must also prioritize among nested missions when allocating equipment and personnel and, in some cases, decide whether the missions will occur simultaneously or sequentially. Future iterations of the MESA application will make use of observations about mission nesting by allowing the user to link and prioritize separate missions into a composite operational plan and aggregated set of requirements for the MEU. We return to the importance and implications of mission nesting in Chapter Five.

[21] SAR is not one of the 15 missions discussed in this report, but it is included in the HA mission.

CHAPTER THREE

Equipment, Personnel, Metrics, and Planning Factors

Planning factors link tasks or military activities to the pieces of equipment or number of military personnel needed to complete the task. For example, a planning factor for the task "clear six miles of roadway" might specify that three military personnel can clear one mile of roadway per hour using a truck able to tow or haul at least one ton of material. A military planner could use this planning factor to determine that the task will take three military personnel six hours to complete or can be accomplished in three hours using six military personnel and two trucks.

Planning factors form the backbone and foundation of any mission planning effort, including the MESA application developed for this study, because they link the activities that the MEU will perform with the necessary equipment and the personnel to operate it. 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 the equipment and personnel available on board, providing commanders with clear information on which tasks can be accomplished and which areas will require substitutions or compromises.

The process of defining planning factors to be used for operational planning involves several steps, including mission deconstruction, linking military tasks with specific pieces of equipment and military units that have the required capabilities, defining relevant metrics, and prioritizing pieces of equipment and unit types based on their relative capabilities. The first step, the deconstruction of missions into their component tasks and activities, was the subject of the previous chapter. This chapter describes in more detail the process used to define planning factors, again using the HA mission, our prototype example.

As noted in Chapter One, we faced some significant methodological challenges in our attempts to define meaningful planning factors that could be used to project equipment requirements. These challenges do not affect the value of our method, the appropriateness of the approach used to define planning factors, or the relevance of this report and the MESA application as a "proof of concept" for U.S. Marine Corps mission planning. Regardless of the specific planning factors used, the approach for defining and applying them described here provides a systematic framework that planners can use to assess and estimate the equipment requirements associated with specific missions. At the same time, it identifies many of the essential challenges inherent in the process that must be incorporated into mission plans and commander assessments. However, methodological challenges do affect the planning factors used in the MESA application and the nature of the output produced. We highlight some of these challenges in the general discussion that follows, as well as their implications for the ultimate output of the MESA tool.

From Missions to Tasks, Subtasks, and Military Activities

We relied on several key sources as we deconstructed missions into their component tasks and activities. First, we used Marine Corps doctrinal publications and joint publications to identify the tasks and activities likely to span missions, as well as the specific tasks and phases involved in each of the 15 missions. We focused most extensively on the HA mission because we planned to use it as our prototype for the MESA application.

Next, we used Navy/Marine Corps Manual 3500.14 and the Marine Corps Task List, as well as joint publications, U.S. Agency for International Development, and United Nations publications to identify more specific subtasks and activities involved in each phase of relevant missions. The joint publications are especially valuable because they outline the specific tasks involved in most missions included in the mission set and are often explicit about the role played by military and civilian organizations.

When defining planning factors specifically for the HA mission, the information provided in Navy/Marine Corps Manual 3500.14 and related publications was especially useful because the detailed information on the requirements for each activity informed preliminary notions about the types of equipment most relevant to each task.

Detailed Humanitarian Assistance Mission Tasks and Subtasks

Chapter Two discussed the various tasks associated with the humanitarian mission in general terms. This was part of the deconstruction process. Here, we start from that deconstruction and identify subtasks and activities that support those tasks. Table 3.1 records the results of our analysis of the deconstruction supported by the various documents mentioned earlier. The specific tasks, subtasks, and activities listed in the table are used by the MESA application. Although complete mission deconstruction was carried out for each of the 15 missions, we completed the planning factor and metric definition process for the HA mission only.

Challenge

One challenge of this initial deconstruction was specifying the subtasks and activities involved in HA (and other) operations to a level of detail that supported a close match between task and equipment and the development of accurate, realistic planning factors. Since we were dealing with only a generic HA mission, drilling down to this level of specificity was difficult. For example, we can state with some certainty that the HA mission will involve cargo transport, but we cannot specify precisely what type of cargo or the distance. We can guess that road clearance may be necessary, but we do not know what types of obstacles must be cleared. A lack of specificity in our subtasks prevents a close match between required equipment and tasks and places some limitation on the assignment of planning factors. It is difficult to precisely specify equipment requirements for road clearance, for example, without knowing what is being cleared or to assign equipment to a task such as "local infrastructure repair" without knowing exactly what is being repaired and how.

We addressed this challenge by matching equipment to tasks based on the equipment's specific capabilities and providing flexibility within the MESA application for the user to refine the list or prioritization of equipment as needed based on specific operational demands. Importantly, despite these challenges, the approach used here to move from the larger HA mission to a set of deconstructed tasks that can support planning factors is a valuable one that can be applied by MEU commanders and planners to assess the requirements of complex missions.

Table 3.1
Humanitarian Assistance Tasks, Subtasks, and Activities

Task	Subtasks and Activities
Mission planning	Reconnaissance Surveillance
Establishing command center	Insert a joint task force (JTF) and secure command center(s) Establish and secure communication lines Plan and direct intelligence and logistics
Road and area clearance	Clear transport routes of debris, IEDs Conduct essential infrastructure repairs
Establishing and securing sites for assistance provision	Clear areas for HA provision Assist in construction/repair of local facilities Transport supplies for Marine Corps operations
Providing assistance at central sites or with mobile units	Transport and distribute emergency food and other aid Provide critical medical care Transport supplies for Marine Corps operations Transport personnel for search and recovery operations or force protection
Restoring the provision of critical services	Assist in restoration of local utilities and services Assist in local infrastructure repair Transport supplies for Marine Corps operations
Transition to host-nation control	Transfer security functions and provision of basic services to local police Train local personnel

Linking Equipment to Tasks, Subtasks, and Activities

Once the tasks and activities were defined, each activity had to be linked to the appropriate metrics and pieces of equipment with required capabilities. In this section, we discuss the methods we used to accomplish this, and we highlight the difficulties associated with trying to link equipment to subtasks and activities.

Identifying the Appropriate Metrics

The first challenge was to identify the appropriate metrics for the equipment designated to support a given task. For example, to define planning factors for the task "Transport X personnel Y miles in Z hours," an analyst or planner would need to define the relevant metrics for the personnel transport task (in this case, personnel transported some distance per hour), identify all available vehicles capable of personnel transport, and define the specific capabilities of all relevant pieces of equipment. These pieces of information, taken together, allowed us to match the tasks to suitable equipment, develop planning factors, and choose the most effective alternative from the available pieces of equipment.

In the case of personnel transport, the metrics are fairly straightforward: the number of personnel transported and the distance traveled in a given period. For other tasks, the selection of proper metrics and the selection of relevant equipment and units may be more challenging. For example, it may be difficult to define the appropriate metrics for road clearance as a task, since the metrics may depend on whether clearance involves removing IEDs, fallen

trees, water, or large rocks. These challenges affect the metrics that we used and, ultimately, our planning factors because it may be difficult to match equipment to tasks with broadly defined metrics. While passenger capacity and speed are common metrics used to define truck capabilities, area cleared per hour or trees removed per hour are not commonly listed as technical specifications. Thus, these challenges affect the MESA output.

Equipment Selection

After specifying the appropriate metrics for each task, we used a list of equipment available to a MEU to match all military tasks with the equipment required for their effective completion.[1] We relied on equipment manuals that described in detail the capabilities of each piece of equipment, including its weight, speed, towing or hauling capacity, range, frequencies transmitted, and other details relevant to its use to explicitly define the capabilities of each item on the MEU loading list.[2] We then grouped the available equipment by type and matched these groups to specific military activities, essentially linking metrics with equipment capabilities.

The final step involved using task metrics and equipment capabilities, along with sponsor input, to define the planning factors. This choice was driven partly by necessity: The Marine Corps does not maintain a set of more rigorous planning factors that link equipment to subtasks. Measures of equipment capability are not traditional planning factors, but they do provide insight into the types of tasks a given piece of equipment may be able to perform and how its capabilities compare with those of other types of equipment. Ideally, we want to know exactly how many of each type of vehicle would be required to clear a roadway of a specific type of debris or which sets of engineering equipment could be used to assist in construction or drilling activities based on past MEU experience. We would like to have the capabilities of trucks defined not only in miles per hour and payload but also in terms of their contribution to road clearance or infrastructure repair tasks. Although Marine Corps commanders can make fairly accurate approximations of these capabilities, this information is not contained in existing manuals.

The estimated planning factors derived for this application are based on our mission deconstruction and careful analysis of equipment capacities. Furthermore, as discussed earlier, the planning factors may affect the MESA application output, but this does not alter the value of the approach. Once a mission has been deconstructed into subtasks, those subtasks must be linked to equipment with metrics that define how well that equipment completes the task, thereby producing planning factors.

Table 3.2 presents a sample of the planning factors associated with one task of the HA mission: "Develop an assistance plan." The metrics for reconnaissance and surveillance may include the area surveyed per hour or signals processed per minute, depending on the type of surveillance and the type of equipment. The metrics for route clearance might be area cleared per hour or obstacles removed per hour, depending on the context. Planning tables similar to Table 3.2 for each task in the HA mission can be found in Appendix B.

Once the tables linking task, subtask, and activities to equipment were created, the RAND research team hosted a workshop in RAND's offices in Arlington, Virginia. Marine Corps officers who had been involved in HA operations were invited to attend. They were

[1] Appendix A presents the complete equipment list with associated capabilities.

[2] If the equipment was not on the loading list provided by the sponsor, the number available was set to zero.

Table 3.2
Sample Planning Table

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Develop assistance plan	Reconnaissance	Range (distance traveled on one tank of gas)	E0947	Light armored vehicle (LAV-25A1)
			D1161	M1161 internally transportable vehicle
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
	Surveillance	Area surveyed per hour	ZUAVC	UAV ground control station
		Signals processed per minute	ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			A3232	Transportable TACSATCOM (AN/TSC-154)

NOTE: TAMCN = Table of Authorized Materiel Control Number. UAV = unmanned aerial vehicle. TACSATCOM = tactical satellite communication.

asked to use their expertise to assess whether we had properly defined HA mission tasks and had assigned the right pieces of equipment to each task. Their comments allowed us to define the tasks more precisely and to refine our assignment of equipment. For example, they alerted us to several pieces of equipment that were always allocated together (e.g., the UAV system), as well as to the fact that tanks and armored vehicles are often considered too threatening to be used in an HA mission.

Prioritizing Equipment Based on Contribution

The workshop also provided valuable input on the *prioritization* of equipment. Linking equipment to tasks and subtasks indicates which pieces of equipment *can* complete a given task, but it says nothing about which pieces of equipment will be *best* at accomplishing the task. Equipment prioritization is a valuable contribution of this report and the accompanying MESA application, particularly for mission planners facing potential resource constraints. A prioritized list ranks equipment based on how effectively it can complete a given task and identifies potential second- and third-tier substitutions between pieces of equipment as required by availability. Planning factors that include some sense of prioritization are valuable because they guide the allocation of equipment and provide the commander with some amount of flexibility when the first choice is not aboard or not available for other reasons.

Many factors can affect the prioritization of equipment. For example, security concerns can make certain pieces of equipment more effective than others in a given situation. As noted by our workshop participants, in HA missions, heavily armed vehicles may be perceived as threatening by the local population, giving them a lower rank than Humvees or medium tactical vehicle replacements (MTVRs). The terrain or weather may also affect vehicle prioritization, as will mission objectives and concerns. The choice of vehicle for personnel transport when speed is the top concern may be distinct from that chosen when remaining undetected is of highest importance.

Currently, the MESA application does not account for terrain or weather; it assumes ideal conditions. However, there is unused functionality in the application that would permit the user to specify terrain and weather conditions. These parameters would be passed to the equipment allocation routines in the form of varying demand for different equipment types. For example, a hot desert climate could increase the demand for air-cooling capacity.

As mentioned earlier, our prioritization of equipment was informed by the workshop panel. Officers participating in the panel drew on their own experiences to rank the equipment according to its ability to complete each task. We asked each participant to rank the equipment that we had linked with each task (including the pieces they had added to the groups) in the order that they would choose to use it, assuming that all types of equipment were available to them. Finally, participants provided input on the appropriateness of the metrics, capabilities, tasks, and activities that we had defined for the HA mission. Table 3.3 shows an example of what the resulting input might look like. In this case, the participant added the CH-53 helicopter and eliminated the AAV, ranking the remaining pieces of equipment.

Once we received and integrated the input from all workshop participants, we used a computer-based algorithm to assign an overall ranking to each piece of equipment. This technical process is described in more detail in Chapter Four. The prioritization and ranking itself is important because it defines the order in which pieces of equipment will be selected and used to complete mission tasks. For example, if a unit must conduct reconnaissance but no helicopters are available, then UAVs may be the next best option. Similar rankings among trucks used for cargo or personnel transport may also facilitate substitution between pieces of equipment, depending on availability.

The prioritized lists of equipment with their capabilities and metrics, attached to tasks, allowed us to state which pieces of equipment could accomplish which tasks and the order in which available equipment should be allocated. These planning factors formed the basis for the MESA application described in Chapter Four.

Relative Task Importance

Prioritization focuses on the best piece of equipment to accomplish a task. In addition to this feature, the MESA application is also able to respond to a user's assessment of the relative

Table 3.3
Humanitarian Assistance Tasks, Subtasks, and Activities

Task	Tasks and Subtasks	Equipment	Rank
Mission planning	Reconnaissance	UH-1	1
	Surveillance	CH-46	2
		UAV	3
		LAV	4
		AAV	X
		CH-53	2

NOTE: In this example, both the CH-46 and the CH-53 were considered equally capable of performing the reconnaissance and surveillance missions.

importance of the tasks that need to be accomplished. The most important tasks are usually the ones that get accomplished first and therefore are allocated the top-priority equipment available.

The user assigns relative importance to tasks when executing the tool. The method used for this calculation is the Analytic Hierarchy Process (AHP). AHP involves building a hierarchy (ranking) of decision elements and then making comparisons between each possible pair in each cluster (as a matrix). This gives a weighting for each element within a cluster (or level of the hierarchy) and a consistency ratio (useful for checking the consistency of the data).[3] We discuss the details of AHP in Chapter Four.

Fungibility and Equipment Packages

Unfortunately, the seemingly simple and straightforward linking of mission tasks and subtasks to equipment gets a bit more complex when it comes to substituting one piece of equipment with another and determining which pieces of equipment must be deployed together for a particular task. We refer to these two complementary issues as *fungibility* and *packaging*.

Fungibility

The use of planning factors to substitute between pieces of equipment with similar capabilities raises the issue of fungibility. A set of trucks may be more or less fungible. They may not always transport the same weight or number of personnel, but they can accomplish similar objectives and can replace one another in a pinch or in the case of heightened demand. However, trucks and radios are not fungible. If the MEU needs to send a radio communication for help, a truck is likely to be of little use. If the unit needs to transport personnel, the radio is unlikely to fulfill the requirement.

Where it exists, fungibility is useful because it allows commanders to complete missions and meet their responsibilities even when optimal equipment is not available. Clearly, not performing a critical task because the ideal equipment is not available is generally not an option for commanders. The prioritization of equipment and its integration into the MESA application ensures that the concept of fungibility is also incorporated, making trade-offs automatically or based on user-defined parameters.

Packaging

The second key consideration in our discussion thus far is equipment packages. While there may be certain tasks, such as personnel transport, that can be performed with a single type of equipment, other tasks, such as civil control operations, road clearance, and shelter construction, require several types of equipment functioning together to achieve a single goal. 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.

For route or area clearance, for example, a package might include (1) a truck with towing capacity, (2) demining equipment, (3) a truck with hauling capacity, and (4) barriers and barricades to provide security. Some equipment packages are required. For example, the UAV has

[3] The AHP model was designed by Thomas L. Saaty as a decisionmaking aid. See Thomas L. Saaty, *The Analytic Hierarchy Process*, New York: McGraw Hill, 1980.

three main pieces, and one piece would not be allocated without the others because all are required for it to function. Similarly, many combat operations centers must be allocated a truck able to transport them from the MEU to the command center (or from one location to another, in the case of a mobile command center).

As an alternative to predefined packages of equipment, planning can be a more iterative and user-driven process in which the user defines the packages that must be allocated to complete a specific task. Regardless of how the package is defined, what is important from a planning perspective is that task completion most often requires several pieces of equipment working together. Planners should, therefore, think about both substitution and complementarity when allocating equipment to tasks.

Final Planning Factors

A completed set of planning factors, then, incorporates many pieces of information. Each task and activity is linked with relevant metrics and the pieces of equipment that possess the required capabilities. The pieces of equipment themselves are prioritized based on their capabilities and other mission-specific factors to enable substitution and optimization. In addition, tasks can be ranked by relative importance, depending on how the user views them.

Each aspect of the planning factors is important to the development of the MESA application and helps link resource requirements with the tasks and activities of a given mission. Once the user specifies the necessary tasks and relevant external conditions (e.g., threat level, weather, terrain), the MESA application is able to develop a list of required equipment based on what is available. Although we tracked this process to completion only for the HA mission, it should be possible to conduct a similar exercise for each of the other 14 missions.

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 more than one mission. 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.

Finally, the MESA application does not produce an optimal solution for allocating equipment to tasks. The SRFA is able to optimally allocate units to missions, and it can also handle multiple missions. The MESA tool 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 performing it.

CHAPTER FOUR

The MAGTF Equipment Structural Assessment (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. The MESA application incorporates the deconstructed missions and task-specific planning factors developed as part of this research effort and produces as an output a notional set of equipment that could be used to complete a specific user-defined mission.

This chapter provides a general description of the application. A detailed user's manual can be found at Appendix C.

Overview

The MESA software consists of a series of tabs (depicted in Figure 4.1 and listed in Table 4.1) containing input fields that define a scenario. The user navigates through the tabs, filling in the fields as needed to define the mission and its component tasks, subtasks, and other characteristics. Once the user is satisfied with the mission parameters, the program will allocate equipment from the selected inventory and assign it to the individual tasks according to predetermined preferences. If the user decides that the results are worth saving for future reference and planning purposes, they can be exported to a Microsoft® Excel® spreadsheet. If there is insufficient equipment to complete a task, the application will display the percentage of each task that can be completed with the equipment available.

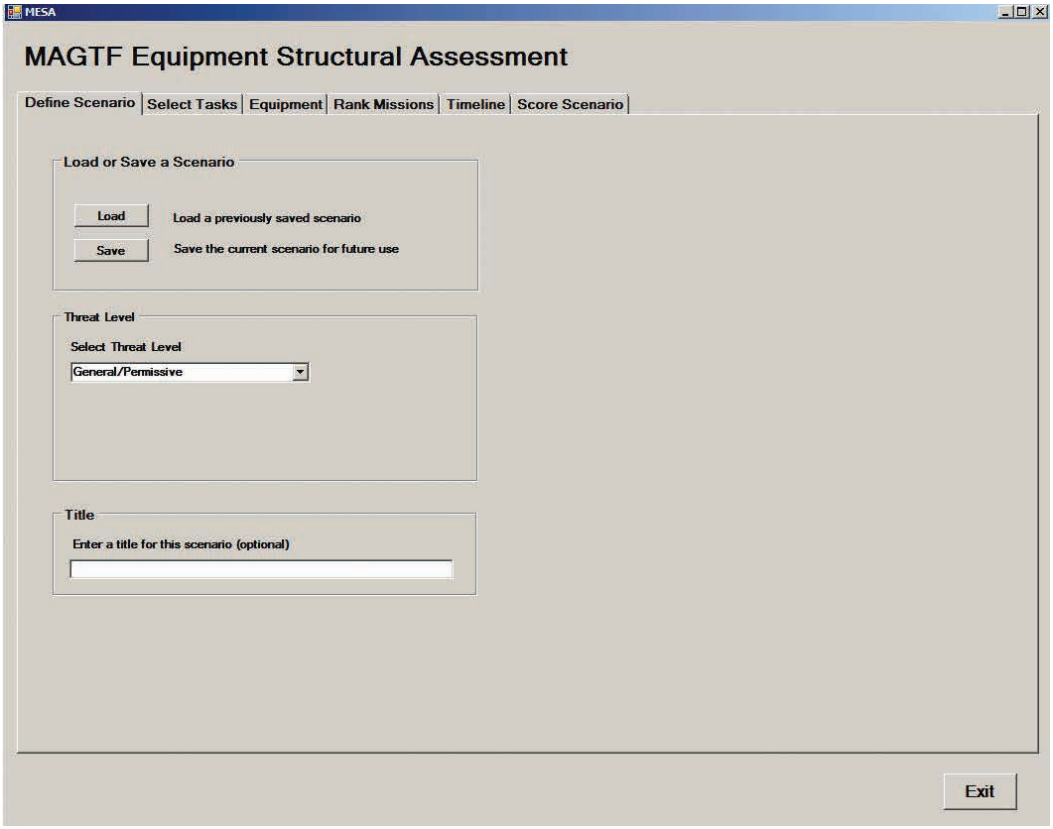
The application is designed so that much of its appearance (e.g., the input screens) and the data inputs (equipment definitions, inventories, and rankings of preferred equipment) can be configured by the user. The application is largely data-driven and configured via an Excel spreadsheet included on the accompanying CD. 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. However, there are some aspects of the functionality that cannot be modified without making changes to the underlying Microsoft Visual Basic® code. These points are noted in the user's manual in Appendix C.

Application Inputs

The MESA application assesses the equipment requirements of a given mission based on a number of user-defined inputs. The current prototype allows for only a single mission. Future

configurations will allow for multiple missions to accommodate situations in which a primary mission might be a combat mission, combined with a humanitarian mission. The following sections describe the inputs required. Appendix C uses examples to illustrate how these inputs are entered.

Figure 4.1
Main Screen of the MESA Application



RAND *TR1253-4.1*

Table 4.1
MESA Application 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.

Missions and Tasks

The user first determines the mission and the specific tasks required. At present, the only mission available is the HA mission. Examples of HA-related tasks are mission planning, establishing a command post, securing routes, providing perimeter defense, establishing locations for providing assistance, and so on. The HA tasks included in the MESA application match those identified in the mission deconstruction, described in Chapter Two.

In the MESA application, these tasks are laid out as a series of input screens where the user can specify the requirements of each task. Examples include the number of hours of aerial surveillance necessary for planning the mission, and the amount of supplies needing transportation. Within each task, the user can tailor the operational conditions, including variables such as the weather, the level of threat, and the existence of host-nation support. To enable further mission tailoring, the mission input screens are configured from a spreadsheet tab that can be modified by the user.

Prioritization

After determining the mission and tasks, the user must next prioritize these tasks based on their importance to the mission. The default is to treat each task equally, and if the user is satisfied with this prioritization, then no additional information need be provided. However, if one of the tasks is significantly more important than another—for example, if perimeter security is more important that the restoration of basic services—the user can specify this on the "Rank Tasks" screen. When a task is prioritized, its equipment needs will be filled first, before equipment is allocated to other tasks. This will be especially important when several tasks require similar or overlapping pieces of equipment.

Timelines

The MESA application also needs to know the start and end dates of each selected mission task and subtask. The default is for each task to start on day 1 and end on day 15.[1] If the user is satisfied with this timeline, nothing more need be done. However, if one task needs to start before another—for example, if mission planning needs to start before the command post is established—then the user can specify this on the "Timeline" tab (see Figure 4.1).

When a sequence is defined, tasks that are necessary first steps are resourced prior to subsequent ones. The implications of sequencing in terms of equipment requirements depend on whether the tasks are overlapping or must be performed in sequence, as well as on whether pieces of equipment can be used more than once. If a piece of equipment can be used several times, then sequencing may have minimal effects. However, if tasks overlap, or if each piece of equipment can be used only once, then tasks that occur early in the mission (or that have the highest priority) may be fully resourced while those at the end lack needed equipment or rely on substitutions.

