The Military Missions and Means Framework

Mr. Jack H. Sheehan
PM Knowledge Integration
DoD DOT&E/C3I & Strategic Systems
4850 Mark Center Drive, Alexandria, VA 22311
Jack.Sheehan@osd.mil

Dr. Paul H. Deitz
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-TD
Aberdeen Proving Ground, MD 21005-5071
phd@amsaa.army.mil

Mr. Britt E. Bray
Dynamics Research Corporation
213 C4 Delaware Street, Leavenworth, KS 66048
bbray@drc.com

Mr. Bruce A. Harris
Dynamics Research Corporation
60 Frontage Road, Andover, MA 01810
bharris@drc.com

Mr. Alexander B. H. Wong
U.S. Army Materiel Systems Analysis Activity
Aberdeen Proving Ground, MD 21005-5071
awong@amsaa.army.mil

ABSTRACT

As the Department of Defense (DoD) transforms itself from a forces-based, materiel-centric Cold War posture to a capabilities-based, mission-centric asymmetric-warfare posture, it is increasingly vital that military planners, operators, and analysts concern themselves not only with "doing things right" (i.e., the technical architecture) but also with "doing the right things" (i.e., the operational architecture). Moreover, the historic "right thing" of winning the large-scale conventional engagements in Europe has given way to multiple and diverse "right things" of unconventional combat, homeland defense, peacekeeping missions, and various kinds of military operations other than war (MOOTW). To address these complex new objectives, a framework is needed to comprehensively organize and rigorously specify operational purposes and goals and then explicitly relate, map, and allocate them to the proposed technical means for accomplishment. This paper describes the fundamental elements and usage of the military Missions and Means Framework (MMF), which is increasingly being used to represent the synthesis of military operations and the employment of materiel/forces to accomplish these operations. The MMF provides a disciplined procedure for implementing the transformation guidance in Rumsfeld (2003) and Chu (2003) and the acquisition reform promulgated in Wolfowitz (2003a, 2003b) and Myers (2003).

ABOUT THE AUTHORS

Mr. Jack H. Sheehan is the Program Manager for Knowledge Integration in the C3I and Strategic Systems Directorate of the office of the Director, DoD Operational Test and Evaluation (DOT&E), under an Interagency Personnel Act (IPA) agreement with the University of Texas at Austin. He has concurrent, collateral assignments within Headquarters, U.S. Army G8 and the USD/AT&L Defense Modeling and Simulation Office (DMSO).

Dr. Paul H. Deitz is the Technical Director for the U.S. Army Materiel Systems Analysis Activity (AMSAA). He is a member of the Senior Executive Service with approximately 40 years of experience in laser effects, ballistic vulnerability, and live fire test and evaluation of U.S. Army combat systems.

Mr. Britt E. Bray, LTC(R) USA is a senior military analyst for the Dynamics Research Corporation after retiring from the Army with 23 years of experience in operations, training, plans, and combat development. A graduate of the Army's Command and General Staff College, he served at company through corps levels and also gained Joint experience in the J3 of a Joint Task Force.

Mr. Bruce A. Harris, COL(R) USA is the Director of the Training and Performance Analysis Division of the Dynamics Research Corporation. He retired from the Army with 29 years of service and is a former Headquarters, Army Staff planner and department chair at the National War College.

Mr. Alexander B. H. Wong is a senior analyst assigned to AMSAA's Office of the Technical Director.

The Military Missions and Means Framework

Mr. Jack H. Sheehan
PM Knowledge Integration
DoD DOT&E/C3I & Strategic Systems
4850 Mark Center Drive, Alexandria, VA 22311
Jack.Sheehan@osd.mil

Dr. Paul H. Deitz
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-TD
Aberdeen Proving Ground, MD 21005-5071
phd@amsaa.army.mil

Mr. Britt E. Bray
Dynamics Research Corporation
213 C4 Delaware Street, Leavenworth, KS 66048
bbray@drc.com

Mr. Bruce A. Harris
Dynamics Research Corporation
60 Frontage Road, Andover, MA 01810
bharris@drc.com

Mr. Alexander B. H. Wong
U.S. Army Materiel Systems Analysis Activity
Aberdeen Proving Ground, MD 21005-5071
awong@amsaa.army.mil

PURPOSE

This paper presents the Missions and Means Framework (MMF) for warfare representation. MMF is not a theory of war. Rather, it is a framework for explicitly specifying the military mission and quantitatively evaluating the mission utility of alternative warfighting Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) services and products.