Roster of Available Equipment

The MESA application allocates equipment to missions from a predetermined list. The equipment roster appears on the "Equipment" tab (see Figure 4.1), which currently includes approximately 75 pieces of noncombat equipment. These include surveillance assets, transportation

[1] The 15-day planning horizon can be adjusted as required. This figure was chosen based on input from Marine Corps personnel familiar with MEU HA missions.

equipment, communication equipment, mobile command posts, and so forth.[2] Each piece of equipment is accompanied by several metrics describing its capabilities, such as range, speed, or load capacity. These metrics are used to determine how many of a specific piece of equipment is required to perform each task in a mission. The selection of equipment and the definition of appropriate metrics were addressed in detail in Chapter Three.

Equipment Inventories

In concept, the MESA application is intended to evaluate mission success given limited inventories of equipment. To do this, it needs to have a *count*, or inventory, of each piece of available equipment. By default, the application uses a universe of available equipment that is based on a sample MEU equipment inventory. It also includes two additional inventories: a "no-aircraft" inventory, which has no fixed- or rotary-wing aircraft, and a "limited transport" inventory, with limited wheeled transport. These additional inventories represent constrained scenarios similar to those often faced by MEUs, with incomplete equipment rosters due to lift limitations or maintenance problems. Like other application inputs, the equipment inventories are included in the configuration spreadsheet. The user can easily modify the three existing inventories or develop and save additional inventories as necessary to reflect the prevailing logistical situation.

Hierarchies of Preferred Equipment

For each task, the MESA application allocates equipment based on a prioritized list of equipment deemed suitable to perform the task. The development of this list was described in Chapter Three. The application ranks the equipment based on input from Marine Corps officers with recent MEU command element experience, provided during the RAND-hosted workshop. The application uses these rankings and the available inventory to assign equipment to tasks. For example, if the task is surveillance, the list of equipment might be (1) UAV, (2) Osprey helicopter, and (3) Humvee. The MESA application would first look to see where there are any available UAV units; if so, it would allocate a UAV unit to the surveillance task. If none were available, the MESA application would go to the next choice on the list, the Osprey helicopter, and confirm whether any are available. The list can be adjusted as needed based on the operational conditions. The application currently has a list of preferred equipment for each task in the HA mission only. However, the user is not bound to these hierarchical lists and can easily change the equipment list on the configuration spreadsheet.

The Analytic Hierarchy Process

In addition to the inputs discussed here, the user is able to affect the allocation of equipment to tasks based on the relative importance of each of the tasks, as discussed in Chapter Three. In this section, we explain the AHP methodology in more detail; we illustrate its use in Appendix B.

Suppose that, for a given application, the user selects four tasks:

$$T = \{t_1, t_2, t_3, t_4\}.$$

[2] See Appendix B for a complete list of equipment, including capabilities, where applicable.

From this, we form a pairwise comparison matrix with the tasks as column and row headings:

$$\mathbf{A} = \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \\ t_4 \end{array} \begin{array}{c} \begin{array}{cccc} t_1 & t_2 & t_3 & t_4 \end{array} \\ \begin{pmatrix} 1 & a_{12} & a_{13} & a_{14} \\ 1/a_{12} & 1 & a_{23} & a_{24} \\ 1/a_{13} & 1/a_{23} & 1 & a_{34} \\ 1/a_{14} & 1/a_{24} & 1/a_{34} & 1 \end{pmatrix} \end{array}.$$

The entries in the matrix express the relative importance of task t_i over t_j. For example, if the user felt that task t_1 was three times as important to accomplishing the mission as task t_2, then the entry for a_{12} would be 3 and the entry for $1/a_{12}$ would be 1/3. The reciprocal reflects the fact that if t_1 is three times as important as task t_2, then task t_2 is only one-third as important as task t_1.

Although not strictly required, we suggest the following relative scoring scheme using a scale from 1 to 9:

- Set $a_{ij} = 1$ if the two tasks are equal in importance (the diagonal in the matrix).
- Set $a_{ij} = 3$ if task t_i is *weakly* more important than task t_j.
- Set $a_{ij} = 5$ if task t_i is *strongly* more important than task t_j.
- Set $a_{ij} = 7$ if task t_i is *very strongly* more important than task t_j.
- Set $a_{ij} = 9$ if task t_i is *absolutely* more important than task t_j.

At this point, an example will help illustrate the process. Assuming that the same four tasks are applicable, a user created the following comparison matrix:

$$\mathbf{A} = \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \\ t_4 \end{array} \begin{array}{c} \begin{array}{cccc} t_1 & t_2 & t_3 & t_4 \end{array} \\ \begin{pmatrix} 1 & 5 & 3 & 1 \\ 1/5 & 1 & 3 & 1 \\ 1/5 & 1/3 & 1 & 3 \\ 1 & 1 & 1/3 & 1 \end{pmatrix} \end{array}.$$

Note that the only relative ranking that the user designated as "strong" is between t_1 and t_2.

Before proceeding, we examine the matrix for consistency. For example, we note that the user rated t_2 more important than t_3 and at the same time rated t_3 as more important that t_4. This should mean that the user would rate t_2 as being more important than t_4. However, he or she considers the two to be equal in importance. Hence, this is an inconsistent ranking. This is not a serious problem in that there are likely to be several inconsistencies—especially as the number of tasks increases. It becomes a problem when the number of inconsistencies becomes very large.

Once the comparison matrix is complete, we normalize the columns of **A**—that is, we sum each column and then divide each entry by that sum. The result is that the sum of each column is 1.0. In the example, we get the following normed matrix:

$$\bar{\mathbf{A}} = \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \\ t_4 \end{array} \begin{array}{c} \begin{array}{cccc} t_1 & t_2 & t_3 & t_4 \end{array} \\ \begin{pmatrix} 0.395 & 0.682 & 0.409 & 0.167 \\ 0.079 & 0.136 & 0.409 & 0.167 \\ 0.131 & 0.046 & 0.136 & 0.500 \\ 0.395 & 0.136 & 0.046 & 0.167 \end{pmatrix} \end{array}.$$

Note that the columns all sum to 1.0. The bar over the **A** indicates that this is a matrix of column-normed weights.[3] The inconsistency in the original comparison matrix can be seen here. For a perfectly consistent matrix, the columns of the normalized comparison matrix would all be identical.

Finally, we compute the average values of each row to establish the final ranking, or importance measure. In this case, we get the following ranking vector, **R(M)**:

$$\mathbf{R}(\mathbf{M}) = \begin{bmatrix} R(t_1) \\ R(t_2) \\ R(t_3) \\ R(t_4) \end{bmatrix} = \begin{bmatrix} 0.413 \\ 0.198 \\ 0.203 \\ 0.186 \end{bmatrix}.$$

Clearly, task t_1 is considered the most important, with the other tasks fairly close to each other. Note that the sum of these rankings is 1.0 as well.

Finally, we address the problem of inconsistency mentioned earlier. The question is, "How do we determine whether our degree of inconsistency is so large as to require rethinking the relative importance assigned to the tasks?" The answer is to calculate the eigenvalues of the normed comparison matrix, $\bar{\mathbf{A}}$.[4] A purely consistent matrix has only one eigenvalue, and it is equal to the dimension of the matrix. In this example, we would get $\lambda = 4$. For an inconsistent matrix, we get n eigenvalues, where n is the dimension of the normed comparison matrix. In this case, we select the largest of the four, $\lambda_{\max}$. Now, we calculate the consistency index:

$$C = \frac{\lambda_{\max} - n}{n-1}$$

[3] Actually, the norm is just the sum of the column entries. This is also referred to as the *Manhattan norm*. By dividing each entry by its norm, we create a set of weights. There are several types of vector norms. The one we are most familiar with is the Euclidean norm. It is calculated by summing the square of each entry and extracting the square root of the sum, thereby producing a scalar, normally considered the "size of the vector." There are several good sources of further information on norms. See, for example, Richard L. Burden and J. Douglas Faires, *Numerical Analysis*, Boston, Mass.: Prindle, Weber, and Schmidt, 1978.

[4] The eigenvalues of a square matrix are calculated by solving its characteristic polynomial: $p(\lambda) = \det(\mathbf{A} - \lambda\mathbf{I}) = 0$, where "det" is the determinant operator and I is the identity matrix. For an $n \times n$ matrix, this results in an nth-order polynomial whose roots are the eigenvalues.

Note that if the comparison matrix is consistent, $\lambda_{max} = n = 3$ and the test consistency index is $C = 0$. In general, for inconsistent comparison matrices, $\lambda_{max} > n$. Consequently, for large values of C, the comparison matrix does not have sufficient consistency.

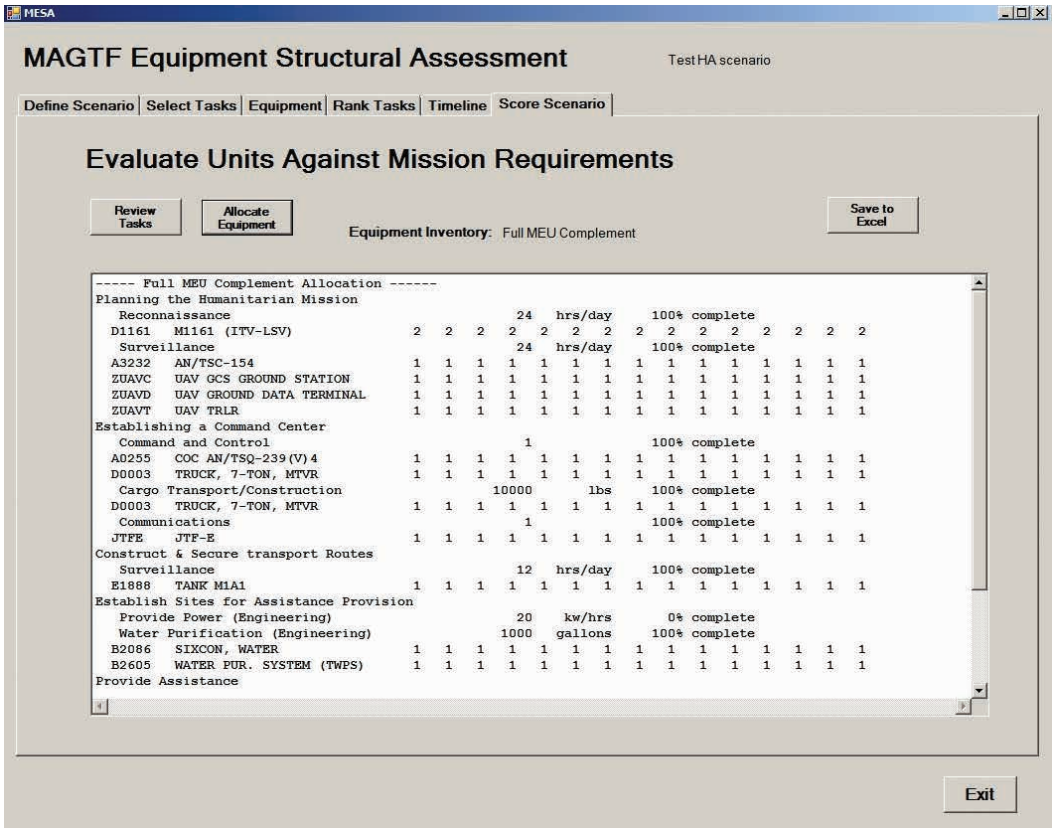
In the current version of the MESA application, the consistency test is not included. It will be included in the next version of the application.

Application Outputs

The MESA application output consists of a list of mission tasks (previously specified by the user); the day-by-day allocated equipment based on the prioritization of tasks, the task parameters, and the equipment inventory and ranking; and a percentage indicating what share of the task has been successfully completed (see Figure 4.2).

The day-by-day equipment allocation is created by cycling through the list of tasks and then comparing each task to the ranking of preferred equipment. If a preferred piece of equipment is available, it is allocated to the task; otherwise, the application moves down the list of equipment according to its ranking. Equipment is allocated until the task is completed. The application determines task completion by comparing the scope of the task as specified by the user (e.g., pounds of supplies to move, number of personnel to transport, kilowatt hours

Figure 4.2
Scenario Scoring Output Screen



RAND *TR1253-4.2*

of electricity to provide) to the appropriate metric for the selected piece of equipment. For example, if the user has specified that 24 hours of aerial surveillance is required each day, and the equipment list specifies that a UAV can provide 12 hours of surveillance per day, then the MESA tool will allocate two UAV units—if they are available.

The final piece of the output spreadsheet is a percentage indicating the share of the task that has been successfully completed with the existing equipment. This information is important to commanders and mission planners because it helps them understand how insufficient equipment will affect mission performance and how they may need to adjust the mission's goals, priority, or scope. Importantly, in some cases, the estimate of the percentage of the task completed can understate the extent to which the unit can complete the task in reality. While marines can think creatively and adapt equipment to meet their needs, there are limits to how many substitutions the MESA application will be able to make on its own.[5]

Once the user is satisfied with the scenario definition and the resulting equipment allocation determined by the MESA application, he or she can elect to save the output to an Excel spreadsheet for further manipulation.

Conclusion

The MESA application described in this chapter uses tasks from mission deconstruction, planning factors and prioritized equipment rankings based on equipment manuals and Marine Corps officer input, and user-defined parameters to estimate the equipment requirements of a given mission and to compare these requirements with available equipment inventories. The tool is still in prototype testing and will require further refinement. In the remainder of this chapter, we summarize the application's capabilities and current limitations.

Capabilities

Output from the MESA application informs planners and commanders about the types of equipment that are essential to mission completion, identifies likely equipment shortfalls, and can assist the commander in assessing the implications of equipment shortfalls on task completion and timeline. Planners and commanders can use this information to adjust mission plans or the equipment traditionally assigned to the MEU.

The application is extremely flexible: Not only does the user define the tasks involved and the operational conditions, but the user can also reconfigure equipment inventories and rankings as necessary or desired. This allows planners and commanders to experiment with different task and equipment specifications.

Limitations

The MESA application as currently configured is strictly a planning tool, and it models only generic MEU missions. Furthermore, the current version can handle only one mission at a time, and, for the prototype, this mission is humanitarian assistance. Such an application

[5] In addition to assessing the fraction of each task that the MEU is able to complete with the onboard equipment, it would be useful to also assess the fraction (percentage) of the overall mission that can be completed. This feature is not as yet included in the application. In addition, such a calculation might prove to be problematic in that not all tasks are equal in importance. We will address this issue in subsequent research.

cannot capture the full range of complexities and alternatives associated with a given MEU mission. As a result, the MESA application produces useful approximations and guidelines but requires additional human input and vetting to translate output into a viable operational plan.

The AHP method discussed earlier is used to assign relative importance to the tasks in a given mission. The method involves a pairwise comparison of tasks. Thus, if the number of tasks is large, the likelihood of an inconsistent ranking is high. There is an inconsistency check that can be applied, but it is not in this current version.

CHAPTER FIVE

Conclusion

The MESA application described in this report provides military planners and commanders with a means to estimate the equipment needed to complete a given set of tasks in a specific mission and to evaluate the sufficiency of available equipment. The tool can also be used to identify likely equipment shortfalls and possible equipment substitutions, as well as to assist commanders in determining the effects of these shortfalls on mission completion. Equipment shortfalls are unlikely to lead to mission failure, as MEU commanders will instead devise ways to use what they have to accomplish necessary tasks and activities. The MEU will also sometimes be able to rely on supplemental forces and equipment from nearby Navy ships or other MEUs. However, equipment shortfalls may still slow mission completion, compromise efficiency, or expose the MEU to additional risks.

The initial iteration of the MESA application focuses only on the HA mission, but the approach described in this report can easily be extended to other mission types. In fact, as it now stands, the MESA application incorporates a good deal of flexibility, allowing the user to specify parameters (such as weather, terrain, and threat level) and to select and prioritize certain mission tasks over others.

As a proof of concept, this report provides a systematic framework that can be used to deconstruct missions into their constituent tasks, identify environmental factors that may affect equipment requirements for specific tasks and activities, define relevant planning factors using task metrics and equipment capability, and allocate equipment to tasks based on these planning factors, in addition to equipment and task prioritization. The MESA tool also incorporates the AHP method, whereby users can specify which tasks are more important than others by constructing a pairwise comparison matrix. This approach allows significant room for user-driven modification that enhances the value of the tool for military planners and commanders.

The value of the MESA application is also clear within a broader analytic context. Military planners face a large number of challenges and choices when determining which pieces of equipment should go aboard a MEU and which should stay behind. The MESA application focuses on one specific piece of this challenge: ensuring that the equipment selected allows the MEU to complete a wide set of possible tasks. The application, with the appropriate data, can also provide commanders with some insight into the implications of shortfalls and allow them to conduct risk assessments that can be compared across several possible equipment allocations. Despite certain methodological limitations that place some constraints on the MESA output, the application and the approach presented in this report serve as planning and diagnostic tools that support and inform MEU commander decisions.

Lessons Learned

The processes of defining planning factors and developing the MESA application led to several observations about the requirements of reconstruction and stability operations and highlighted several issues that commanders and military planners should consider in preparing for future operations.

Common Tasks

The deconstruction of missions into their component pieces shows the significant overlap in the specific tasks and activities involved in the MEU's diverse mission set. Tasks such as creating a mission plan, road and area clearance, and setting up a command center occur in most missions, including those focused on stabilization and those that are combat-oriented. Subtasks and activities, including reconnaissance and surveillance, establishing communication lines, and force protection, are also common to many of the missions described in Chapter Two and Appendix A.

These commonalities are important to mission planning because they imply that there might also be similarities in the equipment requirements of a MEU's diverse missions. In other words, MEUs may be able to use similar sets of equipment to conduct assaults, raids, HA activities, and search and recovery operations. The MESA application assists commanders by identifying many of these possible substitutions and provides an approach that can be used, with the proper inputs, to define metrics and planning factors that can support comparisons of the utility of pieces of equipment across mission types. The MESA application also allows commanders to identify "packages" of equipment that must be allocated together for mission completion. Commanders and military planners should exploit the substitutability of equipment and the overlap in equipment requirements to maximize the readiness and flexibility of the deployed MEU.

Constrained Allocations

As in reality, the MESA application allows the set of equipment available to be constrained, facilitating planning under suboptimal conditions. The tool 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. Prior to a deployment, expected equipment shortfalls can be used to scale back mission objectives or to justify additional equipment allocations. During a deployment, however, commanders may be forced to rely more heavily on substitutions and nontraditional uses of equipment to perform high-priority tasks and activities. Importantly, even when alternative, suboptimal equipment allocations allow for task completion, equipment shortfalls may still have implications in terms of the time, resources, and manpower required to accomplish a specific objective. The metrics included in the MESA application allow commanders to quantify the potential effects of these substitutions, prioritize pieces of equipment based on how effectively they will complete a given task, and assess how fungible or replaceable a specific piece of equipment is under different conditions.

Situation-Dependent Allocations

The process of defining planning factors also underscores the important effect of operational conditions on the equipment requirements of any MEU mission. The level of operational threat, the specific tasks involved, the weather, and the terrain may all affect the types of equip-

ment best suited to a given mission. Military planners and commanders are well aware of the significant effect of external variables and the fact that no two operations are alike. The MESA application addresses this variation by allowing the user to prioritize specific tasks over others within a single mission. However, the equipment requirements defined by the MESA application are still based on simplified scenarios: Externals, such as weather, terrain, and threat level, are not considered. However, parameters may be added to account for these factors if they are considered relevant to the mission plan. For now, MESA is strictly a planning tool and therefore assumes a benign external environment. Military planners and commanders will still need to evaluate and tailor the prioritization of equipment and the output of the MESA application to support actual operations.

Equipment Prioritization

The MESA application also suggests some important observations about equipment prioritization. As noted in Chapter Three, our prioritization was based on a workshop with Marine Corps officers and their assessments of which pieces of equipment they would use to complete certain tasks. The MESA application makes use of this prioritization when allocating equipment. The highest-ranked piece of equipment is allocated first, but when this first choice is not available, the application makes substitutions suggested by the overall ranking of similar pieces of equipment that are able to complete the task.

This essentially simulates a commander's decisionmaking process and underscores the point that, when operating in a constrained environment, the ability to flexibly compare and substitute equipment based on availability is a significant advantage. This observation suggests that planners and commanders would benefit from developing at least an informal ranking or understanding of how different pieces of equipment perform on various common tasks, in both absolute and relative terms.

Task Sequencing and Prioritization

Another lesson that emerged from the development of the MESA application was the importance of task sequencing and prioritization. Task sequencing is important because it affects the order in which equipment is allocated and used and, potentially, which pieces of equipment are available at each point during mission execution. If tasks occur sequentially, equipment used in one task may be available in the next (assuming it does not break). However, if tasks overlap, then equipment required by multiple tasks may be available for only one activity, again forcing substitution and reallocation. Military planners and commanders may be able to maximize readiness and overcome equipment shortfalls by manipulating the timing and sequencing of the tasks and subtasks involved in a given military operation. This could involve reordering the tasks to prioritize certain ones over others, or staggering tasks rather than attempting to execute them concurrently. The MESA application allows users to define task sequencing and therefore to compare the effects of alternative task orders. Of course, in certain situations, commanders and planners may lack the flexibility to make these kinds of revisions.

Relative Task Importance

In some cases, task sequencing may be driven by prioritization. Within any mission, especially those that are complex, certain tasks may be more important than others. For example, in the HA mission, the distribution of essential food and water may take priority over road and infrastructure repairs. Where the two tasks rely on similar equipment, commanders may choose to

allocate that equipment to the provision of assistance first and conduct infrastructure repairs using whatever equipment remains, even if this means only partial task completion. Especially in constrained environments, prioritizing key tasks is one way that commanders can ensure that the most effective pieces of equipment are available to complete the most important mission objectives. The MESA application allows users to assign a ranking to specific tasks in a given mission and to explore how reprioritizing tasks and activities may affect overall mission completion or address the effects of equipment shortfalls.

Clearly, relative importance is situation-dependent; therefore, MESA users are prompted to assign relative importance to each of the tasks. As discussed in Chapter Four, the application uses the AHP framework to translate pairwise importance selections into a formal ranking system. In cases in which such rankings are not needed, the user may bypass this step.

Mission Nesting

A final lesson suggested by the MESA application and of mission deconstruction processes relates to the concept of 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 that must 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 it means that 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. For example, road and area clearance and the establishment of a communication infrastructure may need to be performed once in a given operational area, regardless of the number of separate missions being executed.

The HA mission is one mission type that could be affected by nesting. As described earlier, HA missions sometimes involve NEOs and SAR operations; both are more than "tasks" and will likely have their own mission plans, even when they occur in the context of a larger HA operation. As a result, the NEO and SAR missions could be described as nested within the HA mission. Although the three missions would have to share equipment, they could all make use of cleared roads, command center communication networks, and general stability and security established in the early phases of the HA effort.

Mission nesting may also require attention to prioritization in a manner similar to that described for task prioritization. In a constrained environment with several ongoing missions, commanders may be forced to determine which missions have the highest priority and should be allocated top-ranked equipment and which could be accomplished with a more limited commitment. Continuing the nested-mission example, if noncombat evacuation and HA missions do overlap, they will compete for vehicles: The NEO uses vehicles to transport personnel, and the HA mission uses them to transport supplies. Commanders would need to determine the relative importance of the two tasks, and this importance would then guide equipment allocation.

Currently, the MESA application includes NEOs and SAR as tasks within the HA mission. A next step for the tool 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.

Next Steps and Challenges

The MESA application described in this report currently 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.
- A second challenge concerns sequencing the tasks and assigning relative importance at the task level versus 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. This would provide higher-quality inputs to the MESA application, making the outputs more realistic. 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, providing information on performance and time to completion.

Finally, better documentation of the specific tasks that must be performed in a given mission, along with better ways of capturing the experiences of past MEU commanders, will also provide better data on unexpected equipment substitutions and much-needed performance data from real-world situations.

APPENDIX A

Equipment Capabilities and Mission Deconstruction

This appendix records the equipment capabilities used in the MESA application, as discussed in this report, and it deconstructs each of the remaining 14 missions to supplement the sample deconstruction of the HA mission presented in Chapter Two. Tables A.1–A.6 present the lists of equipment and associated capabilities developed in consultation with U.S. Marine Corps officers at the August 2011 workshop held in RAND's offices in Arlington, Virginia. The list is divided by equipment type. The last category captures the equipment for which no capabilities were listed. In many cases, the use of these items is binary: They are needed or they are not needed.

Table A.1
Equipment Capabilities: Air Conditioners and Heaters

TAMCN	Equipment	BTUs/hour (heat)	BTUs/hour (cool)
B0001	Air conditioner, Marine Corps standard, horizontal, 60Hz	7,000	9,000
B0004	Air conditioner, Marine Corps standard, horizontal, 400Hz, 1.5-ton	12,000	18,000
B0003	Air conditioner, 1.5-ton	13,400	18,000
B0006	Air conditioner, Marine Corps standard, vertical, 400Hz, 3-ton	28,600	37,800
B0014	Air conditioner, 3-ton	36,000	36,000

Table A.2
Equipment Capabilities: Generators

TAMCN	Equipment	kW
B0980	Generator set, diesel engine	2
B0018	Integrated trailer-environmental control unit-generator (ITEG)	22

Table A.3
Equipment Capabilities: Water and Fuel Tanks

TAMCN	Equipment	Capacity (gallons)
D0882	Trailer, MTVR, water, MK149	600
B2085	Six-container fuel storage tank module	900
B2086	Six-container water storage tank module	900
B2605	Tactical water purification system	6,000

Table A.4
Equipment Capabilities, Radios

TAMCN	Equipment	Range (km)
A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)	30
A1955	Radio terminal set, AN/MRC-142A (UHF)	35

Table A.5
Equipment Capabilities: Vehicles, Aircraft, and Seacraft

TAMCN	Equipment	Passengers	Capacity (lbs)	Speed (MPH, land)	Speed (MPH, water)	Range (km)
D0030	Truck, utility, expanded capacity, armament carrier, M1151A1, with B1 armor kit	0	1,800	0	0	0
D0840	Trailer, internally transportable vechicle, ammunition (ITV-AT)	0	1,800	0	0	0
D0032	Truck, utility, expanded capacity, TOW carrier, armored, M1167	0	1,850	0	0	0
D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)	0	2,000	0	0	0
D0016	Trailer, cargo (LTT-H)	0	2,740	0	0	0
E1888	Tank, combat, full-tracked, 120-mm gun, M1A1	0	2,800	62.2	6.5	280
A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)	0	3,025	0	0	0
A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	0	3,025	0	0	0
D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)	0	3,025	0	0	0
D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit	0	3,340	0	0	0
E0948	Light armored vehicle—logistics (LAV-L)	0	4,000	62.2	6.5	437.5
C7033	Shop equipment, contact maintenance, common #20	0	4,500	0	0	0

Table A.5—Continued

TAMCN	Equipment	Passengers	Capacity (lbs)	Speed (MPH, land)	Speed (MPH, water)	Range (km)
D0081	Trailer, general purpose, 4-ton, MK353	0	8,000	0	0	0
D0862	Trailer, MTVR, cargo, MK105	0	8,000	0	0	0
B2561	Extendable boom forklift truck	0	10,000	0	0	0
E0950	Light armored vehicle—maintenance/recovery (LAV-RA1)	0	15,000	62.2	6.5	437.5
B0039	Airfield damage repair kit	0	17,100	0	0	0
D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1	0	23,200	0	0	0
B0060	Medium crawler tractor	0	35,000	0	0	0
D0015	Truck, wrecker, 7-ton, armored, AMK36	0	48,800	0	0	0
E1378	Recovery vehicle, heavy, full-tracked, M88A2	0	140,000	0	0	0
D1002	Truck, ambulance, 2-litter, soft top, M1035	2	4,200	0	0	0
D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)	3	2,000	0	0	0
D1158	Truck, utility, cargo/troop carrier, M998 (HUMVEE)	4	0	0	0	0
D1001	Truck, ambulance, 4-litter, M997	4	2,530	0	0	0
E0947	Light armored vehicle—light assault (LAV-25A1)	6	0	62.2	6.5	400
E0946	Light armored vehicle—command and control (LAV-C2A1)	6	2,220	62.2	6.5	400
UH1	UH-1 Venom	8	3,880	0	0	380
E0796	Assault amphibious vehicle, command, AAVC7A1	9	0	45	8.2	200
E0858	Expeditionary fighting vehicle (CMND)	11	0	0	0	0
D0003	Truck, 7-ton, armored, MTVR	14	24,400	0	0	0
RIB	Rigid inflatable boat	16	0	0	40	300
E0857	Expeditionary fighting vehicle (PERS)	17	0	0	0	0
MV22	MV-22 Osprey	24	20,000	0	0	325
E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)	25	0	45	8.2	200
CH46	CH-46 Sea Knight	25	7,000	0	0	0
E0856	Assault amphibian vehicle, recovery (AAVR7A1)	25	30,000	45	8.2	200
CH53	CH-53 Sea Stallion	30	8,000	0	0	220

Table A.6
Equipment Capabilities: Other

TAMCN	Equipment
A0067	AN/MRC-148 (HF/VHF)
A0499	Digital technical control facility, AN/TSQ-227
A0966	Mobile electronic warfare support system, AN/MLQ-36B
A1957	Radio set, AN/MRC-145A (VHF)
AV8	Harrier
B0063	Tractor, rubber-tired, articulated steering, multipurpose
B0953	Generator set, diesel engine MEP-805A, 30 kW
B1298	Mine clearance system, trailer-mounted, MK2, modification 0
B2464	Tractor, full-tracked with multipurpose bucket
B2482	Tractor, all wheel drive with attachments
B2685	Welding machine, arc, trailer-mounted
CMOC	Civil-military operations center, battalion capability set 1
D0886	Truck, cargo, 22.5-ton, 10x10, (LVSR)
D1063	MTVR, MK37 (MK27 with crane)
E0996	Blade, mine-clearing, track-width mine plow, main battle tank, M1A1
JTFE	Joint Task Force Enabler
MK38	Jump command post, MK38/48
MPC3	Man-portable command, control, and communication system
SWAN	Support Wide Area Network (SWAN)/SWE-DISH (portable satellite Internet terminal)
TENTS	General-purpose tents
ZUAVC	UAV ground control station
ZUAVD	UAV ground data terminal
ZUAVT	UAV trailer

NOTE: No capabilities were listed for the "other" category.

Table A.7 summarizes the deconstruction of the 14 missions and offers some insight into the critical equipment required for each mission. Assessments about required equipment are based on the nature of the mission's tasks and subtasks, as well as more general information about the mission type from joint publications and relevant service guidance. As we did for the HA mission, we discuss each mission in a generic context, leaving some ambiguity in the definition of tasks and subtasks. These deconstructed missions could be used to build planning factors for additional missions by applying the approach described for the HA mission in Chapter Two.

Table A.7
Deconstructed Missions

Mission Type	Description	Tasks	Critical Required Equipment
Amphibious raid	Short-duration, small-scale deliberate attacks from the sea, involving a swift penetration of hostile or denied battlespace	Mission planning Embarkation Movement to operational area Assault, raid, withdrawal	Communications Armored/amphibious vehicles Wire fencing Area clearance equipment
Amphibious assault	Attack launched from the sea by naval and landing forces, embarked in ships or craft involving a landing on a hostile shore	Mission planning Embarkation Movement to operational area Assault	Communications Armored/amphibious vehicles Wire fencing Area clearance equipment
Maritime interdiction operations (MIO)	Operations to intercept commercial, private, or other nonmilitary vessels and conduct visit, board, search, and seizure activities	Mission planning Establish command position Secure area of operations Secure, board, search ship Escort ship to port	Aircraft Communications Containers Diving equipment, ropes
Advance force operations	Operations to shape the battlespace in preparation for the main assault, including reconnaissance, seizure of supporting positions, minesweeping, underwater demolitions, and air support	Mission planning Establish command center Advance ISR Preparation of battlespace Neutralize high-value targets	Aircraft UAV Humvees Communications Armored/amphibious vehicles
Noncombatant evacuation operations (NEO)	Evacuation of noncombatants from countries when their lives are endangered by civil unrest or natural disaster to safe havens or to the United States	Mission planning Establish command center Secure evacuation sites Force protection Civil control Personnel transport Evacuation	Aircraft MTVRs, Humvees Armored/amphibious vehicles Communications Wire fencing Area clearance equipment
Stability operations	Operations that encompass various military missions, tasks, and activities conducted outside the United States in coordination with other instruments of national power to maintain or reestablish a safe and secure environment, provide essential government services, emergency infrastructure reconstruction, and humanitarian relief	Mission planning Establish command center Establish civil security Provide emergency HA Repair essential infrastructure Encourage economic stabilization Reestablish local governance	Aircraft MTVRs, Humvees, trucks Armored/amphibious vehicles Communications Wire fencing Area clearance equipment

Table A.7—Continued

Mission Type	Description	Tasks	Critical Required Equipment
Humanitarian assistance (HA) operations	Operations that respond to manmade and natural disasters and include tasks such as providing personnel and supplies and a mobile, flexible, rapidly responsive medical capability for acute medical care	Mission planning Establish command center(s) Clear and secure roads Secure aid provision sites Provide emergency assistance Restore provision of essential services Transition to host-nation control	Aircraft MTVRs, Humvees, trucks Armored/amphibious vehicles Communications Wire fencing Area clearance equipment
Tactical recovery of aircraft and personnel (TRAP)	An operation conducted to locate and extract distressed personnel and sensitive equipment from enemy-controlled areas during wartime or contingency operations to prevent capture	Mission planning Establish command center(s) Clear and secure routes Reach and secure recovery site Recover personnel, aircraft Extract personnel, equipment	Aircraft Humvees Armored/amphibious vehicles Communications Area/route clearance medical supplies
Joint and combined operations	Operations that include two or more military departments, are commanded by a joint force commander with a joint staff, and incorporate military forces from two or more nations	Command and control Intelligence Fires Movement and maneuver Protection Sustainment	Aircraft, UAVs Humvees, trucks Armored/amphibious vehicles Communications Wire fencing Area clearance equipment
Aviation operations from expeditionary shore-based sites	Marine aviation units operate from expeditionary shore-based sites (in line with unit/platform capabilities), including forward operating bases, expeditionary airfields, forward arming and refueling points, austere forward operating sites, tactical landing zones, and helicopter landing zones	Mission planning Establish command center Preparation and coordination Air reconnaissance Air support operations Assault support	Aircraft Communications Vehicles for ground support

Table A.7—Continued

Mission Type	Description	Tasks	Critical Required Equipment
Support for theater security cooperation (TSC)	Bilateral and multilateral military noncombat activities conducted with allies and other potential partners to build partner capacity and support interoperability and cooperation with U.S. forces	Mission planning Establish command center(s) Counternarcotics operations Counterproliferation operations Provide emergency HA Joint training Security force assistance Armaments and intelligence cooperation IMET, mil-to-mil contacts Arms transfers	Aircraft, UAVs Trucks, Humvees, MTVRs Armored/amphibious vehicles Communications Weapons Area/route clearance Wire fencing Hazmat equipment
Direct-action (DA) operations	Strikes and small-scale offensive actions conducted as special operations in hostile, denied, or politically sensitive areas using specialized military capabilities	Mission planning Establish command center Raid, ambush infiltration Withdrawal	Aircraft, UAVs Humvees Armored/amphibious vehicles Communications Area clearance equipment
Port/airfield seizure operations	Offensive operations to occupy or defend airfields or ports for use by friendly forces	Mission planning Establish command center Seize target Secure target	Aircraft, UAVs Humvees Armored/amphibious vehicles Area clearance equipment
Special reconnaissance[a]	Reconnaissance and surveillance actions conducted as special operations in hostile, denied, or politically sensitive areas to collect information of strategic or operational value	Mission planning Establish command center Covert movement to target Collection of intelligence Force protection Extraction	Aircraft, UAVs Humvees Armored/amphibious vehicles Communications Area clearance equipment
Foreign internal defense (FID)[a]	Participation by civilian and military agencies in any program undertaken by another government or other designated organization to free and protect society from subversion, lawlessness, and insurgency	Mission planning Establish command center Provision of security assistance Civil-military activities Restore local control	Aircraft Trucks, Humvees, MTVRs Armored/amphibious vehicles Communications Weapons

SOURCES: Definitions from OPNAV Instruction 3500.38B, 2007, MCTL 2.0 (September 1, 2010); Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012); and Joint Publication 3-0 (U.S. Joint Chiefs of Staff, 2011).

[a] Definition from Marine Corps Order 3120.9C, *Policy for Marine Expeditionary Units (MEU) and Marine Expeditionary Units (Special Operations Capable) MEU(SOC)*, August 4, 2009, p. 6.

Amphibious Raid and Amphibious Assault

Employed to move forces and equipment from the sea to the shore in support of the ground portion of an operation, amphibious assault is one of the most fundamental Marine Corps missions.[1] In addition to being a mission in its own right, amphibious assault is one of the first phases of many other operations, including conducting reconnaissance, seizing ports or airfields, recovery of personnel or equipment, and even establishing sites for humanitarian aid provision. The amphibious landing is the core task of both amphibious assaults and raids. Amphibious assault serves as the first stage in a larger mission that may involve significant ground activities. In contrast, an amphibious raid typically involves an initial assault, a short-duration ground operation, and a more rapid amphibious withdrawal—essentially, an assault executed in reverse. Importantly, it is also an independent mission type, as listed in Table A.7.

Amphibious assault involves an initial phase in which the beach landing site is prepared for the main force by an advance team or simply through preparatory naval or air fires. This phase is used to eliminate initial threats and ensure the safety of the landing force. Next, the main force comes ashore, often with continued air or naval support that is particularly important in hostile environments. The landing and disembarkation phase of the assault involves not only unloading personnel but also moving essential equipment from land to shore. The amphibious landing may require offensive and defensive operations by the landing force to eliminate enemy forces at or around the landing site. Force protection operations may also be required to set up a secure perimeter that allows the transition to follow-on operations or to neutralize adversary or environmental threats to the force. The amphibious raid or assault will be shaped by many of the same parameters defined for the other tasks. For example, the level of external threat and the status of existing infrastructure define the extent of force protection and clearance operations required, as well as the intensity of potential offensive operations. The mission will also be shaped by the numbers of personnel and the types of equipment required for the ground operation. Environmental characteristics, such as the weather or terrain, may also be important in shaping the landing plan and determining the required equipment.

The equipment involved in an amphibious assault includes amphibious and other types of vehicles for personnel and cargo or equipment transport, armored vehicles for force protection operations, demining and clearance equipment (if necessary), and communication equipment, including navigation and data processing systems. However, the nature and extent of follow-on missions may play a large role in shaping equipment demands. A small advance force carrying out a quick direct-action operation may require a single amphibious vehicle and minimal communication equipment, while a large force involved in HA operations will need many different types of vehicles and supplies.

Maritime Interdiction Operations

MIOs are defined as "efforts to monitor, query, and board merchant vessels in international waters to enforce sanctions against other nations such as those in support of United Nations Security Council Resolutions and/or prevent the transport of restricted goods."[2] They may

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[1] This section draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and Joint Publication 3-02 (U.S. Joint Chiefs of Staff, 2009b).

[2] Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012). The definition has changed over the years, as has the terminology. Joint doctrine now refers to MIOs as *maritime interception operations*. In this report, we retain the terminology in use at the time of this research and incorporated in the current iteration of the MESA application, though we refer here to the

include counternarcotics or countersmuggling activities, as well as efforts to stop piracy or seaborne terrorist attacks. The MIO begins with mission planning. The mission plan, in this case, may identify target ships to be stopped and searched, the expected threat level, areas to be covered in a blockade, or specific types of cargo that are of high interest. The command center for the MIO is likely to be located remotely—on a Marine Corps vessel or amphibious craft.

The interdiction will involve three key tasks. First, the area of operations needs to be secured. In the case of a blockade, securing the area of operations amounts to setting the boundary for the operation, the line at which advancing ships will be stopped. In the case of a board-and-search operation, securing the area of operations means establishing positions from which the target ship can be boarded. The next step is securing, boarding, and searching ships, both to seize smuggled or illegal goods and to prevent prohibited items from passing through the blockade. During this phase, Marine Corps personnel inspect and document the cargo on the ship, seize contraband, make necessary arrests or detentions (i.e., in alien migration scenarios), and interview important crew members. The interdiction operation may conclude with marines escorting the target vessel to the nearest port, especially if the ship is found to have contraband or to be involved in illegal transport. Once the ship reaches port, however, the operation is likely to be turned over to the local police or law enforcement. Factors such as the type of cargo, level of threat from the target vessel, and the number of ships to be secured will significantly affect how the interdiction operation unfolds.

Advance Force Operations

Advance force operations prepare an area for more substantial force maneuvers.[3] They involve reconnaissance, seizure of supporting positions, mine countermeasures, preliminary bombardment, underwater demolitions, and air support.

The advance force operation mission begins with planning and the establishment of a command center, both shaped by the nature and objective of follow-on operations, the level of external threat, and environmental factors. The command center is likely to be small and used by reconnaissance teams as a hub or rendezvous point. The primary task of the advance force operation is to prepare for the main assault or landing collecting specific intelligence and eliminating adversary threats. Advance force operations will also involve more specific activities to prepare the landing areas and transport routes, such as eliminating IEDs, removing obstacles and clearing assembly areas, and neutralizing adversary resistance in the form of weapons or personnel. Finally, shaping operations, including the development of fire support, evacuation, and tactical deception plans, along with psychological operations, may be employed to create a local context that supports operational goals.

Noncombatant Evacuation Operations

According to Joint Publication 3-68, a NEO is a mission

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current definition for clarity. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); Marine Corps Order 3120.9C, 2009; and OPNAV Instruction 3500.38B, 2007.

[3] U.S. Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Landing Force Operations*, Joint Publication 3-02.1, Washington, D.C., May 11, 2004. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); Marine Corps Order 3120.9C, 2009; and OPNAV Instruction 3500.38B, 2007.

> conducted to assist the Department of State (DoS) in evacuating U.S. citizens, Department of Defense (DoD) civilian personnel, and designated host nation (HN) and third country nationals whose lives are in danger from locations in a foreign nation to an appropriate safe haven. Although normally considered in connection with hostile action, evacuation may also be conducted in anticipation of, or in response to, any natural or manmade disaster.[4]

The NEO mission begins with the development of a mission plan that identifies the number of people to evacuate, the medical and other critical needs of these individuals, the level of operational threat, the status of existing infrastructure, and the presence of host-nation support. These same factors may also affect the establishment of the NEO command center (or centers).

The first step in the NEO is to secure transport routes and evacuation sites with a level of security that matches the external threat. The core of the NEO is the transport, processing, and evacuation of noncombatant personnel. NEO evacuations may include some emergency provision of food, water, shelter, and other comforts to evacuees while they await extraction. In hostile situations, force protection operations may be necessary.

Stability Operations

According to joint doctrine,

> Stability Operations encompass various military missions, tasks, and activities conducted outside the United States in coordination with other instruments of national power to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief.[5]

Stability operations involve mission planning and establishing a command center, both in accordance with the level of the external threat, its location, the types of activities required, the presence of local support or coalition forces, the status of current economic and political systems, and the weather and terrain associated with the area of operation. There may be multiple large or small command centers. There are likely to be several command centers if the mission involves many different activities and covers a large area. The main tasks of the stability operation mission will be to establish and maintain basic law and order and to provide physical security for the local population. This may involve enforcing a cease-fire, assisting in disarmament or demobilization, aiding local security forces, and supporting border security. Intelligence, psychological, and information operations are often part of stability operations. Such missions may occur alongside many other missions, such as HA, FID, and noncombatant evacuations.

Tactical Recovery of Aircraft and Personnel

According to Marine Corps Task 6.2.1, a TRAP mission "is performed for the specific purpose of the recovery of personnel, equipment, and/or aircraft. A TRAP is conducted to locate and

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[4] U.S. Joint Chiefs of Staff, 2007a, p. I-1.

[5] Joint Publication 3-0 (U.S. Joint Chiefs of Staff, 2011c). This section also draws on Joint Publication 3-24 (U.S. Joint Chiefs of Staff, 2010a), Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b), and OPNAV Instruction 3500.38B, 2007.

extract distressed personnel and sensitive equipment from enemy controlled area during wartime or contingency operations to prevent capture."[6]

The TRAP mission begins with the planning and the creation of the command center. The mission plan will define the threat level, the number of personnel or pieces of equipment to recover, and environmental factors, such as the status of existing infrastructure, the terrain, and support from local forces, that may affect mission execution. The TRAP command center is likely to be located remotely. The primary task of the mission is to recover and extract personnel or equipment on board or ejected from fallen aircraft. The insertion or TRAP team may engage in air or ground operations. Clearance operations to eliminate mines and other threats may be required once the team is on the ground and as it moves toward isolated personnel and equipment. Once the TRAP team reaches the rescue site, it will begin force protection and civil control operations, perform maintenance or disassembly operations on equipment, and provide medical care to personnel. The mission concludes with the extraction of personnel and equipment. The TRAP mission is supported by intelligence and surveillance, psychological operations, and force protection.

Joint and Combined Operations

Joint and combined operations are undertaken in conjunction with other services (Army, Navy, Air Force) or with partner countries (combined operations).[7] Joint and combined operations are involved in many of the missions already described here, including HA, FID, NEOs, security cooperation, and stability operations.

Joint and combined operations involve some unique challenges and have a fairly specific set of tasks, which are in joint publications. Joint and combined command and control involves establishing a joint or multinational command center able to support the joint operation, preparing plans and orders that define lines of responsibility, assessing the threat, integrating forces from each service or nation, and identifying the procedures for sharing information. Joint and combined intelligence operations involve collecting, analyzing, and disseminating ground intelligence, human intelligence, and aerial intelligence collected by UAVs, satellites, partner nations, and other sources into a single product that informs ongoing operations. Joint and combined fires operations include aerial, ground, or naval activities and involve selecting targets, providing oversight and logistics support, destroying enemy aircraft and missiles, interdicting enemy capabilities, executing information operations and other strategic effects, and conducting postoperation assessments.

Joint and combined movement and maneuver operations involve deploying or moving joint and combined forces by land, air, or sea; eliminating obstacles, such as IEDs and other threats; conducting defensive operations as needed to delay the movement of enemy forces; holding strategically important territory; and conducting direct-action and special reconnaissance missions to support ongoing operations.

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[6] Marine Corps Order 3120.9C, 2009, Marine Corps Task 6.2.1. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and Joint Publication 3-0 (U.S. Joint Chiefs of Staff, 2011).

[7] This section draws on Joint Publication 3-0 (U.S. Joint Chiefs of Staff, 2011c); Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); Marine Corps Order 3120.9C, 2009; and OPNAV Instruction 3500.38B, 2007.

Joint and combined protection operations focus on conserving the joint force's fighting potential with active and passive defensive measures that protect both personnel and information, as well as on establishing the systems needed to respond to emergencies and recover personnel. Finally, joint and combined sustainment operations involve activities executed to ensure the health, safety, and sustainment of joint and combined forces, including human resource support, religious and ministry operations, financial management, legal support, establishing and maintaining sustainment bases, and the provision of food, water, medical supplies, arms, and equipment.

Aviation Operations from Expeditionary Shore-Based Sites

Marine aviation units maintain the capability to operate from expeditionary shore-based sites (in line with unit/platform capabilities), including forward operating bases, expeditionary airfields, forward arming and refueling points, austere forward operating sites, tactical landing zones, and helicopter landing zones.[8]

Aviation operations begin with mission planning and the establishment of the command center. The mission plan must take into account the level of operational threat, the types of aviation operations required, and associated missions. The command center is likely to support both aviation operations and the larger missions that they support. Aviation operations are used mainly to conduct air reconnaissance; to offer logistical support to ground forces; to transport equipment, supplies, and personnel; and to evacuate deployed forces, injured personnel, and noncombatants. In addition to support functions, aviation operations also include anti-air and interdiction operations to protect air space and enforce no-fly zones. They may also involve active and passive defense, as well as offensive operations or strikes against adversary targets. Finally, aviation operations often provide support for assault operations, either for battlefield illumination or for the transport, delivery, and evacuation of deployed forces, personnel, noncombatants, and equipment.