NEED

In the post-9/11 world, the United States needs the capability to counter new, emerging concepts and threats while retaining the overmatch to deter existing, conventional capabilities. Relevant to extant U.S. warfighting capabilities, this requires strategic mobility in hours/days, not weeks/months; Joint netted lethality in close combat; and Combined and noncombatant survivability in complex terrain. In addition, although the nation invests more in military capability than most of the world combined, to achieve national security objectives over the long haul, the suitability of solutions (i.e., total DOTMLPF life-cycle ownership cost) and the time to field capabilities must improve.

Effectiveness and survivability will require unprecedented integration and interoperability across the Services and down to the lowest echelons. Sustainment footprint and personnel efficiency drive suitability. Decision cycles drive fielding time.

Information technology is a key enabler in each case, for both (new) materiel and non-materiel solutions. Unfortunately, the underlying computing technology is changing faster than operational capabilities can be conceived and implemented. Technology “churning” can impede the fielding of effective systems. Non-information technology components of military-grade materiel solutions (the fundamental platforms, vehicles, air frames, and hulls) are expensive, slowly evolving, long-lead elements both in development and manufacture. The pace and disruption of spiral development can make waste here.

OBJECTIVE

Einstein once said that the “perfection of means and confusion of ends seem to characterize our age.” Unfortunately, these words characterize certain DoD transformation initiatives today, where efforts focus largely on the ***materiel***—the physical means needed for successful military prosecution—without adequate consideration for (or linkage to) the ***missions***—the end actions that must be accomplished to meet objectives. To use the terminology of the engineer’s maxim, form (the technical and systems architecture) is often not following function (the operational architecture).

To enable DoD transformations, from concept through actual combat, a framework is needed to help the warfighter, engineer, and comptroller specify a common understanding of military operations, systems, and information and provide quantitative mission assessment of alternative solutions.

A disciplined procedure is required to explicitly specify the mission, allocate means, and assess mission accomplishment. Procedure objectives are to (1) unify the warfighter, engineer, and comptroller understanding of missions and means; (2) account for the tangible, physical, objectively measurable factors (traditional testing and evaluation) and the intangible, cognitive, ultimately subjective factors (traditional warfighter expertise) that constitute mission success; (3) be sufficiently credible, timely, and affordable to make hard decisions—and have those decisions stay made; (4) be sufficiently consistent, concise, repeatable, and scalable to compete effectively with alternative methodologies; and (5) provide a disciplined process to implement the transformation guidance in Rumsfeld (2003) and Chu (2003) and associated acquisition reform in Wolfowitz (2003a, 2003b) and Myers (2003).

RELATED EFFORTS

As reported in Deitz (2002), tailored adaptations of the MMF have been successfully applied in these areas:

- Future Combat Systems (FCS) operational requirements definition (Purdy, PM-FCS)
- Joint Training System (JTS) life-cycle (Rothmann, OSD/P&R)
- Naval aviation training (Duke, NAWC-TSD)
- Comanche analysis of alternatives and Army Battle Control System test and evaluation (Krondak, TRAC-FLVN)
- Air Operations Center design (Andrew, ESC-Hanscom).

More recently, Deitz (2003) and Hughes (2003) report that the MMF has been employed to help define the FCS test and evaluation concept.

THE FRAMEWORK

Fundamental Elements

The Missions and Means Framework (MMF) uses 11 fundamental elements to organize and specify military operations. As shown in Figure 1, mission content is organized into seven groups (hereafter called **Levels**):

Level-7. Purpose, Mission
Level-6. Context, Environment
Level-5. Index, Location/Time
Level-4. Tasks, Operations
Level-3. Functions, Capabilities
Level-2. Components, Forces
Level-1. Interactions, Effects

In addition, the following four transformations (hereafter called **Operator**s) are included:

$O_{1,2}$x: transforms **Level-1** interaction specifications into **Level-2** component states.
$O_{2,3}$x: transforms **Level-2** component states into **Level-3** functional performance.
$O_{3,4}$x: transforms **Level-3** functional performance into **Level-4** task effectiveness.
$O_{4,1}$x: transforms **Level-4** task sequences into **Level-1** interaction conditions.