Support for Theater Security Cooperation

The *DoD Dictionary of Military and Associated Terms* defines security cooperation as including

> all Department of Defense interactions with foreign defense establishments to build defense relationships that promote specific US security interests, develop allied and friendly military capabilities for self-defense and multinational operations, and provide US forces with peacetime and contingency access to a host nation.[9]

Security cooperation missions can include a range of activities, from HA to joint training exercises, counternarcotics operations, and military exchanges for officers of foreign nations.

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[8] Marine Corps Order 3120.9C, 2009, Marine Corps Task 1.3.3.3.2. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; and Headquarters, U.S. Marine Corps, *Aviation Operations*, Marine Corps Warfighting Publication 3-2, Washington, D.C., May 9, 2000.

[9] Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012). This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); Marine Corps Order 3120.9C, 2009; OPNAV Instruction 3500.38B, 2007; Gregory J. Dyekman, *Security Cooperation: A Key to the Challenges of the 21st Century*, Carlisle, Pa.: Strategic Studies Institute, U.S. Army War College, November 2007; Headquarters, U.S. Department of the Army, *Multiservice Tactics, Techniques, and Procedures for NBC Protection*, Field Manual 3-11.4, Washington, D.C., June 2003; U.S. Joint Chiefs of Staff, *Public Affairs*, Joint Publication 3-61, Washington, D.C., August 25, 2010b; and U.S. Joint Chiefs of Staff, *Peace Operations*, Joint Publication 3-07.3, Washington, D.C., October 17, 2007b.

These missions begin with a mission plan that outlines the key goals, the types of activities involved, the threat level, the level of support provided by local forces, and the status of existing infrastructure. The command center for security cooperation is likely to be a combined one with members of the host nation integrated with the U.S. team. Depending on the number of activities involved and their locations, there may be multiple command centers.

Security cooperation operations include many tasks and activities, the common thread being that they involve U.S. military personnel working alongside, assisting, and training personnel from the host nation or nations. The most straightforward forms include joint military training and exercises in which U.S. and foreign militaries train together to improve interoperability and prepare for potential or future international security challenges. Activities may include international military education and training (IMET), in which foreign military officers travel to the United States to attend education and training programs, along with financial assistance to support training in partner nations and to finance weapons purchases.[10] Other activities focus on improving interoperability for future operations, such as armament cooperation and intelligence-sharing. Security cooperation can also involve direct interaction between U.S. forces and the local population, such as through HA and public affairs efforts.

Finally, there are security cooperation activities in which U.S. personnel work with foreign militaries to address an international security challenge. Counternarcotic or counterdrug operations include activities to detect, interdict, or eliminate any cultivation, processing, transport, or sale of illegal drugs. Counter- and nonproliferation activities include interdiction; offensive operations or passive or active defensive operations to eliminate threats posed by weapons of mass destruction, to disrupt the transfer of such technologies, or to minimize the effects of an attack; security operations to ensure the safety of chemical, biological, radiological, nuclear, and high-yield explosive facilities; and consequence management to conduct decontamination and provide medical care when needed.[11]

Direct-Action Operations

Direct-action operations include short-duration strikes and other small-scale offensive actions using special operations tactics, often in hostile, denied, or politically sensitive environments. Direct-action operations employ specialized military capabilities to seize, destroy, capture, exploit, recover, or damage designated targets.[12]

Like other missions, direct-action operations involve planning and setting up a command center. The mission plan will define the specific mission objective and identify the environmental conditions, the level of threat, status of internal infrastructure, presence of local support, and type of operations supported. Most of these types of operations require only short-term deployments, so the command center is likely to be small and located remotely. Direct-action operations include recovery of personnel or materiel, emplacing mines or munitions, direct raids, and strikes on adversary targets. They are also likely to be covert and involve some risk

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[10] See Defense Security Cooperation Agency, "International Military Education and Training (IMET)," web page, undated. For additional information about financial assistance programs, see Defense Security Cooperation Agency, "Warsaw Initiative Fund Guidance," memorandum, DCSA 05-18, August 12, 2005.

[11] Field Manual 3-11.4 (Headquarters, U.S. Department of the Army, 2003).

[12] Joint Publication 1-02 (U.S. Joint Chiefs of Staff, 2012). This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); Marine Corps Order 3120.9C, 2009; OPNAV Instruction 3500.38B, 2007; and U.S. Joint Chiefs of Staff, *Special Operations*, Joint Publication 3-05, Washington, D.C., April 18, 2011a.

of hostile interaction with adversary forces, as well as preparatory fires, force protection, and neutralizing chemical, biological, radiological, nuclear, and high-yield explosive threats.[13]

Airfield/Port Seizure Operations

The airfield/port seizure mission is described in Marine Corps Order 3120.9C as follows:

> Secure an airfield, port or other key facilities in order to support Marine Air Ground Task Force (MAGTF) missions, receive follow-on forces or enable the introduction of follow-on forces.[14]

Airfield/port seizure begins with mission planning and the establishment of a command center. The mission plan will define the specific objective, the mode of transport, local conditions, operational environment, weather, terrain, and the threat level. The command center may be remotely based if the operation is an amphibious one in hostile territory or forward deployed if the operation relies on ground forces.

The core task is the actual seizure of a key facility (in this case, an airfield or port). The mission begins with the covert movement of a forward-deployed team to the site by air, land, or sea. The seizure will likely require offensive and force protection operations to eliminate adversary targets, gain control of key assets, and secure key access points. The seizure operation itself will also be affected by the area or number of facilities that must be secured, the size of the local population, the need for civil control operations, and the number of insurgents or adversary forces. Once seized, the airfield or port can be used for additional operations.

Special Reconnaissance

Special reconnaissance is defined by Marine Corps Order 3120.9C as follows:

> Reconnaissance and surveillance conducted as a special operation in hostile, denied, or politically sensitive environments to collect or verify information of strategic or operational significance, employing military capabilities not normally found in conventional forces. These actions provide an additive capability for commander and supplement other conventional reconnaissance and surveillance actions.[15]

Special reconnaissance is used primarily to gather detailed intelligence on a specific target area in the lead-up to a raid, assault, or targeted strike. The special reconnaissance mission begins with a planning phase that is informed by the mission objective, the conditions on the ground, the operational environment, and the threat level. Since special reconnaissance missions typically involve short-term deployments—often into hostile areas—the command center will most likely be remotely based and responsible for intelligence operations and secure communication.

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[13] OPNAV Instruction 3500.38B, 2007.

[14] Marine Corps Order 3120.9C, 2009. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b) and OPNAV Instruction 3500.38B, 2007.

[15] Marine Corps Order 3120.9C, 2009. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b) and OPNAV Instruction 3500.38B, 2007.

The core of the special reconnaissance mission involves intelligence collection. However, the mission also involves unconventional tactics in hostile environments and the short-term deployment of covert teams with specific intelligence-collection objectives.

Foreign Internal Defense

FID missions are defined by Marine Corps Order 3120.9C as follows:

> Participation by civilian and military agencies of a government in any of the action programs taken by another government or other designated organization to free and protect its society from subversion, lawlessness and insurgency.[16]

The FID operation begins with mission planning and the establishment of a command center (or centers), along with activities shaped by the operational environment, the extent and type of assistance needed, the contribution of partner nations, and the capabilities of the host nation. Activities such as communication, intelligence, and logistics support will be performed through the command center. Many FID operations and their command centers are joint or have support from partner nations. The core of the FID mission is the provision of security assistance to the host nation—for example, training for local security and law enforcement organizations or more direct involvement in security operations to protect key local assets (e.g., government buildings, police stations).

The extent of the security assistance needed will depend on the external threat and the baseline capabilities of the host-nation security forces. FID operations promote rule of law and often require civil control, force protection, and law enforcement operations, such as arrests and detentions. FID missions may also include civil-military operations, such as humanitarian assistance, repairing local infrastructure, public affairs, and psychological operations.

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[16] Marine Corps Order 3120.9C, 2009. This section also draws on Navy/Marine Corps Manual 3500.44 (Headquarters, U.S. Marine Corps, 2008b); OPNAV Instruction 3500.38B, 2007; Joint Publication 3-0 (U.S. Joint Chiefs of Staff, 2011c); and U.S. Joint Chiefs of Staff, *Foreign Internal Defense*, Joint Publication 3-22, Washington, D.C., July 12, 2010a.

APPENDIX B

Planning Factors

This appendix presents the detailed planning factors used to support the MESA application for the HA model. This format was used to record the inputs from the workshop held in RAND's offices in Arlington, Virginia, on August 4, 2011. The resulting spreadsheets were used to prepare the planning factors for input into the MESA application.

Tables B.1–B.7 show the content of the Excel spreadsheets included as tabs in a single file. In this case, for the HA mission, there are seven tasks. As we proceed with the development of the MESA application, the planning factors for each of the 15 missions will be recorded in a single file.

Table B.1
Develop a Mission Plan

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Develop assistance plan	Reconnaissance	Range (distance traveled on one tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			ZAV8B	AV-8 Harrier
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
			ZUH1Y	UH-1 Iroquois
			ZCH53E	CH-53 Sea Stallion
	Surveillance	Range (distance traveled in × hours/days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal

Table B.1—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Develop assistance plan (continued)	Surveillance	Range (distance traveled in × hours/days)	ZUAVT	UAV trailer
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier
			ZCH53E	CH-53 Sea Stallion
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
Evaluate potential transport routes	Reconnaissance	Area surveyed/hour; miles surveyed/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
			ZAV8B	AV-8 Harrier
				Skids
			ZCH53E	CH-53 Sea Stallion
			ZCH46E	CH-46 Sea Knight
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor ready, M1152A1 with B2 armor kit
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D1063	Medium tactical vehicle replacement, MK37 (MK27 with crane)
			ZUH1Y	UH-1 Iroquois
	Surveillance	Area surveyed/hour; frequencies transmitted	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)

Table B.1—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Evaluate potential transport routes (continued)	Surveillance	Area surveyed/hour; frequencies transmitted	A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			ZAV8B	AV-8 Harrier
				Skids
			ZCH53E	CH-53 Sea Stallion
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
			ZUH1Y	UH-1 Iroquois

Table B.2
Establish Command Center(s)

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Insert a forward command element and a JTF	Provide shelter	Number of people sheltered		
	Command and control	Operations supported	A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
			E0796	Assault amphibious vehicle, command, AAVC7A1
			A0254	Civil-military operations center, battalion capability set 1
			A9100	Man-portable command, control, and communication system
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor ready, M1152A1 with B2 armor kit
	Personnel transport	Number of personnel transported/hour	E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle–light assault (LAV-25A1)
			A0246	Support Wide Area Network (SWAN)/SWE-DISH (portable satellite Internet terminal)
			ZCH53E	CH-53 Sea Stallion
				Rigid inflatable boat
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
Establish lines of communication	Construction; cargo transport	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Establish lines of communication (continued)	Construction Cargo transport	Cargo lifted or transported (lbs)	D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo 22.5-ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity, rough-terrain truck forklift, 5,070 lbs
			B2685	Welding machine, arc, trailer-mounted
	Construction; cargo transport	Cargo lifted or transported (lbs)	ZCH53E	CH-53 Sea Stallion
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight
	Area clearance (engineering)	Area cleared/hour	B0060	Medium crawler tractor
			B0063	Tractor, rubber-tired, articulated steering, multipurpose
			B2464	Tractor, full-tracked with multipurpose bucket
			E0996	Blade, mine clearing, track-width mine plow, main battle tank, M1A1
			B2482	Tractor, all-wheel drive with attachments
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B1298	Mine clearance system, trailer-mounted, MK2, modification 0
			E1888	Tank, combat, full-tracked, 120-mm gun, M1A1

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Establish lines of communication (continued)	Communication	Frequency transmitted data types supported; operations supported	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A0499	Digital technical control facility, AN/TSQ-227
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			A0067	AN/MRC-148 (HF/VHF)
			E0796	Assault amphibious vehicle, command, AAVC7A1
			A0814A	Joint Task Force Enabler
			A0246	Support Wide Area Network/SWE-DISH (satellite Internet terminal)
Conduct defensive operations	Personnel transport	Number of personnel transported/hour	E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			E0856	Assault amphibian vehicle, recovery (AAVR7A1)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
	Cargo transport; construction engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct defensive operations (continued)	Cargo transport; construction engineering	Cargo lifted or transported (lbs)	D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo 22.5 ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity, rough-terrain truck forklift, 5,070 lbs
			ZCH53E	CH-53 Sea Stallion
	Area clearance (engineering)	Area cleared/hour	B0039	Airfield damage repair kit
			B0060	Medium crawler tractor
			B0063	Tractor, rubber-tired, articulated steering, multipurpose
			B2464	Tractor, full-tracked with multipurpose bucket
			E0996	Blade, mine clearing, track-width mine plow, main battle tank, M1A1
			B2482	Tractor, all-wheel drive with attachments
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5070 lbs
			B1298	Mine clearance system, trailer-mounted, MK2, modification 0
Plan and direct intelligence and information operations	Reconnaissance	Range (distance traveled on one tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0857	Expeditionary fighting vehicle (PERS)
			E0858	Expeditionary fighting vehicle (CMND)

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Plan and direct intelligence and information operations (continued)	Reconnaissance	Range (distance traveled on one tank of gas)	E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCH53E	CH-53 Sea Stallion
				Skids
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZAV8B	AV-8 Harrier
			ZUH1Y	UH-1 Iroquois
	Surveillance	Range (distance traveled in × hours/days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Plan and direct intelligence and information operations (continued)	Command and control	Operations supported	A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
			A0499	Digital technical control facility, AN/TSQ-227
			A0966	Mobile electronic warfare support system, AN/MLQ-36B
			E0846	Light armored vehicle—command and control (LAV-C2A1)
			E0947	Assault amphibian vehicle, command (AAVC7A1)
			E0948	Light armored vehicle—logistics (LAV-L)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZUH1Y	UH-1 Iroquois
Plan and direct logistics operations	Cargo transport	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0030	Truck, utility, expanded capacity, armament carrier, M1151A1, with B1 armor kit
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0840	Trailer, internally transportable vehicle ammunition (ITV-AT)
			D0862	Trailer, MTVR, cargo, MK105
			D0886	Truck, cargo, 22.5-ton, 10x10, (LVSR)
			B2085	Six-container fuel storage tank module

Table B.2—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Plan and direct logistics operations (continued)	Cargo transport	Cargo lifted or transported (lbs)	B2086	Six-container water storage tank module
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZCH53E	CH-53 Sea Stallion
			A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
	Command and control	Operations supported	A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
			A0499	Digital technical control facility, AN/TSQ-227
			A0966	Mobile electronic warfare support system, AN/MLQ-36B
			E0846	Light armored vehicle—command and control (LAV-C2A1)
			E0947	Assault amphibian vehicle, command (AAVC7A1)
			E0948	Light armored vehicle—logistics (LAV-L)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZUH1Y	UH-1 Iroquois

Table B.3
Construct and/or Secure Transport Routes

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Repair and clear roads	Cargo transport; construction engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo, 22.5-ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			ZCH53E	CH-53 Sea Stallion
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
	Area clearance (engineering)	Area cleared/hour	B0039	Airfield damage repair kit
			B0060	Medium crawler tractor
			B0063	Tractor, rubber-tired, articulated steering, multipurpose
			B2464	Tractor, full-tracked with multi-purpose bucket
			E0996	Blade, mine clearing, track-width mine plow, main battle tank, M1A1

Table B.3—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Repair and clear roads (continued)	Area clearance (engineering)	Area cleared/hour	B2482	Tractor, all-wheel drive with attachments
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B1298	Mine clearance system, trailer-mounted, MK2, modification 0
			E1888	Tank, combat, full-tracked, 120-mm gun, M1A1
Secure transport routes	Personnel transport; civil control; defensive operations	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCH53E	CH-53 Sea Stallion
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
	Reconnaissance	Range (distance traveled on a tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
				Assault support aircraft (MV-22, C-130)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZUH1Y	UH-1 Iroquois

Table B.3—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Secure transport routes (continued)	Reconnaissance	Range (distance traveled on a tank of gas)	ZCH53E	CH-53 Sea Stallion
			ZCH46E	CH-46 Sea Knight
			ZAV8B	AV-8 Harrier
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
	Surveillance	Range (distance traveled in × hours/ days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			E1888	Tank, combat, full-tracked, 120-mm gun, M1A1
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion

Table B.4
Establish and Secure Sites for HA Provision

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Establish assistance provision facilities	Cargo transport; construction engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo 22.5-ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B2685	Welding machine, arc, trailer-mounted
			ZCK130J	C-130 Hercules
			ZCH53E	CH-53 Sea Stallion
			ZMV22B	MV-22 Osprey
	Area clearance (engineering)	Area cleared/hour	B0039	Airfield damage repair kit
			B0060	Medium crawler tractor
			B0063	Tractor, rubber-tired, articulated steering, multipurpose (TRAM)

Table B.4—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Establish assistance provision facilities (continued)			B2464	Tractor, full-tracked with multipurpose bucket
			E0996	Blade, mine clearing, track-width mine plow, main battle tank, M1A1
			B2482	Tractor, all-wheel drive with attachments
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B1298	Mine clearance system, trailer-mounted, MK2, modification 0
			E1888	Tank, combat, full-tracked, 120-mm gun, M1A1
	Provide power (engineering)	kWh	B0953	Generator set, diesel engine, MEP 805A, 30 kW
			B0980	Generator set, diesel engine
			B0018	Integrated trailer-environmental control unit-generator (ITEG)
	Water purification (engineering)	Gallons purified/hour	B2086	Six-container water storage tank module
			B2605	Tactical water purification system
	Communication	Frequency transmitted; data types supported; operations supported	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A0499	Digital technical control facility, AN/TSQ-227
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			A0067	AN/MRC-148 (HF/VHF)
			E0796	Assault amphibian vehicle, command (AAVC7A1)
			A0246	Support Wide Area Network (SWAN)/SWE-DISH (portable satellite Internet terminal)/SWE-DISH (portable satellite Internet terminal)
			A0814A	Joint Task Force Enabler

Table B.4—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Transport needed supplies	Cargo transport	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0030	Truck, utility, expanded capacity, armament carrier, M1151A1, with B1 armor kit
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0840	Trailer, internally transportable vehicle ammunition (ITV-AT)
			D0862	Trailer, MTVR, cargo, MK105
			D0886	Truck, cargo 22.5-ton, 10x10 (LVSR)
			B2085	Six-container fuel storage tank module
			B2086	Six-container water storage tank module
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
	Personnel Transport	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)

Table B.4—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Transport needed supplies (continued)	Personnel Transport	Number of personnel transported/hour	ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
Secure assistance site	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
				Air frames
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
				Skids
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
	Reconnaissance	Range (distance traveled on a tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit

Table B.4—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Secure assistance site (continued)	Reconnaissance	Range (distance traveled on a tank of gas)	ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
	Surveillance	Range (distance traveled in × hours/ days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion

Table B.5
Provide Assistance at Central Sites or with Mobile Units

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Transport and process evacuees	Personnel transport	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
				Assault support aircraft (MV-22, C-130)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
			ZUH1Y	UH-1 Iroquois
	Provide shelter	Number of people sheltered		
Provide medical care	Personnel transport	Number of casualties transported and treated	D1001	Truck, ambulance, 4-litter, M997
			D1002	Truck, ambulance, 2-litter, soft top, M1035
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			ZMV22B	MV-22 Osprey
			ZCK130J	C-130 Hercules
			D0003	Transport for personnel with non-life-threatening injury

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Provide medical care (continued)	Personnel transport	Number of casualties transported and treated	D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
			ZUH1Y	UH-1 Iroquois
	Provide shelter	Number of people sheltered		General-purpose tents
Provide food and water	Provide food	Number of people fed		
	Water purification (engineering)	Gallons purified/hour	B2086	Six-container water storage tank module
			B2605	Tactical water purification system
Conduct NEOs	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
			ZUH1Y	UH-1 Iroquois
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCK130J	C-130 Hercules
	Reconnaissance	Range (distance traveled on a tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct NEOs (continued)	Reconnaissance	Range (distance traveled on a tank of gas)	D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZAV8B	AV-8 Harrier
				Skids
			ZCH53E	CH-53 Sea Stallion
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
	Surveillance	Range (distance traveled in × hours/ days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
	Communication	Frequency transmitted; data types supported; operations supported	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct NEOs (continued)	Communication	Frequency transmitted; data types supported; operations supported	A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A0499	Digital technical control facility, AN/TSQ-227
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			A0067	AN/MRC-148 (HF/VHF)
			E0796	Assault amphibian vehicle, command (AAVC7A1)
	Command and control	Number of operations supported	A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
			A0499	Digital technical control facility, AN/TSQ-227
			A0966	Mobile electronic warfare support system, AN/MLQ-36B
			E0946	Light armored vehicle—command and control (LAV-C2A1)
			E0796	Assault amphibian vehicle, command (AAVC7A1)
			D0033	Prime mover for A0255
			A0254	Civil-military operations center, battalion capability set 1
Conduct SAR operations	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
				Small boats
			ZCH53E	CH-53 Sea Stallion
			ZCH46E	CH-46 Sea Knight
			ZUH1Y	UH-1 Iroquois

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct SAR operations (continued)	Command and control	Number of operations supported	A0255	Combat operations center, tactical command system, AN/TSQ-239(V)4 (battalion/squadron)
			A0499	Digital technical control facility, AN/TSQ-227
			A0966	Mobile electronic warfare support system, AN/MLQ-36B
			E0946	Light armored vehicle—command and control (LAV-C2A1)
			E0796	Assault amphibian vehicle, command (AAVC7A1)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			A0067	Jump command post, MK38/48
			A0254	Civil-military operations center, battalion capability set 1
			A1957	MRC-145
	Communication	Frequency transmitted; data types supported; operations supported	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A0499	Digital technical control facility, AN/TSQ-227
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			A0067	AN/MRC-148 (HF/VHF)
			E0796	Assault amphibian vehicle, command (AAVC7A1)
			A0246	Support Wide Area Network (SWAN)/SWE-DISH (portable satellite Internet terminal)
	Reconnaissance	Range (distance traveled on a tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct SAR operations (continued)	Reconnaissance	Range (distance traveled on a tank of gas)	E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP/armor-ready, M1152A1 with B2 armor kit
			ZUH1Y	UH-1 Iroquois
			ZAV8B	AV-8 Harrier
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
	Provide medical care	Number of patients treated	D1001	Truck, ambulance, 4-litter, M997
			D1002	Truck, ambulance, 2-litter, soft top, M1035
			D1063	MTVR, MK37 (MK27 with crane)
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
			ZUH1Y	UH-1 Iroquois
	Equipment maintenance	Vehicles repaired in × hours	E0856	Assault amphibian vehicle, recovery (AAVR7A1)
			E0950	Light armored vehicle—maintenance/recovery (LAV-RA1)
			E1378	Recovery vehicle, heavy, full-tracked, M88A2
			C7033	Shop equipment, contact maintenance, common #20
	Surveillance	Range (distance traveled in × hours/days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Conduct SAR operations (continued)	Surveillance	Range (distance traveled in × hours/ days)	A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZUH1Y	UH-1 Iroquois
				Skids
			ZAV8B	AV-8 Harrier
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion
Provide sanitation	Cargo transport; engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0030	Truck, utility, expanded capacity, armament carrier, M1151A1, with B1 armor kit
			D0033	Truck, utility, expanded capacity, enhanced, IAP/armor-ready, M1152A1 with B2 armor kit

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Provide sanitation (continued)	Cargo transport; engineering	Cargo lifted or transported (lbs)	D0081	Trailer, general-purpose, 4-ton, MK353
			D0840	Trailer, internally transportable vehicle ammunition (ITV-AT)
			D0862	Trailer, MTVR, cargo, MK105
			D0886	Truck, cargo 22.5-ton, 10x10, (LVSR)
			B2085	Six-container fuel storage tank module
			B2086	Six-container water storage tank module
			B2561	extendable boom forklift truck
			D1063	MTVR, MK37 (MK27 with crane)
Provide electricity	Provide power (engineering)	kWh	B0953	Generator set, diesel engine MEP-805A, 30 kW
			B0980	Generator set, diesel engine
			B0018	Integrated trailer-environmental control unit-generator (ITEG)
Support personal comfort	Air purification (engineering)	BTUs	B0001	Air conditioner, Marine Corps standard, horizontal, 60Hz, 9,000 BTUs
			B0003	Air conditioner, 1.5-ton, 18,000 BTUs/hour
			B0004	Air conditioner, Marine Corps standard, horizontal, 400Hz, 1.5-ton
			B0006	Air conditioner, Marine Corps standard, vertical, 400Hz, 3-ton
			B0014	Air conditioner, 3-ton, 36,000 BTUs/hour
Secure assistance provision site	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCH46E	CH-46 Sea Knight

Table B.5—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Secure assistance provision site (continued)	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	ZCH53E	CH-53 Sea Stallion
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)

Table B.6
Restore Provision of Basic Services

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Restore power	Cargo transport; engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo, 22.5-ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B2685	Welding machine, arc, trailer-mounted
			ZMV22B	MV-22 Osprey
			ZCH53E	CH-53 Sea Stallion
			ZCH46E	CH-46 Sea Knight
			ZCK130J	C-130 Hercules
	Provide power (engineering)	kWh	B0953	Generator set, diesel engine, MEP-805A, 30 kW
			B0980	Generator set, diesel engine
			B0018	Integrated trailer-environmental control unit-generator (ITEG)

Table B.6—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Restore power (continued)	Cargo transport; engineering	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0032	Truck, utility, expanded capacity, TOW carrier, armored, M1167
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0840	Trailer, internally transportable vehicle ammunition (ITV-AT)
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo, 22.5-ton, 10x10 (LVSR)
			B2685	Welding machine, arc, trailer-mounted
			ZCK130J	C-130 Hercules
				Tactical water purification system
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight
			ZCH53E	CH-53 Sea Stallion

Table B.6—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Restore power (continued)	Water purification (engineering)	Gallons purified/hour	B2086	Six-container water storage tank module
			B2605	Tactical water purification system
				Host nation
				External open-market/import
Rebuild local infrastructure (including roads, building, and police stations)	Cargo transport; engineering; construction	Cargo lifted or transported (lbs)	D0003	Truck, cargo, 7-ton, armored, without winch, AMK23/AMK23A1
			D0007	Truck, dump, 7-ton, armored, without winch, AMK29/AMK29A1
			D0015	Truck, wrecker, 7-ton, armored, AMK36
			D0016	Trailer, cargo (LTT-H)
			D0017	Light tactical trailer, Marine Corps chassis (LTT-MCC)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0081	Trailer, general purpose, 4-ton, MK353
			D0862	Trailer, MTVR, cargo, MK105
			D0882	Trailer, MTVR, water, MK149
			D0886	Truck, cargo, 22.5-ton, 10x10 (LVSR)
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B2685	Welding machine, arc, trailer-mounted
			ZMV22B	MV-22 Osprey
			ZCH46E	CH-46 Sea Knight

Table B.6—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Rebuild local infrastructure (including roads, building, and police stations) (continued)	Cargo transport; engineering; construction	Cargo lifted or transported (lbs)	ZCH53E	CH-53 Sea Stallion
			ZCK130J	C-130 Hercules
	Area clearance (engineering)	Area cleared/hour	B0039	Airfield damage repair kit
			B0060	Medium crawler tractor
			B0063	Tractor, rubber-tired, articulated steering, multipurpose
			B2464	Tractor, full tracked with multipurpose bucket
			E0996	Blade, mine clearing, track-width mine plow, main battle tank, M1A1
			B2482	Tractor, all-wheel drive with attachments
			B2561	Extendable boom forklift truck
			B2566	Light-capacity rough-terrain truck forklift, 5,070 lbs
			B1298	Mine clearance system, trailer-mounted, MK2, modification 0
			E1888	Tank, combat, full-tracked, 120-mm gun, M1A1
Provide security at key local buildings	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			ZCH53E	CH-53 Sea Stallion
			ZMV22B	MV-22 Osprey
			ZCK130J	C-130 Hercules

Table B.6—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Provide security at key local buildings (continued)	Reconnaissance	Range (distance traveled per tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor ready, M1152A1 with B2 armor kit
			ZMV22B	MV-22 Osprey
			ZCK130J	C-130 Hercules
				Skids
	Surveillance	Range (distance traveled in × hours/ days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station
			ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit

Table B.7
Transition to Host-Nation Control

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Support elections	Personnel transport; civil control; perimeter security	Number of personnel transported/hour	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			D1158	Truck, utility, cargo/troop carrier, M998 (Humvee)
	Reconnaissance	Range (distance traveled on a tank of gas)	D1161	M1161 internally transportable vehicle, light strike variant (ITV-LSV)
			D1162	M1162 internally transportable vehicle, prime mover–weapon (PM-W)
			E0846	Assault amphibian vehicle, personnel carrier (AAVP7A1)
			E0947	Light armored vehicle—light assault (LAV-25A1)
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit
			ZCK130J	C-130 Hercules
			ZMV22B	MV-22 Osprey
	Surveillance	Range (distance traveled in × hours/days)	A1954	Radio terminal set, AN/MRC142B, digital wideband transmission system (UHF)
			A1955	Radio terminal set, AN/MRC-142A (UHF)
			A1957	Radio set, AN/MRC-145A (VHF)
			A3232	Transportable tactical satellite communication system (TACSATCOM), Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154
			ZUAVC	UAV ground control station

Table B.7—Continued

Subtask	Supporting Activity	Performance Metrics and Capabilities	TAMCN	Equipment
Support elections (continued)	Surveillance	Range (distance traveled in × hours/ days)	ZUAVD	UAV ground data terminal
			ZUAVT	UAV trailer
			D0033	Truck, utility, expanded capacity, enhanced, IAP (integrated armor package)/armor-ready, M1152A1 with B2 armor kit

APPENDIX C

MESA User's Guide

This guide is designed to assist the user in developing a scenario involving a humanitarian assistance (HA) mission using the RAND-developed Marine Air-Ground Task Force (MAGTF) Equipment Structural Assessment (MESA). The mission may be tailored to accommodate the specific requirements of the proposed scenario. The sequencing of tasks can be specified, if applicable; the MESA software allocates equipment on board the Marine Expeditionary Unit (MEU) to accomplish the specified tasks. The application software CD is included in a pocket attached to the back cover of printed copies of this report. The application also accompanies the online version of this report as a separate downloadable file at http://www.rand.org/pubs/technical_reports/TR1253.html.

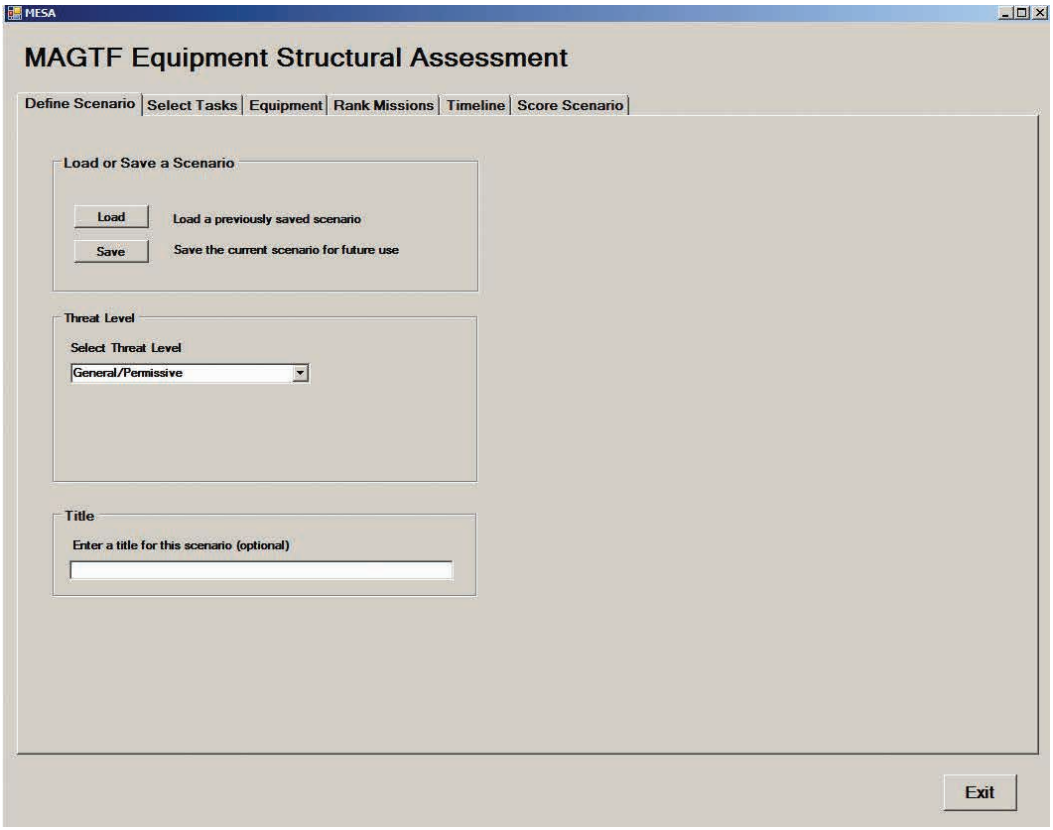
Overview

The MESA software consists of a series of tabs (depicted in Figure C.1 and listed in Table C.1) containing input fields that define a scenario. The user navigates through the tabs, filling in the fields as appropriate to define the mission and its component tasks, subtasks, and other characteristics. Once the user is satisfied with the mission parameters, the program will allocate equipment from the selected inventory and assign it to the individual tasks according to predetermined preferences. If the user decides that the results are worth saving for future reference and planning purposes, he or she can export them to a Microsoft® Excel® spreadsheet.

Table C.1
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.

Figure C.1
Main Screen of the MESA Application



RAND *TR1253-C.1*

Installation and Operation

The MESA application is designed so that most of the major components—input screens, missions, mission tasks, equipment inventories, and equipment rankings—can be reconfigured by making changes to the Excel spreadsheet, "configure.xls," on the accompanying CD. In this sense, it is largely data-driven. However, there are some aspects of the functionality that cannot be modified without making changes to the underlying Microsoft Visual Basic® code. These are noted in the text where they occur.

Installation

The steps to install and run the MESA software are as follows:

1. Drag and unzip "MESA.zip" onto the computer's desktop.
2. Open the resulting folder and double-click on "mclift.exe." The MESA application should start up with the main screen ("Define Scenario"), as shown in Figure C.1.

3. From this point, the user can define a scenario, allocate equipment, and save the results as described next.[1]

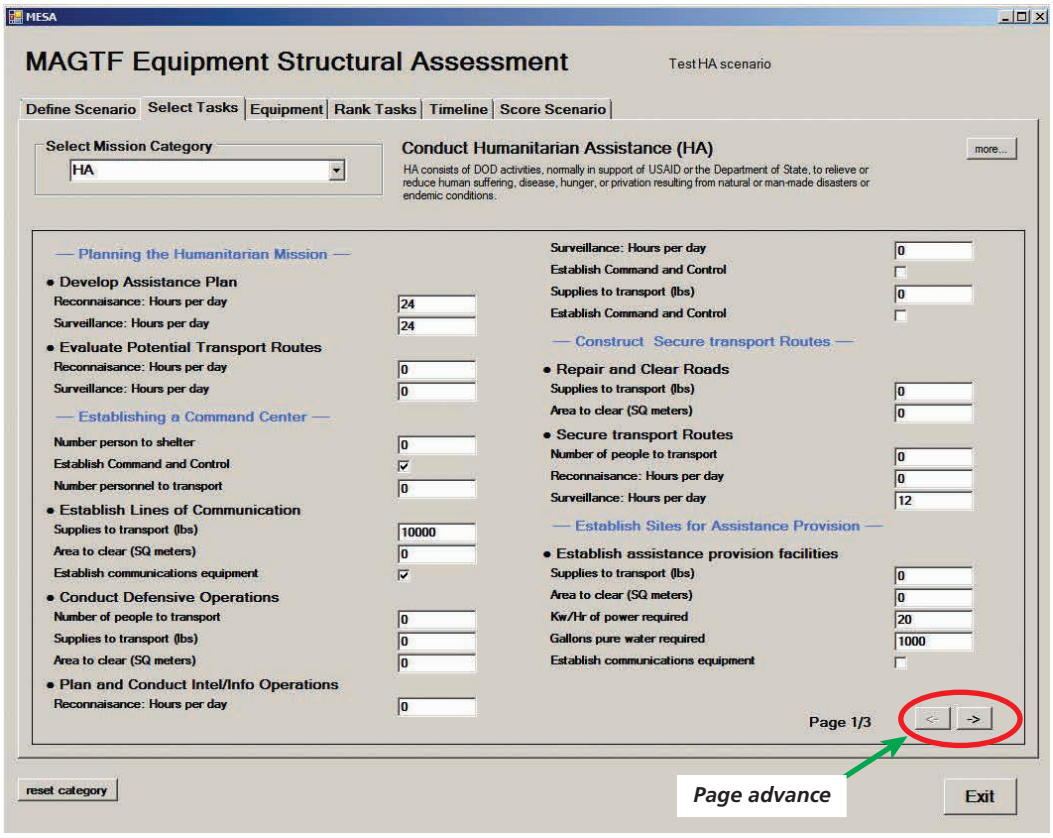
"Define Scenario" Screen

The "Define Scenario" screen (see Figure C.1) is the initial tab seen by the user when the application is started. From here, scenarios can be loaded and saved after they have been defined. There is also an option to add a scenario title. Note that the "Threat Level" drop-down box is not yet functional.

"Select Tasks" Screen

From the "Select Tasks" tab (see Figure C.2), the user can choose the specific task required for each mission. At present, only the HA mission is implemented; however, the underlying structure of the application will support multiple additional missions. Each input field has an exact one-to-one correspondence to the rows of the "MissionControl" tab of the configure.xls

Figure C.2
The "Select Tasks" Screen



RAND *TR1253-C.2*

[1] For developers: The MESA application is a standard Visual Basic application developed with Microsoft Visual Studio® 10.0. To modify the Visual Basic code underlying the application, drag the "MESADevelopment" folder from the installation CD to the desktop (or any other desired location). Open the folder and double-click on "mclift.vbproj." This will open the application in the Visual Studio development interface. It is necessary to have Visual Studio 10.0 installed on the local machine.

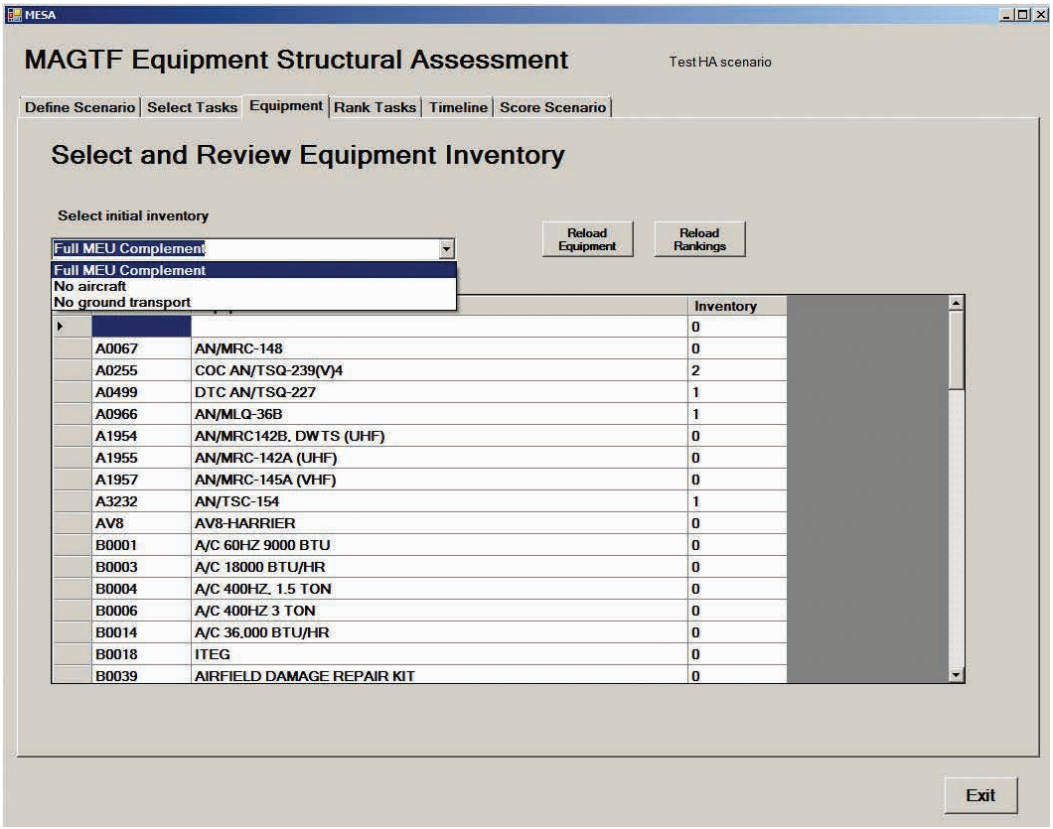
spreadsheet. This is because the "Select Tasks" tab is built dynamically based on the configure.xls spreadsheet. In principle, the entire appearance and functionality of this tab can be reconfigured by making changes to configure.xls. Instructions follow for modifying the configure.xls spreadsheet.

When the application is first launched, before any saved scenarios have been loaded or any tasks have been selected, the HA mission screen appears by default with all fields initialized to zero and all check boxes unchecked. The HA mission consists of three pages of input fields, which can be selected by using the forward and back arrows in the lower right corner of the screen.

"Equipment" Screen

From the "Equipment" screen (see Figure C.3), the user can select the equipment inventory from which individual items of equipment are drawn to perform each of the tasks specified. The drop-down menu displays a list of available inventories. The application includes three default inventories: full MEU complement, no aircraft, and no transport. However, the user has the option to create and fine-tune multiple inventories to reflect the equipment available to a specific MEU. Additional inventories can be created on the configure.xls spreadsheet, as described next.

Figure C.3
The "Equipment" Screen

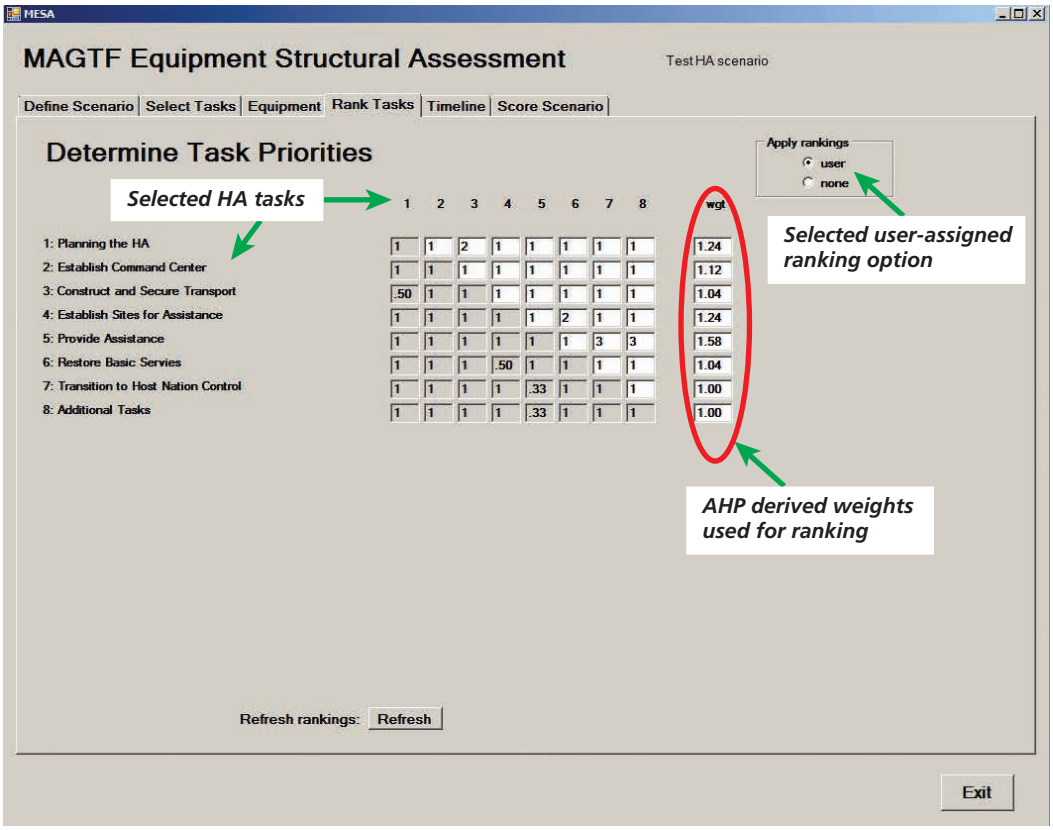


RAND *TR1253-C.3*

"Rank Tasks" Screen

If resources are constrained, the user may wish to prioritize the selected missions. The "Rank Tasks" screen (see Figure C.4) allows the user to select the default task ranking of one task or override the default task ranking. If the user wishes to override the defaults, he or she can enter relative preference weightings using the ranking matrix. Checking the "user" radio button in the upper right corner of the "Rank Tasks" tab will generate an alternative set of weights based on the values entered in the task matrix. (Checking the "none" radio button will reestablish a neutral weighting scheme with all weights equal to 1.0.) Entries in the matrix represent the relative importance of the row tasks versus the column tasks. For example, if the user determines that "Establish sites for assistance" is twice as important as "Restore basic services," then a "2" would be entered in column 4 of row 1. The system then uses the Analytic Hierarchy Process (AHP) to produce the relative ranking.[2]

Figure C.4
The "Rank Tasks" Screen



RAND *TR1253-C.4*

[2] AHP is especially suitable for complex decisions that involve the comparison of decision elements that are difficult to quantify. It involves building a hierarchy (ranking) of decision elements and then making comparisons between each possible pair in each cluster (as a matrix). This gives a weighting for each element within a cluster (or level of the hierarchy), as well as a consistency ratio (useful for checking the consistency of the data). The AHP model was designed by T. L. Saaty as a decisionmaking aid. See T. L. Saaty, *The Analytic Hierarchy Process*, New York: McGraw Hill, 1980.

The numbers to the right of each row are the relative weights that characterize the ranking. In this case, the "Provide assistance" task is the most important, with a score of 1.58; tasks 7 and 8 are the least important.

"Timeline" Screen

Once the scenario is defined and the tasks have been selected and ranked by relative importance, the user may specify the start and finish time for any task or subtask using the "Timeline" screen, as illustrated in Figure C.5. The "Timeline" screen presents the user with a dynamic list of the tasks selected on the "Select Tasks" screen. By specifying start and end dates, the user can sequence the tasks. For example, it may be appropriate to first "secure borders and highways" before "restoring civilian infrastructure."

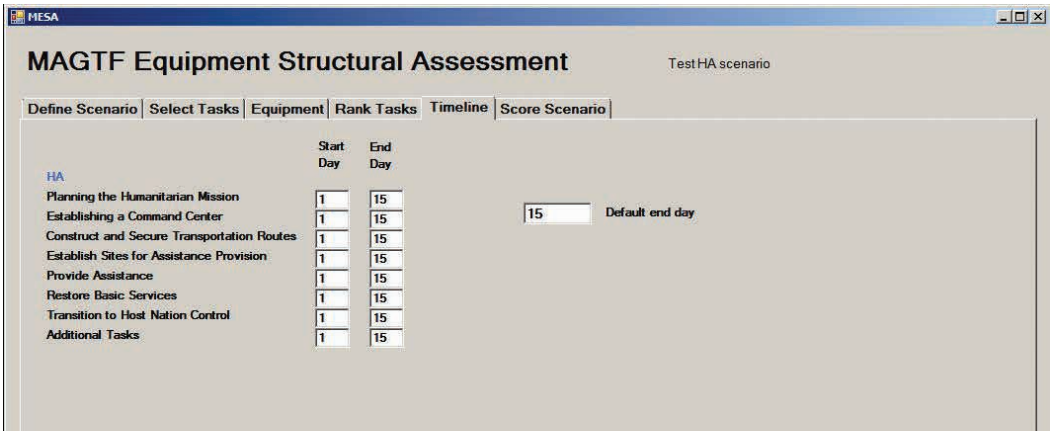
If no start or finish date is selected for a given task, it is assumed that the start date is the first day of the mission and that it lasts for 15 days, which is the default.[3] The user can also specify a new default end day, which will apply to the time frame of the entire mission.

"Score Scenario" Screen

Once the user is satisfied with the mission and task selection, the equipment inventory, and the timeline, he or she can proceed to the "Score Scenario" screen (see Figure C.6). First, the selected tasks can be reviewed by clicking on the "Review Tasks" button, then the "Allocate Equipment" button. This will direct the MESA application to allocate equipment from the selected inventory and display the results, task by task, on the output screen. The display will have separate columns for each day, defined on the "Timeline" tab.

Once the outputs are deemed satisfactory, clicking on the "Save to Excel" button will open an Excel spreadsheet populated with the result of the equipment allocation.

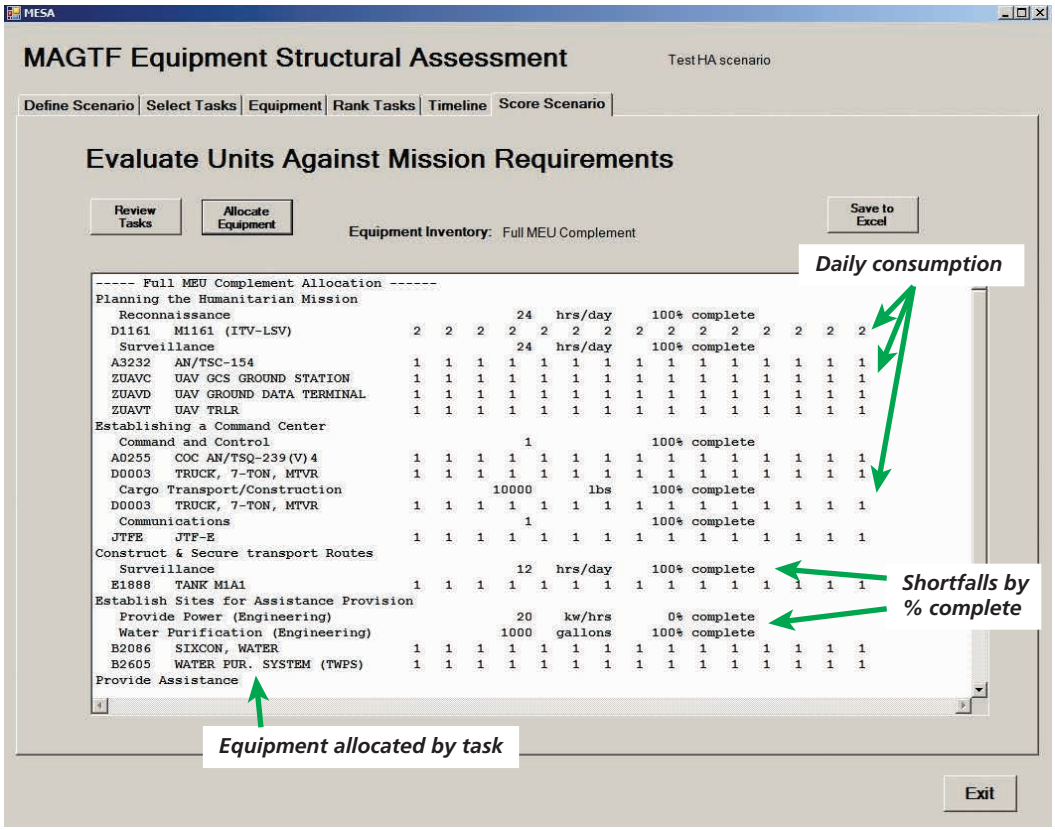
Figure C.5
The "Timeline" Screen



RAND *TR1253-C.5*

[3] This planning horizon was chosen based on the experience of Marines Corps personnel who served in MEU command elements on HA missions.

Figure C.6
The "Score Scenario" Screen



RAND *TR1253-C.6*

Stepping Through a Simple Scenario

This section steps through a simple scenario, running an allocation based on a previously saved scenario. We begin by loading a previously saved scenario from the "Define Scenario" tab as shown in Figure C.7.

Next, we review the task selection on the "Select Tasks" tab as shown in Figure C.8. The red-circled items highlight the stored settings, which the user may choose to modify.

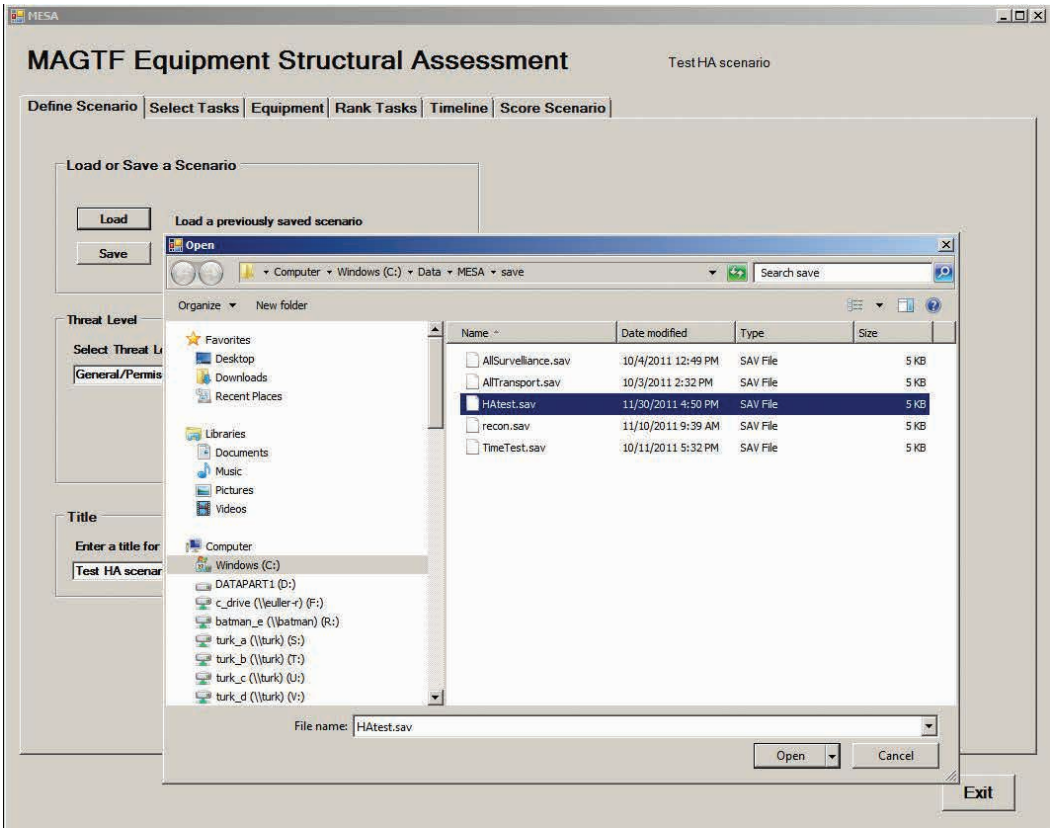
Next, the user can set the timeline for each of the tasks on the "Timeline" tab, as shown in Figure C.9.

Once the user is satisfied with the tasks selected and the timelines chosen, the selected tasks can be reviewed on the "Score Scenario" screen, as shown in Figure C.10.

Finally, the user can allocate equipment and save the results as an Excel spreadsheet, as shown in Figure C.11. The red-circled buttons indicate the sequence of actions to first generate the allocation and then save it to a spreadsheet.

There is relatively little overhead in setting up and running scenarios, so the user can iterate as much as desired. It is recommended that once a scenario is defined that it be permanently saved for future use from the "Define Scenario" tab.

Figure C.7
Selecting a Previously Saved Scenario



RAND *TR1253-C.7*

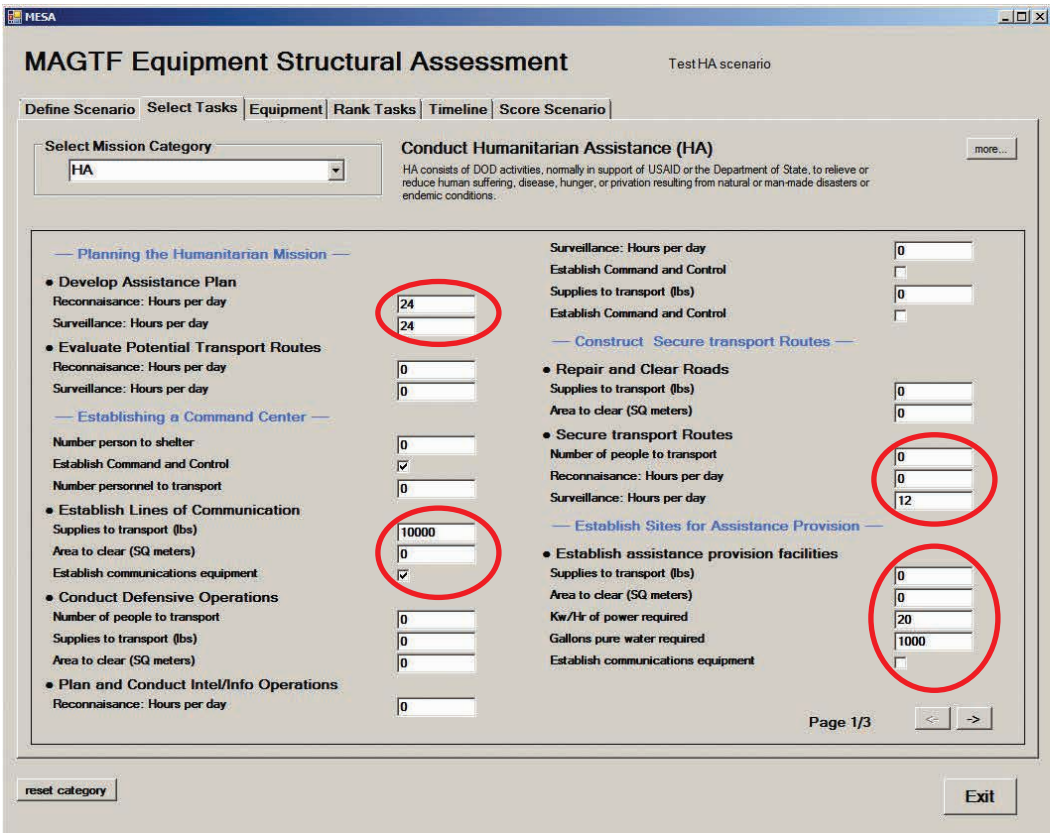
The "configure.xls" Spreadsheet

The configure.xls spreadsheet is located in the main directory of the MESA application. It is used to configure many aspects of the tool: the input screens, the universe of equipment, the hierarchy of preferred equipment, and the different inventories available for each scenario. It is designed to be modified by the user in order to customize and extend the application; however, it is *strongly advised* that the user first make a copy of the original spreadsheet because it is highly likely that initial attempts to modify the configure.xls file will result in an error in the application. Next, we describe the purpose of each of the important spreadsheet tabs and provide instructions for modifying each.

"Missions" Tab

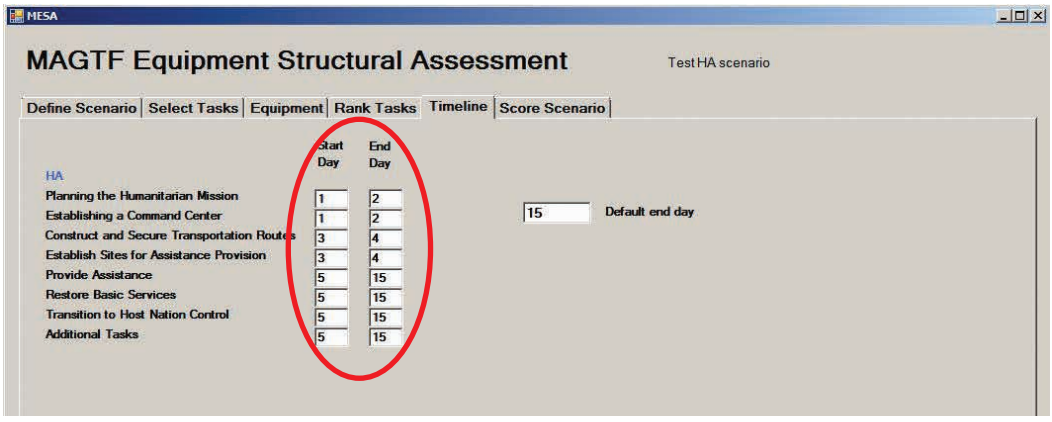
The "Missions" tab (see Figure C.12) lists all the missions and tasks available to the MESA application. At present, the application supports only a single mission (HA), so there is no need to make modifications to this tab. In the future, it will be possible to add, delete, and substantially reconfigure the list of available missions from this tab, but for now, it should not be modified by the user.

Figure C.8
The Saved "Select Tasks" Screen



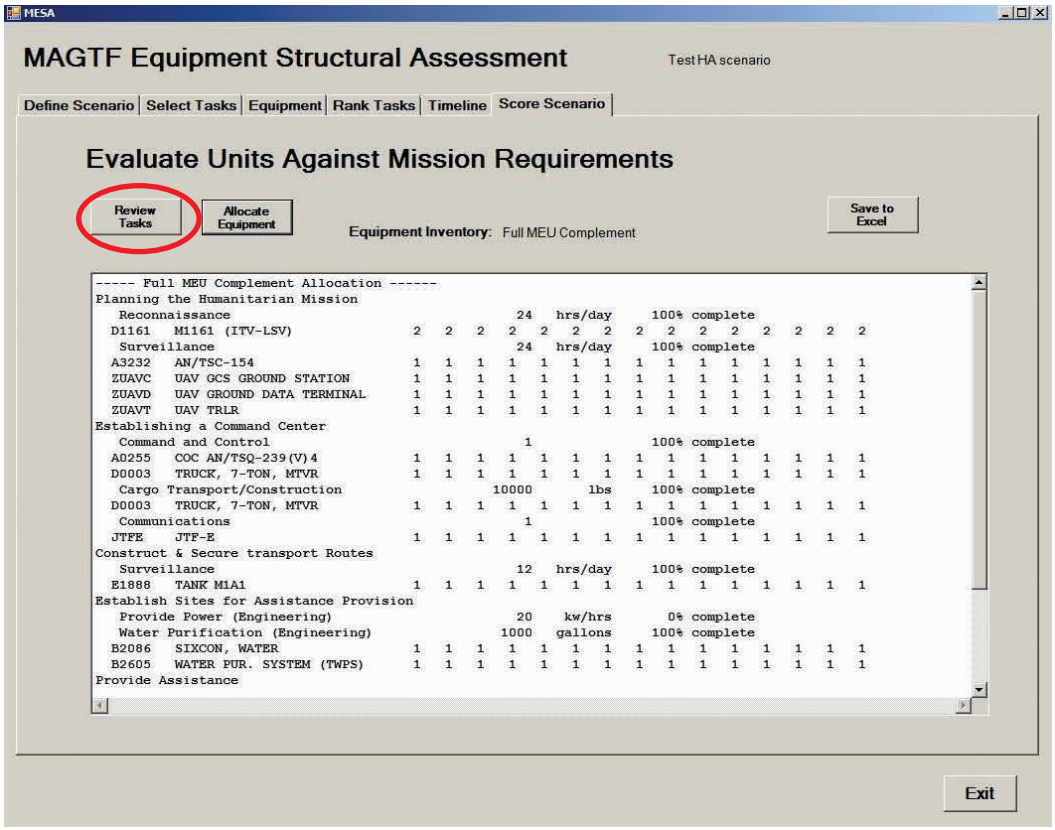
RAND *TR1253-C.8*

Figure C.9
The Saved "Timeline" Screen



RAND *TR1253-C.9*

Figure C.10
The Saved "Score Scenario" Screen



RAND *TR1253-C.10*

"MissionControls" Tab

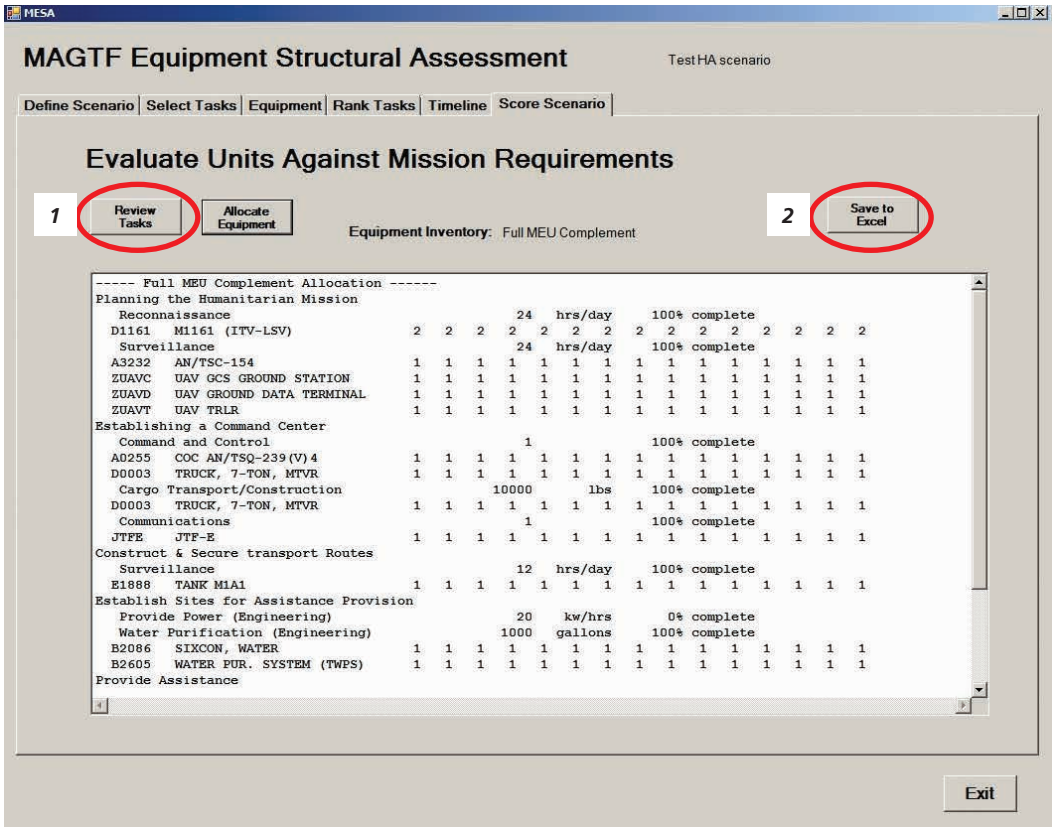
The "MissionControls" tab (see Figure C.13) is read by the MESA application at start-up and is used to configure all input fields on the "Select Tasks" screen. Each row represents a single activity associated with the HA mission and its tasks. Each row also has a counterpart on the "EquipmentRankings" tab, where the application identifies the equipment suitable for the activity.

Modifying Input Fields on the "MissionControls" Tab

All input fields on the "Select Tasks" tab of the MESA application are defined on the "MissionControls" tab of the configuration spreadsheet. The name of the tab reflects the fact that each row of the spreadsheet generates a unique Visual Basic input field, or "control." By adding (or deleting) rows from the "MissionControls" tab, new input fields can be added (or existing fields deleted) from the "Select Tasks" screen of the application.

It is essential that any new input fields added to (or deleted from) the "MissionControls" tab have a matching row added or deleted in the "Rankings" tab because there is an exact one-to-one correspondence between the rows of the "MissionControls" tab and the rows in the "Rankings" tab. If these two tabs are not synchronized, the MESA application will not function. We describe how to modify the "Rankings" tab in the section "Modifying the Hierarchy of Equipment Preferences," later in this guide.

Figure C.11
Producing the Final Allocation and Saving to Excel



RAND *TR1253-C.11*

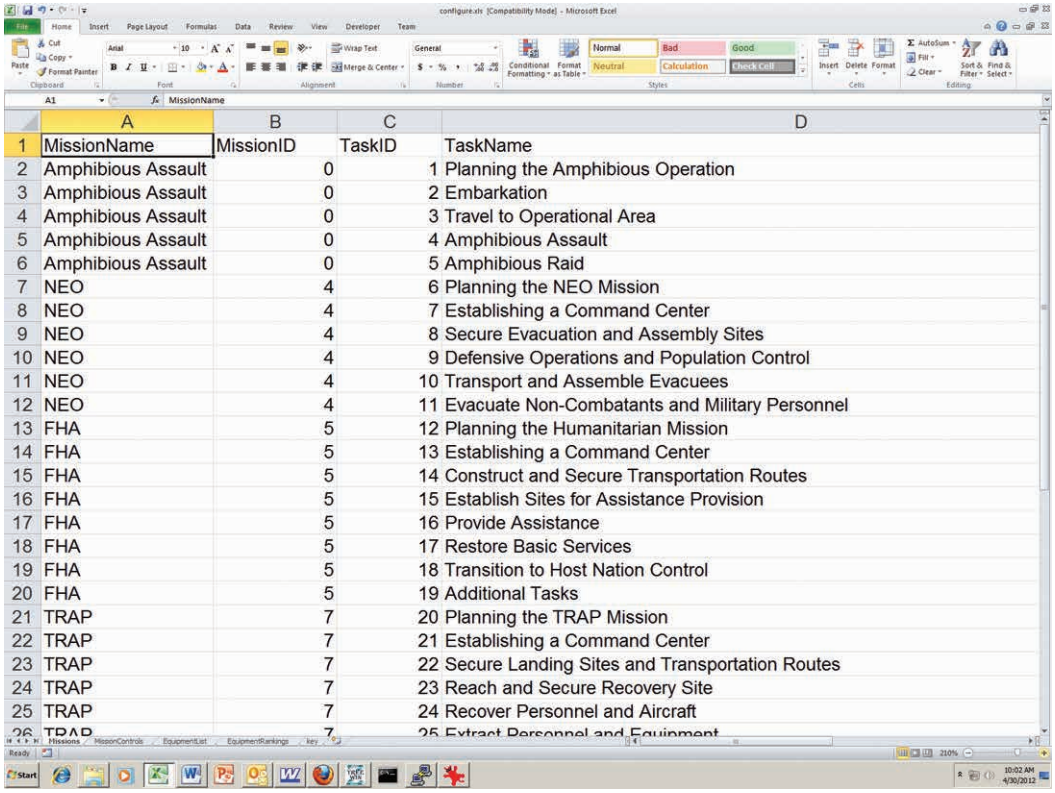
Two types of controls are currently supported by the MESA application: (1) text box, a simple text box entry field with a label, and (2) check box, a yes/no check box with a label. To add a new control or input field, copy a similar row—either a check box or a text box—and insert it in the appropriate location on the "MissionControls" tab. Modify the columns "SubtaskName," "ActivityName," and "Unit," as necessary, to identify the new input field. Be sure that the "ActivityID" column starts with 1 and increases sequentially by 1 for each row of the "MissionControls" tab. If "ActivityID" gets out of sequence or gaps appear, the application will cease functioning. The red-highlighted row in Figures C.14 and C.15 illustrate the process.

In Figures C.14 and C.15, a new input control defined in row 74 of the "MissionControls" tab has a counterpart in row 74 of the "EquipmentRankings" tab. It is essential that the user keep these two spreadsheets synchronized. Pay particular attention to the "ActivityID" field; it must be consistent with the "ActivityID" column on the "MissionControls" tab. If these entries are not synchronized, the application will not be able to associate the correct equipment with each activity.

Several columns in the "MissionControls" tab aid in formatting the input fields on the "Select Tasks" screen:

- "PageID" (column B; not shown in Figure C.14): This column is used to increment the page number for the HA mission. Changing the value will cause a page break, and

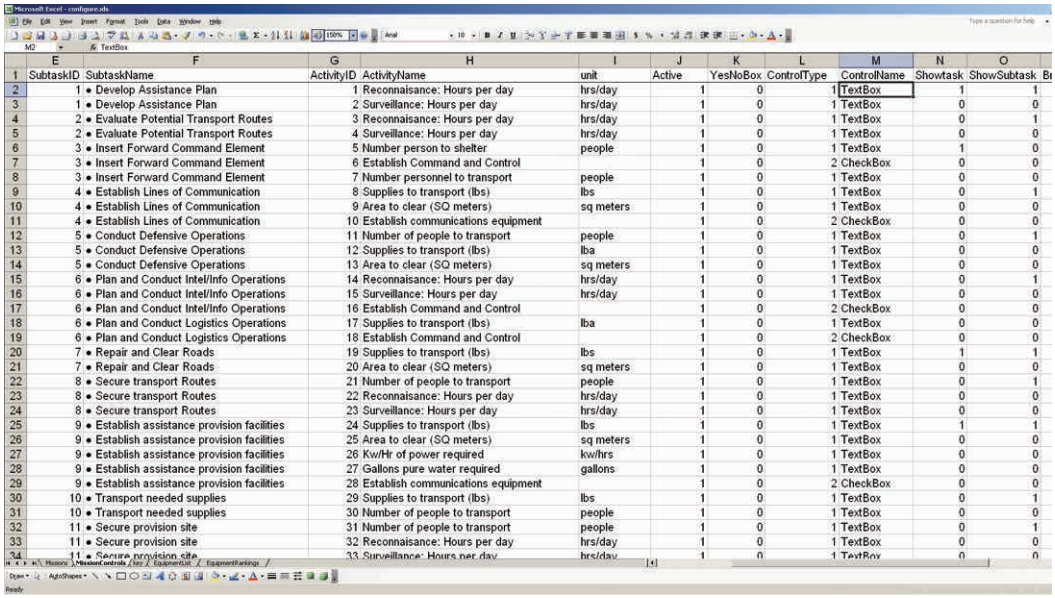
Figure C.12
The "Missions" Tab



	A	B	C	D
1	MissionName	MissionID	TaskID	TaskName
2	Amphibious Assault	0	1	Planning the Amphibious Operation
3	Amphibious Assault	0	2	Embarkation
4	Amphibious Assault	0	3	Travel to Operational Area
5	Amphibious Assault	0	4	Amphibious Assault
6	Amphibious Assault	0	5	Amphibious Raid
7	NEO	4	6	Planning the NEO Mission
8	NEO	4	7	Establishing a Command Center
9	NEO	4	8	Secure Evacuation and Assembly Sites
10	NEO	4	9	Defensive Operations and Population Control
11	NEO	4	10	Transport and Assemble Evacuees
12	NEO	4	11	Evacuate Non-Combatants and Military Personnel
13	FHA	5	12	Planning the Humanitarian Mission
14	FHA	5	13	Establishing a Command Center
15	FHA	5	14	Construct and Secure Transportation Routes
16	FHA	5	15	Establish Sites for Assistance Provision
17	FHA	5	16	Provide Assistance
18	FHA	5	17	Restore Basic Services
19	FHA	5	18	Transition to Host Nation Control
20	FHA	5	19	Additional Tasks
21	TRAP	7	20	Planning the TRAP Mission
22	TRAP	7	21	Establishing a Command Center
23	TRAP	7	22	Secure Landing Sites and Transportation Routes
24	TRAP	7	23	Reach and Secure Recovery Site
25	TRAP	7	24	Recover Personnel and Aircraft
26	TRAP	7	25	Extract Personnel and Equipment

RAND *TR1253-C.12*

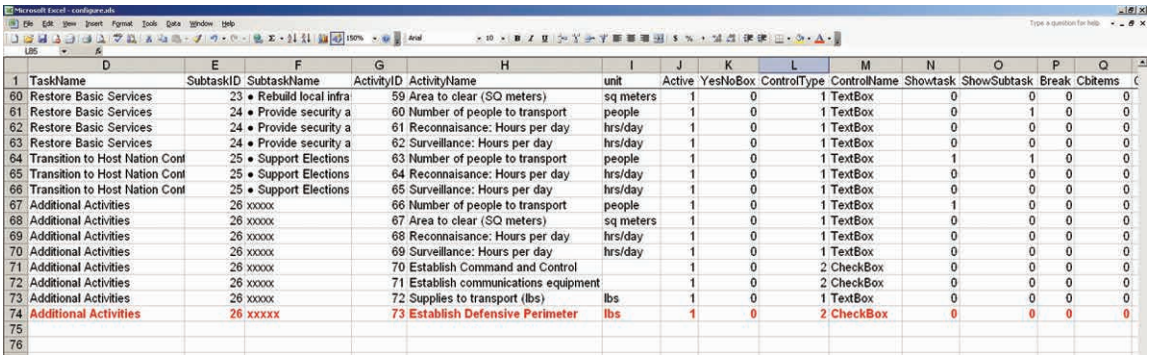
Figure C.13
The "MissionControls" Tab



	E	F	G	H	I	J	K	L	M	N	O
1	SubtaskID	SubtaskName	ActivityID	ActivityName	unit	Active	YesNoBox	ControlType	ControlName	Showtask	ShowSubtask
2	1	• Develop Assistance Plan	1	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	1	1
3	1	• Develop Assistance Plan	2	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0
4	2	• Evaluate Potential Transport Routes	3	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	1
5	2	• Evaluate Potential Transport Routes	4	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0
6	3	• Insert Forward Command Element	5	Number person to shelter	people	1	0	1	TextBox	1	0
7	3	• Insert Forward Command Element	6	Establish Command and Control		1	0	2	CheckBox	0	0
8	3	• Insert Forward Command Element	7	Number personnel to transport	people	1	0	1	TextBox	0	0
9	4	• Establish Lines of Communication	8	Supplies to transport (lbs)	lbs	1	0	1	TextBox	0	1
10	4	• Establish Lines of Communication	9	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0
11	4	• Establish Lines of Communication	10	Establish communications equipment		1	0	2	CheckBox	0	0
12	5	• Conduct Defensive Operations	11	Number of people to transport	people	1	0	1	TextBox	0	1
13	5	• Conduct Defensive Operations	12	Supplies to transport (lbs)	lba	1	0	1	TextBox	0	0
14	5	• Conduct Defensive Operations	13	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0
15	6	• Plan and Conduct Intel/Info Operations	14	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	1
16	6	• Plan and Conduct Intel/Info Operations	15	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0
17	6	• Plan and Conduct Intel/Info Operations	16	Establish Command and Control		1	0	2	CheckBox	0	0
18	6	• Plan and Conduct Logistics Operations	17	Supplies to transport (lbs)	lba	1	0	1	TextBox	0	0
19	6	• Plan and Conduct Logistics Operations	18	Establish Command and Control		1	0	2	CheckBox	0	0
20	7	• Repair and Clear Roads	19	Supplies to transport (lbs)	lbs	1	0	1	TextBox	1	1
21	7	• Repair and Clear Roads	20	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0
22	8	• Secure transport Routes	21	Number of people to transport	people	1	0	1	TextBox	0	1
23	8	• Secure transport Routes	22	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	0
24	8	• Secure transport Routes	23	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0
25	9	• Establish assistance provision facilities	24	Supplies to transport (lbs)	lbs	1	0	1	TextBox	1	1
26	9	• Establish assistance provision facilities	25	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0
27	9	• Establish assistance provision facilities	26	Kw/Hr of power required	kw/hrs	1	0	1	TextBox	0	0
28	9	• Establish assistance provision facilities	27	Gallons pure water required	gallons	1	0	1	TextBox	0	0
29	9	• Establish assistance provision facilities	28	Establish communications equipment		1	0	2	CheckBox	0	0
30	10	• Transport needed supplies	29	Supplies to transport (lbs)	lbs	1	0	1	TextBox	0	1
31	10	• Transport needed supplies	30	Number of people to transport	people	1	0	1	TextBox	0	0
32	11	• Secure provision site	31	Number of people to transport	people	1	0	1	TextBox	0	1
33	11	• Secure provision site	32	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	0
34	11	• Secure provision site	33	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0

RAND *TR1253-C.13*

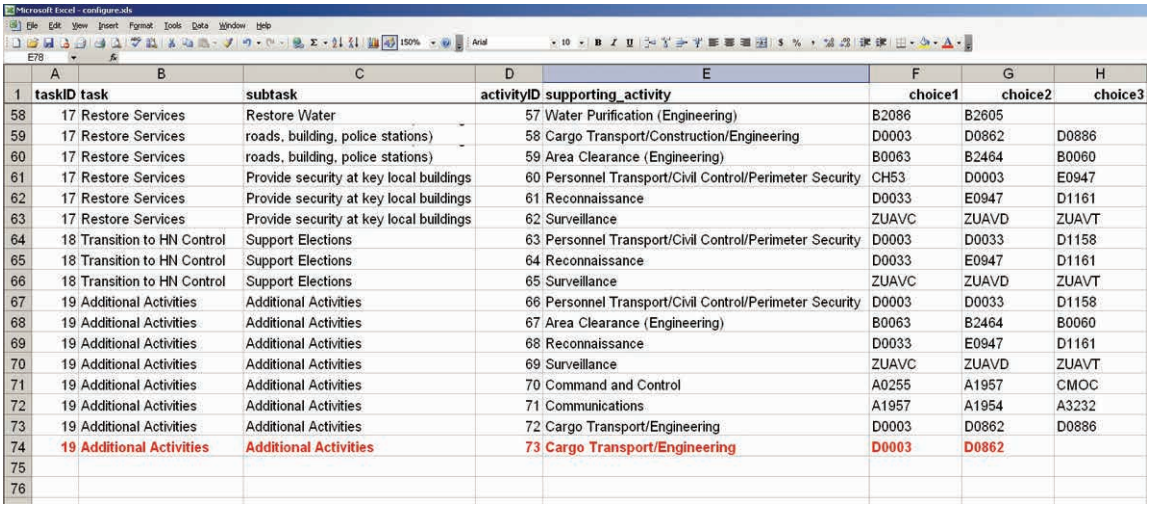
Figure C.14
Adding a New Input Field to the "MissionControls" Tab



	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	TaskName	SubtaskID	SubtaskName	ActivityID	ActivityName	unit	Active	YesNoBox	ControlType	ControlName	Showtask	ShowSubtask	Break	Cbitems
60	Restore Basic Services	23	• Rebuild local infra	59	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0	0	0
61	Restore Basic Services	24	• Provide security a	60	Number of people to transport	people	1	0	1	TextBox	0	1	0	0
62	Restore Basic Services	24	• Provide security a	61	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
63	Restore Basic Services	24	• Provide security a	62	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
64	Transition to Host Nation Conf	25	• Support Elections	63	Number of people to transport	people	1	0	1	TextBox	1	1	0	0
65	Transition to Host Nation Conf	25	• Support Elections	64	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
66	Transition to Host Nation Conf	25	• Support Elections	65	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
67	Additional Activities	26	xxxxx	66	Number of people to transport	people	1	0	1	TextBox	1	0	0	0
68	Additional Activities	26	xxxxx	67	Area to clear (SQ meters)	sq meters	1	0	1	TextBox	0	0	0	0
69	Additional Activities	26	xxxxx	68	Reconnaisance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
70	Additional Activities	26	xxxxx	69	Surveillance: Hours per day	hrs/day	1	0	1	TextBox	0	0	0	0
71	Additional Activities	26	xxxxx	70	Establish Command and Control		1	0	2	CheckBox	0	0	0	0
72	Additional Activities	26	xxxxx	71	Establish communications equipment		1	0	2	CheckBox	0	0	0	0
73	Additional Activities	26	xxxxx	72	Supplies to transport (lbs)	lbs	1	0	1	TextBox	0	0	0	0
74	Additional Activities	26	xxxxx	73	Establish Defensive Perimeter	lbs	1	0	2	CheckBox	0	0	0	0
75														
76														

RAND *TR1253-C.14*

Figure C.15
Adding a New Input Field to the "EquipmentRankings" Tab



	A	B	C	D	E	F	G	H
1	taskID	task	subtask	activityID	supporting_activity	choice1	choice2	choice3
58	17	Restore Services	Restore Water	57	Water Purification (Engineering)	B2086	B2605	
59	17	Restore Services	roads, building, police stations)	58	Cargo Transport/Construction/Engineering	D0003	D0862	D0886
60	17	Restore Services	roads, building, police stations)	59	Area Clearance (Engineering)	B0063	B2464	B0060
61	17	Restore Services	Provide security at key local buildings	60	Personnel Transport/Civil Control/Perimeter Security	CH53	D0003	E0947
62	17	Restore Services	Provide security at key local buildings	61	Reconnaissance	D0033	E0947	D1161
63	17	Restore Services	Provide security at key local buildings	62	Surveillance	ZUAVC	ZUAVD	ZUAVT
64	18	Transition to HN Control	Support Elections	63	Personnel Transport/Civil Control/Perimeter Security	D0003	D0033	D1158
65	18	Transition to HN Control	Support Elections	64	Reconnaissance	D0033	E0947	D1161
66	18	Transition to HN Control	Support Elections	65	Surveillance	ZUAVC	ZUAVD	ZUAVT
67	19	Additional Activities	Additional Activities	66	Personnel Transport/Civil Control/Perimeter Security	D0003	D0033	D1158
68	19	Additional Activities	Additional Activities	67	Area Clearance (Engineering)	B0063	B2464	B0060
69	19	Additional Activities	Additional Activities	68	Reconnaissance	D0033	E0947	D1161
70	19	Additional Activities	Additional Activities	69	Surveillance	ZUAVC	ZUAVD	ZUAVT
71	19	Additional Activities	Additional Activities	70	Command and Control	A0255	A1957	CMOC
72	19	Additional Activities	Additional Activities	71	Communications	A1957	A1954	A3232
73	19	Additional Activities	Additional Activities	72	Cargo Transport/Engineering	D0003	D0862	D0886
74	19	Additional Activities	Additional Activities	73	Cargo Transport/Engineering	D0003	D0862	
75								
76								

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the input fields will continue on the next page (screen). There are currently three pages supported under the HA mission.

- "ShowTask" (column N): Setting the value to 1 causes the current task (the "TaskName" column) to be printed on a separate line before the current input control.
- "ShowSubtask" (column O): Setting the value to 1 causes the current subtask (the "SubtaskName" column) to be printed on a separate line before the current input control.

A number of columns on the "MissionControls" tab are not currently used by the application. Starting with "Break" (column P), these fields are reserved for future use by the MESA tool. Changing them will not have any effect on the application.

"EquipmentList" Tab

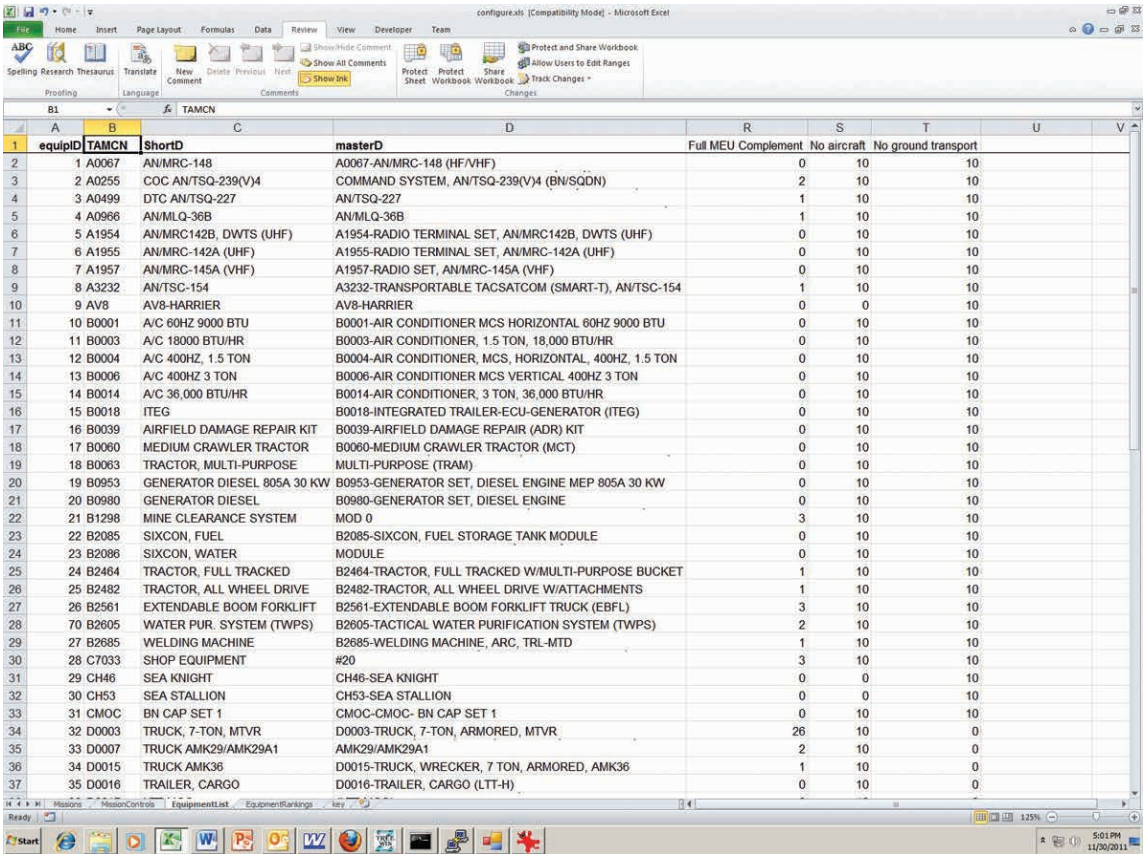
Each row in the "EquipmentList" tab (see Figure C.16) represents a piece of Marine Corps equipment that will be of potential use in supporting the missions, tasks, and activities selected by the user. This list is not necessarily comprehensive, and, as described later, the user can easily add new equipment if desired. The list currently includes no combat equipment.

Modifying the "EquipmentList" Tab

The user can add or modify pieces of equipment on the "EquipmentList" tab of the configure.xls spreadsheet. At a minimum, each equipment item needs a Table of Authorized Materiel Control Number (TAMCN) identifier, a short, descriptive phrase under the "ShortID" column, plus as many capability metrics as are available or appropriate. These can include speed, carrying capacity, passenger capacity, and maximum daily hours of operation. The performance metrics are entered into the appropriate columns on the "EquipmentList" tab. Finally, the user must enter inventory values for each new piece of equipment.

Figure C.17 illustrates how a new piece of equipment might be entered into the spreadsheet. The last line (in red) represents a new "Transport Truck" that will now be available to the MESA application to allocate to specific tasks.

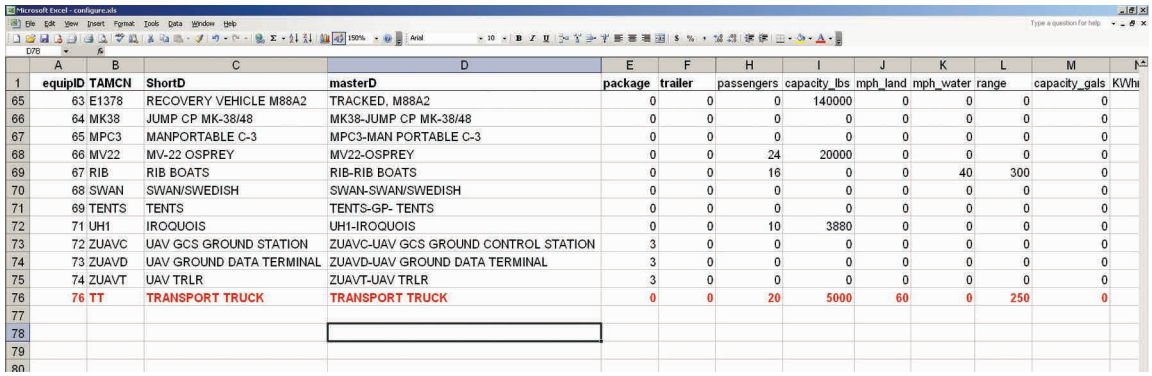
Figure C.16
The "EquipmentList" Tab



equipID	TAMCN	ShortD	masterD	Full MEU Complement	No aircraft	No ground transport
1	A0067	AN/MRC-148	A0067-AN/MRC-148 (HF/VHF)	0	10	10
2	A0255	COC AN/TSQ-239(V)4	COMMAND SYSTEM, AN/TSQ-239(V)4 (BN/SQDN)	2	10	10
3	A0499	DTC AN/TSQ-227	AN/TSQ-227	1	10	10
4	A0966	AN/MLQ-36B	AN/MLQ-36B	1	10	10
5	A1954	AN/MRC142B, DWTS (UHF)	A1954-RADIO TERMINAL SET, AN/MRC142B, DWTS (UHF)	0	10	10
6	A1955	AN/MRC-142A (UHF)	A1955-RADIO TERMINAL SET, AN/MRC-142A (UHF)	0	10	10
7	A1957	AN/MRC-145A (VHF)	A1957-RADIO SET, AN/MRC-145A (VHF)	0	10	10
8	A3232	AN/TSC-154	A3232-TRANSPORTABLE TACSATCOM (SMART-T), AN/TSC-154	1	10	10
9	AV8	AV8-HARRIER	AV8-HARRIER	0	0	10
10	B0001	A/C 60HZ 9000 BTU	B0001-AIR CONDITIONER MCS HORIZONTAL 60HZ 9000 BTU	0	10	10
11	B0003	A/C 18000 BTU/HR	B0003-AIR CONDITIONER, 1.5 TON, 18,000 BTU/HR	0	10	10
12	B0004	A/C 400HZ, 1.5 TON	B0004-AIR CONDITIONER, MCS, HORIZONTAL, 400HZ, 1.5 TON	0	10	10
13	B0006	A/C 400HZ 3 TON	B0006-AIR CONDITIONER MCS VERTICAL 400HZ 3 TON	0	10	10
14	B0014	A/C 36,000 BTU/HR	B0014-AIR CONDITIONER, 3 TON, 36,000 BTU/HR	0	10	10
15	B0018	ITEG	B0018-INTEGRATED TRAILER-ECU-GENERATOR (ITEG)	0	10	10
16	B0039	AIRFIELD DAMAGE REPAIR KIT	B0039-AIRFIELD DAMAGE REPAIR (ADR) KIT	0	10	10
17	B0060	MEDIUM CRAWLER TRACTOR	B0060-MEDIUM CRAWLER TRACTOR (MCT)	0	10	10
18	B0063	TRACTOR, MULTI-PURPOSE	MULTI-PURPOSE (TRAM)	0	10	10
19	B0953	GENERATOR DIESEL 805A 30 KW	B0953-GENERATOR SET, DIESEL ENGINE MEP 805A 30 KW	0	10	10
20	B0980	GENERATOR DIESEL	B0980-GENERATOR SET, DIESEL ENGINE	0	10	10
21	B1298	MINE CLEARANCE SYSTEM	MOD 0	3	10	10
22	B2085	SIXCON, FUEL	B2085-SIXCON, FUEL STORAGE TANK MODULE	0	10	10
23	B2086	SIXCON, WATER	MODULE	0	10	10
24	B2464	TRACTOR, FULL TRACKED	B2464-TRACTOR, FULL TRACKED W/MULTI-PURPOSE BUCKET	1	10	10
25	B2482	TRACTOR, ALL WHEEL DRIVE	B2482-TRACTOR, ALL WHEEL DRIVE W/ATTACHMENTS	1	10	10
26	B2561	EXTENDABLE BOOM FORKLIFT	B2561-EXTENDABLE BOOM FORKLIFT TRUCK (EBFL)	3	10	10
28	B2605	WATER PUR. SYSTEM (TWPS)	B2605-TACTICAL WATER PURIFICATION SYSTEM (TWPS)	2	10	10
29	B2685	WELDING MACHINE	B2685-WELDING MACHINE, ARC, TRL-MTD	1	10	10
30	C7033	SHOP EQUIPMENT	#20	3	10	10
31	CH46	SEA KNIGHT	CH46-SEA KNIGHT	0	0	10
32	CH53	SEA STALLION	CH53-SEA STALLION	0	0	10
33	CMOC	BN CAP SET 1	CMOC-CMOC- BN CAP SET 1	0	10	10
34	D0003	TRUCK, 7-TON, MTVR	D0003-TRUCK, 7-TON, ARMORED, MTVR	26	10	0
35	D0007	TRUCK AMK29/AMK29A1	AMK29/AMK29A1	2	10	0
36	D0015	TRUCK AMK36	D0015-TRUCK, WRECKER, 7 TON, ARMORED, AMK36	1	10	0
37	D0016	TRAILER, CARGO	D0016-TRAILER, CARGO (LTT-H)	0	10	0

RAND *TR1253-C.16*

Figure C.17
Adding a New Equipment Item to the "EquipmentList" Tab



	A	B	C	D	E	F	H	I	J	K	L	M
1	equipID	TAMCN	ShortD	masterD	package	trailer	passengers	capacity_lbs	mph_land	mph_water	range	capacity_gals
65	63	E1378	RECOVERY VEHICLE M88A2	TRACKED, M88A2	0	0	0	140000	0	0	0	0
66	64	MK38	JUMP CP MK-38/48	MK38-JUMP CP MK-38/48	0	0	0	0	0	0	0	0
67	65	MPC3	MANPORTABLE C-3	MPC3-MAN PORTABLE C-3	0	0	0	0	0	0	0	0
68	66	MV22	MV-22 OSPREY	MV22-OSPREY	0	0	24	20000	0	0	0	0
69	67	RIB	RIB BOATS	RIB-RIB BOATS	0	0	16	0	0	40	300	0
70	68	SWAN	SWAN/SWEDISH	SWAN-SWAN/SWEDISH	0	0	0	0	0	0	0	0
71	69	TENTS	TENTS	TENTS-GP- TENTS	0	0	0	0	0	0	0	0
72	71	UH1	IROQUOIS	UH1-IROQUOIS	0	0	10	3880	0	0	0	0
73	72	ZUAVC	UAV GCS GROUND STATION	ZUAVC-UAV GCS GROUND CONTROL STATION	3	0	0	0	0	0	0	0
74	73	ZUAVD	UAV GROUND DATA TERMINAL	ZUAVD-UAV GROUND DATA TERMINAL	3	0	0	0	0	0	0	0
75	74	ZUAVT	UAV TRLR	ZUAVT-UAV TRLR	3	0	0	0	0	0	0	0
76	76	TT	TRANSPORT TRUCK	TRANSPORT TRUCK	0	0	20	5000	60	0	250	0

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The MESA application also recognizes that certain pieces of equipment are part of "packages," as discussed in the main text of this report. A package consists of multiple pieces of equipment. For example, an unmanned aerial vehicle (UAV) comes as a package of three pieces of equipment: a ground control station, a ground control terminal, and a trailer. On the spreadsheet, the package column is used to identify all the pieces of equipment that should be grouped together. The UAV components in Figure C.17 are identified by the number 3 in the "Package" column. The MESA application understands that when a piece of equipment with a non-zero package value is assigned to a task, it must look through the equipment list for all other items that share the same package number and allocate those to the task as well. Currently, there are three packages: A0255 mobile command center plus a prime mover, B2605 water purification system and B2086 storage tanks, and the previously mentioned UAV.

There is also a special package value (99) that is assigned to all trailers and towed equipment. If the value 1 appears in the trailer column (column F in Figure C.17), then the MESA application looks for an available prime mover with a package value of 4 and assigns it along with the towed equipment.

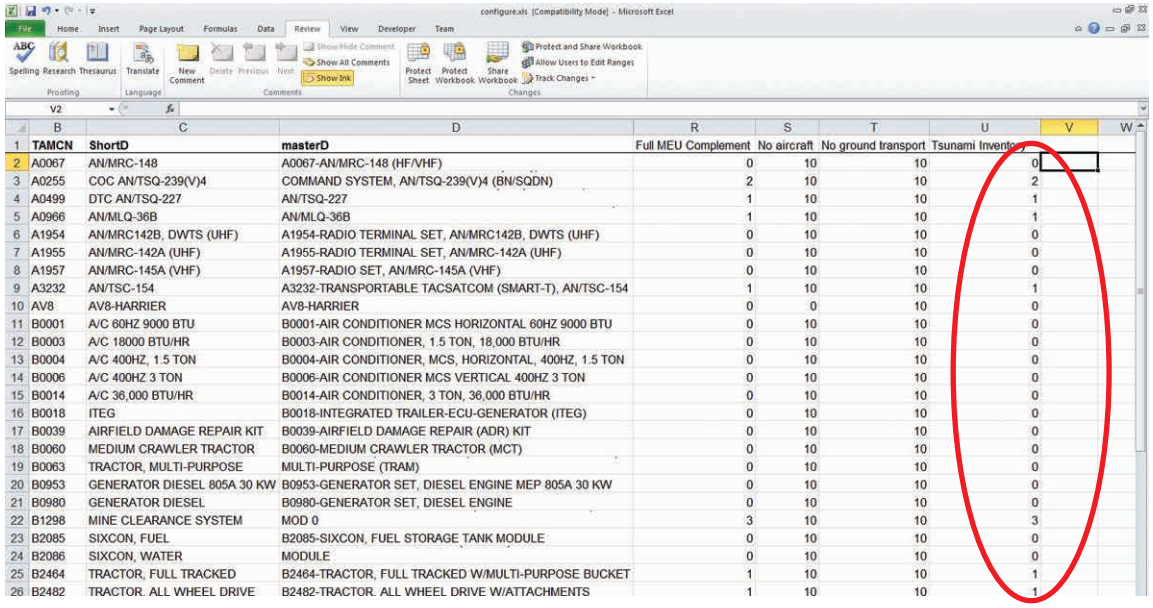
To create new packages, the user simply identifies the equipment that should be grouped together and enters a new, unique package number in the "Package" column of the "EquipmentList" tab on the spreadsheet (column E in Figure C.17). This value can be any number other than 1, 2, 3, or 99, since these values have already been assigned.

Finally, the new piece of equipment needs an inventory value for each inventory available to the application. The inventory value is an integer value representing the number of pieces of this equipment in each inventory. The inventories appear in the far right of the "EquipmentList" tab of the spreadsheet (not shown in Figure C.17). Currently, there are three inventories: full MEU complement, no aircraft, and limited transport.

Modifying Equipment Inventories

Earlier, we explained that all individual pieces of equipment need an inventory value in each inventory. It is easy to modify these values for any existing inventory. For example, if the user determines that the full MEU complement inventory should have fewer D0003 medium tactical vehicle replacement (MTVR) trucks, then he or she must change the value for D0003 (row 34 on the "EquipmentList" tab, not shown in Figure C.18) under that inventory column

Figure C.18
Adding the "Tsunami Inventory" in Column U



	B	C	D	R	S	T	U	V	W
1	TAMCN	ShortD	masterD	Full MEU Complement	No aircraft	No ground transport	Tsunami Inventory		
2	A0067	AN/MRC-148	A0067-AN/MRC-148 (HF/VHF)	0	10	10	0		
3	A0255	COC AN/TSQ-239(V)4	COMMAND SYSTEM, AN/TSQ-239(V)4 (BN/SQDN)	2	10	10	2		
4	A0499	DTC AN/TSQ-227	AN/TSQ-227	1	10	10	1		
5	A0966	AN/MLQ-36B	AN/MLQ-36B	1	10	10	1		
6	A1954	AN/MRC142B, DWTS (UHF)	A1954-RADIO TERMINAL SET, AN/MRC142B, DWTS (UHF)	0	10	10	0		
7	A1955	AN/MRC-142A (UHF)	A1955-RADIO TERMINAL SET, AN/MRC-142A (UHF)	0	10	10	0		
8	A1957	AN/MRC-145A (VHF)	A1957-RADIO SET, AN/MRC-145A (VHF)	0	10	10	0		
9	A3232	AN/TSC-154	A3232-TRANSPORTABLE TACSATCOM (SMART-T), AN/TSC-154	1	10	10	1		
10	AV8	AV8-HARRIER	AV8-HARRIER	0	0	10	0		
11	B0001	A/C 60HZ 9000 BTU	B0001-AIR CONDITIONER MCS HORIZONTAL 60HZ 9000 BTU	0	10	10	0		
12	B0003	A/C 18000 BTU/HR	B0003-AIR CONDITIONER, 1.5 TON, 18,000 BTU/HR	0	10	10	0		
13	B0004	A/C 400HZ, 1.5 TON	B0004-AIR CONDITIONER, MCS, HORIZONTAL, 400HZ, 1.5 TON	0	10	10	0		
14	B0006	A/C 400HZ 3 TON	B0006-AIR CONDITIONER MCS VERTICAL 400HZ 3 TON	0	10	10	0		
15	B0014	A/C 36,000 BTU/HR	B0014-AIR CONDITIONER, 3 TON, 36,000 BTU/HR	0	10	10	0		
16	B0018	ITEG	B0018-INTEGRATED TRAILER-ECU-GENERATOR (ITEG)	0	10	10	0		
17	B0039	AIRFIELD DAMAGE REPAIR KIT	B0039-AIRFIELD DAMAGE REPAIR (ADR) KIT	0	10	10	0		
18	B0060	MEDIUM CRAWLER TRACTOR	B0060-MEDIUM CRAWLER TRACTOR (MCT)	0	10	10	0		
19	B0063	TRACTOR, MULTI-PURPOSE	MULTI-PURPOSE (TRAM)	0	10	10	0		
20	B0953	GENERATOR DIESEL 805A 30 KW	B0953-GENERATOR SET, DIESEL ENGINE MEP 805A 30 KW	0	10	10	0		
21	B0980	GENERATOR DIESEL	B0980-GENERATOR SET, DIESEL ENGINE	0	10	10	0		
22	B1298	MINE CLEARANCE SYSTEM	MOD 0	3	10	10	3		
23	B2085	SIXCON, FUEL	B2085-SIXCON, FUEL STORAGE TANK MODULE	0	10	10	0		
24	B2086	SIXCON, WATER	MODULE	0	10	10	0		
25	B2464	TRACTOR, FULL TRACKED	B2464-TRACTOR, FULL TRACKED W/MULTI-PURPOSE BUCKET	1	10	10	1		
26	B2482	TRACTOR, ALL WHEEL DRIVE	B2482-TRACTOR, ALL WHEEL DRIVE W/ATTACHMENTS	1	10	10	1		

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from 26 to whatever is deemed appropriate. The only point to keep in mind is that when a package is changed, all the elements of the package should be changed together.

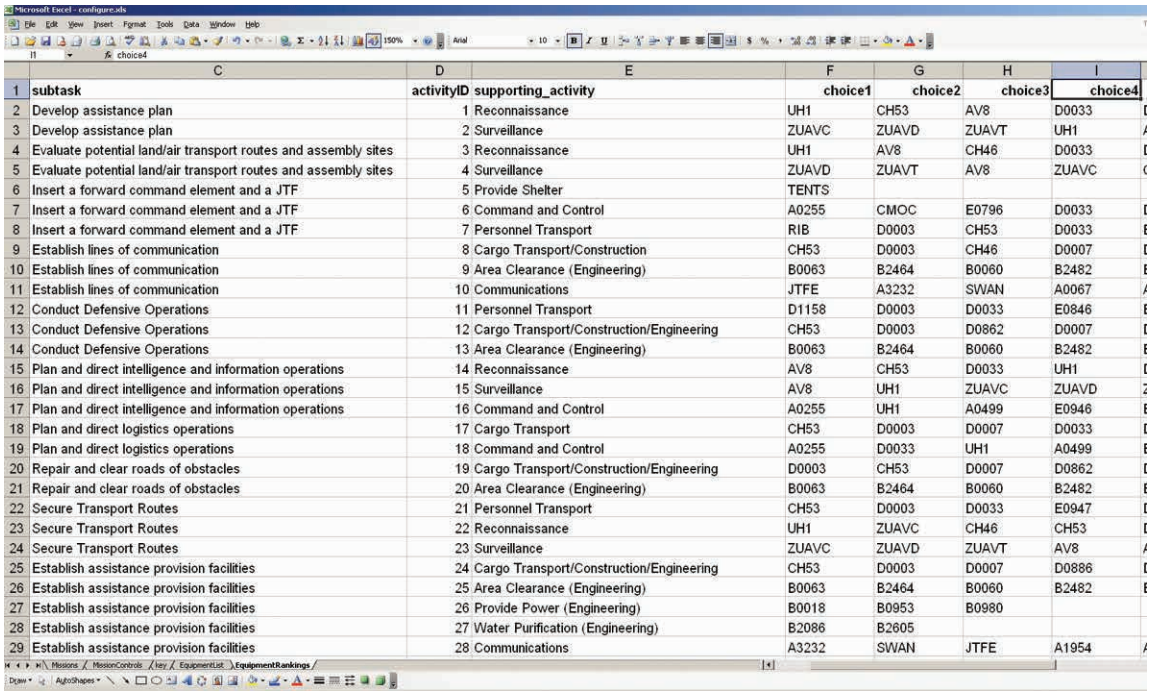
Adding an entire new inventory is similarly straightforward. Suppose we wish to add a fourth inventory designed to meet the needs of tsunami relief. First, the name of the new inventory should be entered into row 1 of the first available column after the "No Ground Transport" inventory, in this case, column U. We have chosen the name "Tsunami Inventory" for this new inventory, as shown in Figure C.18. Then the user should proceed down the column, entering either zero or a positive integer into each row of equipment. The user will then save the spreadsheet, close and restart the application, and MESA will automatically detect the new inventory and make it available for selection from the drop-down menu on the "Equipment" screen of the application.

"EquipmentRankings" Tab

The "EquipmentRankings" tab (Figure C.19) provides the application with a list of preferred equipment to perform each of the tasks selected by the user on the "Select Tasks" screen. Each row of the tab has an exact one-to-one correspondence with the rows of the "MissionControls" tab. The columns—labeled choice1, choice2, and so on—represent the first, second, and third equipment choices for each task defined by the user on the "Select Tasks" screen. Whenever the user enters a positive number for a task, the application will look at the corresponding row on the "EquipmentRankings" tabs and attempt to allocate equipment based on the rankings that appear there. MESA currently supports up to 20 equipment choices for each activity.

The equipment rankings are specified by TAMCN values. The MESA application recognizes these and is able to index them correctly into the "EquipmentList" tab to determine the operational characteristics of the piece of equipment.

Figure C.19
The "EquipmentRankings" Tab



	C	D	E	F	G	H	I
1	subtask	activityID	supporting_activity	choice1	choice2	choice3	choice4
2	Develop assistance plan	1	Reconnaissance	UH1	CH53	AV8	D0033
3	Develop assistance plan	2	Surveillance	ZUAVC	ZUAVD	ZUAVT	UH1
4	Evaluate potential land/air transport routes and assembly sites	3	Reconnaissance	UH1	AV8	CH46	D0033
5	Evaluate potential land/air transport routes and assembly sites	4	Surveillance	ZUAVD	ZUAVT	AV8	ZUAVC
6	Insert a forward command element and a JTF	5	Provide Shelter	TENTS			
7	Insert a forward command element and a JTF	6	Command and Control	A0255	CMOC	E0796	D0033
8	Insert a forward command element and a JTF	7	Personnel Transport	RIB	D0003	CH53	D0033
9	Establish lines of communication	8	Cargo Transport/Construction	CH53	D0003	CH46	D0007
10	Establish lines of communication	9	Area Clearance (Engineering)	B0063	B2464	B0060	B2482
11	Establish lines of communication	10	Communications	JTFE	A3232	SWAN	A0067
12	Conduct Defensive Operations	11	Personnel Transport	D1158	D0003	D0033	E0846
13	Conduct Defensive Operations	12	Cargo Transport/Construction/Engineering	CH53	D0003	D0862	D0007
14	Conduct Defensive Operations	13	Area Clearance (Engineering)	B0063	B2464	B0060	B2482
15	Plan and direct intelligence and information operations	14	Reconnaissance	AV8	CH53	D0033	UH1
16	Plan and direct intelligence and information operations	15	Surveillance	AV8	UH1	ZUAVC	ZUAVD
17	Plan and direct intelligence and information operations	16	Command and Control	A0255	UH1	A0499	E0946
18	Plan and direct logistics operations	17	Cargo Transport	CH53	D0003	D0007	D0033
19	Plan and direct logistics operations	18	Command and Control	A0255	D0033	UH1	A0499
20	Repair and clear roads of obstacles	19	Cargo Transport/Construction/Engineering	D0003	CH53	D0007	D0862
21	Repair and clear roads of obstacles	20	Area Clearance (Engineering)	B0063	B2464	B0060	B2482
22	Secure Transport Routes	21	Personnel Transport	CH53	D0003	D0033	E0947
23	Secure Transport Routes	22	Reconnaissance	UH1	ZUAVC	CH46	CH53
24	Secure Transport Routes	23	Surveillance	ZUAVC	ZUAVD	ZUAVT	AV8
25	Establish assistance provision facilities	24	Cargo Transport/Construction/Engineering	CH53	D0003	D0007	D0886
26	Establish assistance provision facilities	25	Area Clearance (Engineering)	B0063	B2464	B0060	B2482
27	Establish assistance provision facilities	26	Provide Power (Engineering)	B0018	B0953	B0980	
28	Establish assistance provision facilities	27	Water Purification (Engineering)	B2086	B2605		
29	Establish assistance provision facilities	28	Communications	A3232	SWAN	JTFE	A1954

RAND *TR1253-C.19*

Column Z on the "EquipmentRankings" tab (not shown in Figure C.19) tells MESA what equipment metric to use to determine the correct number of pieces of equipment to allocate to an activity. In the following example, row 9 (ActivityID 8) currently has a "3" entered in the Z column (not shown in Figure C.19). The number "3" can be decoded by accessing the "Key" tab, which indicates that 3 represents "capacity_lbs," or load capacity. When adding new input fields to the "MissionControls" tab, it is important that the correct metric constant (defined on the "Key" tab) is entered in the corresponding row of the "EquipmentRankings" tab.

The following example illustrates the process. Suppose that, on the "Select Tasks" screen on page 1 of the HA mission, the user has entered the value 10,000 lbs for the input field "Supplies to transport" under "Establish lines of communication." Looking at the "MissionControls" spreadsheet tab, we see that this is ActivityID 8 (row 9). The MESA application now looks for ActivityID 8 (also row 9) on the "EquipmentRankings" tab and then looks across to the "choice1" column, where we see the TAMCN value CH53, a Sea Stallion helicopter. The application will then check the current equipment inventory, and if a Sea Stallion is available, it will allocate it to this task. To determine the number of Sea Stallions necessary for this operation, the application will compare the 10,000 lbs entered by the user with the load capacity (the "capacity_lbs" column on the "EquipmentList" tab) and see that the Sea Stallion can carry 8,000 lbs. Thus, MESA will allocate two Sea Stallions to this task, assuming that the load must be delivered all at once. If Sea Stallions are not available for this activity, then the application will move to the next item on the "EquipmentRankings" tab—D0003 MTVR—and perform a similar inventory check and load-capacity check.

Modifying the Hierarchy of Equipment Preferences

Modifying the hierarchy of equipment preferences is a matter of editing the TAMCN values on the "EquipmentRankings" tab. In the above example, for the load transport activity defined on row 9 (ActivityID 8), the first choice was a CH53 Sea Stallion. If the user decides that it would be preferable to have the first choice be a D0003 MTVR, then he or she would delete the value "CH53" for cell 9F (see Figure C.20) and then shift the remaining choices in that row 1 column to the left.

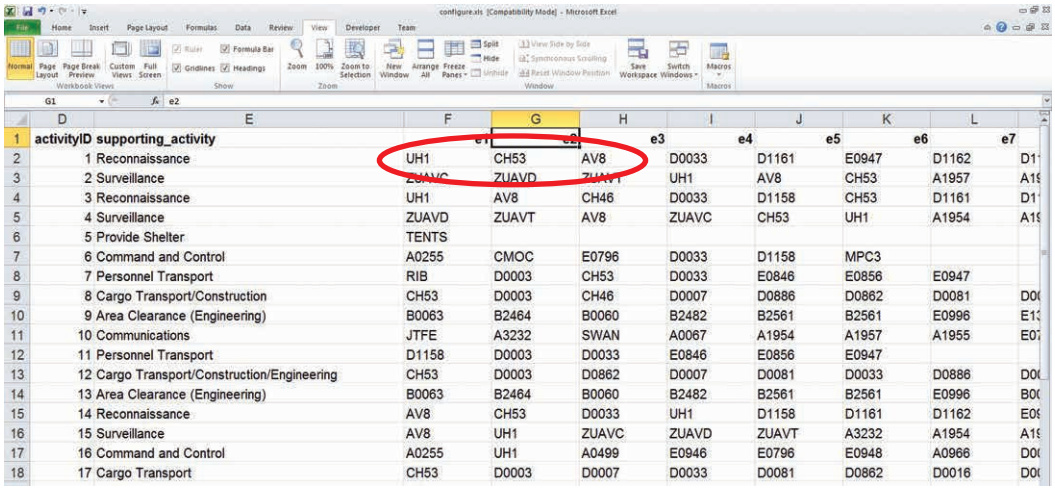
In general, equipment rankings can be modified by the user as needed.

What Cannot Be Changed Without Modifying the Visual Basic Code

Many aspects of the MESA application can be modified by changing the configure.xls spreadsheet. However, other modifications can be made only by modifying the underlying Visual Basic code. A few examples follow.

- Equipment allocator: Currently, the MESA application assigns equipment based on a single metric associated with each piece of equipment. For example, if the task is to move 10,000 lbs of supplies, the application will allocate transport based on the metric "lbs_capacity" on the "EquipmentList" tab of the configuration spreadsheet. This may not be the ideal method for allocating equipment, and it might be that an algorithm that allocates based on several metrics would be superior. This functionality cannot be changed without modifying the underlying Visual Basic code, however.
- Adding a new metric: Similarly, if the user wants to add an entirely new metric to the "EquipmentList" tab—for example, the weight of a piece of equipment—this can be accomplished only by modifying the Visual Basic code in the Visual Studio graphical user interface.

Figure C.20
Modifying the "EquipmentRankings" Tab



	activityID	supporting_activity	e1	e2	e3	e4	e5	e6	e7
2	1	Reconnaissance	UH1	CH53	AV8	D0033	D1161	E0947	D1162	D1
3	2	Surveillance	ZUAVC	ZUAVD	ZUAVT	UH1	AV8	CH53	A1957	A1
4	3	Reconnaissance	UH1	AV8	CH46	D0033	D1158	CH53	D1161	D1
5	4	Surveillance	ZUAVD	ZUAVT	AV8	ZUAVC	CH53	UH1	A1954	A1
6	5	Provide Shelter	TENTS							
7	6	Command and Control	A0255	CMOC	E0796	D0033	D1158	MPC3		
8	7	Personnel Transport	RIB	D0003	CH53	D0033	E0846	E0856	E0947	
9	8	Cargo Transport/Construction	CH53	D0003	CH46	D0007	D0886	D0862	D0081	D0
10	9	Area Clearance (Engineering)	B0063	B2464	B0060	B2482	B2561	B2561	E0996	E1
11	10	Communications	JTFE	A3232	SWAN	A0067	A1954	A1957	A1955	E0
12	11	Personnel Transport	D1158	D0003	D0033	E0846	E0856	E0947		
13	12	Cargo Transport/Construction/Engineering	CH53	D0003	D0862	D0007	D0081	D0033	D0886	D0
14	13	Area Clearance (Engineering)	B0063	B2464	B0060	B2482	B2561	B2561	E0996	B0
15	14	Reconnaissance	AV8	CH53	D0033	UH1	D1158	D1161	D1162	E0
16	15	Surveillance	AV8	UH1	ZUAVC	ZUAVD	ZUAVT	A3232	A1954	A1
17	16	Command and Control	A0255	UH1	A0499	E0946	E0796	E0948	A0966	D0
18	17	Cargo Transport	CH53	D0003	D0007	D0033	D0081	D0862	D0016	D0

RAND *TR1253-C.20*

- Adding pages: As noted earlier, there are currently three pages supported under the HA mission on the "Select Tasks" screen. Adding an additional page is not difficult, but at this time, it requires some simple modification to the Visual Basic code. It would also require some modification of the Visual Basic code to make this a dynamic feature driven by the configure.xls spreadsheet.

None of these potential functional modifications would be particularly difficult to implement. However, at present, they are not modifiable via the configuration spreadsheet.

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