Also note in Figure 1 the MMF's multi-sided nature. The OPFOR coalition influences the outcome of OWNFOR's mission prosecution. The MMF is a symmetric representation of an asymmetric (perhaps decidedly asymmetric) conflict.

A **Level-7** Mission specification package with references to associated **Level-6** Environment and **Level-5** Location/Time specification packages collectively represents the "Missions" part of the MMF; **Level-1** through **Level-4** and the four **Operators** are collectively the "Means" by which Missions are accomplished (hence, the name Missions and Means Framework). The MMF is intended to provide a compatible extension to the Vulnerability/ Lethality Taxonomy in Deitz (1989, 1999) and Klopcic (1992), the DoD Architecture Framework in Wolfowitz (2003c), and the Functional Descriptions of the Mission Space (FDMS) in Haddix (2003).

Stocking and Assembly Perspectives

The framework has two names for the mission content specified by each **Level**. Consider a building construction metaphor. A buyer employs a builder to construct a home suitable for a resident. The builder constructs the home by tailoring and assembling standard building materials from a supplier.

Using this metaphor, when mission content in a **Level** is viewed like standard parts in a reference library (by analogy, standard materials stocked in a building supply), the MMF uses the first name for the **Level** content: Purpose, Context, Index, Task, Function, Component, and Interaction. Just as in a building supply (where similar materials are stocked together), when the MMF names, records, and references content from this perspective (hereafter called the Stocking Perspective), the organization within the **Level** is an orthogonal decomposition into homogeneous collections of similar content. For example, in the Stocking Perspective, types of armored ground vehicles would be specified in one **Level-2** branch of

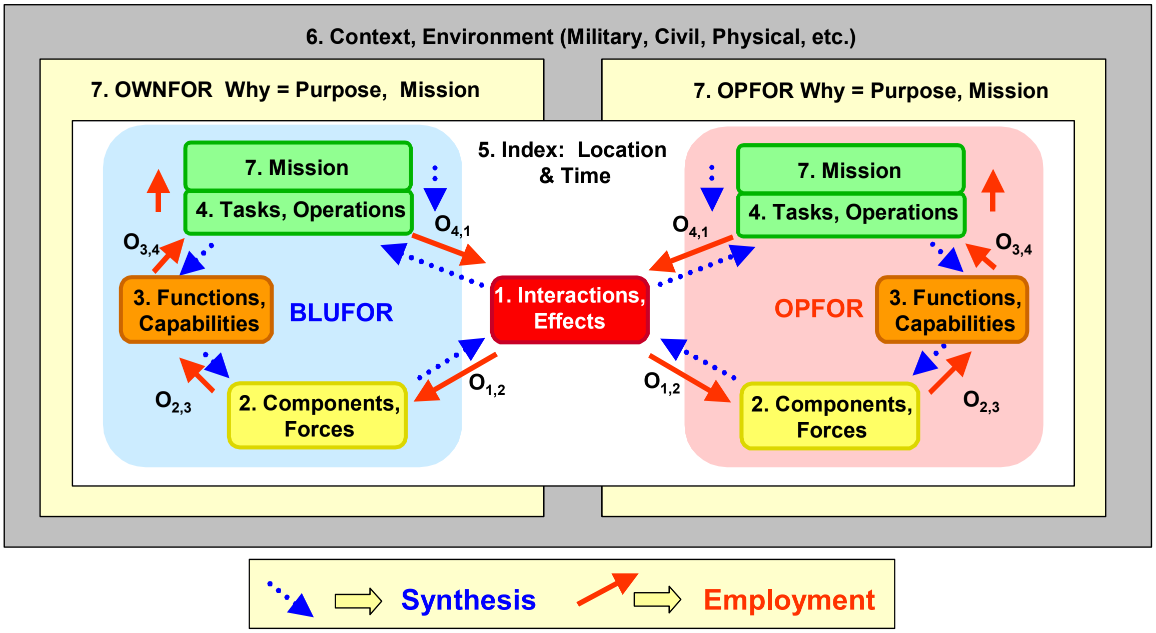

Figure 1. A Two-Sided Missions and Means Framework

the decomposition, types of fighter interceptors would be described in a separate **Level-2** branch, and both would be described as Components.

When mission content in a **Level** is viewed as an assembled package that satisfies a mission requirement (by analogy, a completed room or feature in the home under construction), the framework uses the second name for the **Level** content: Mission, Environment, Location/Time, Operation, Capability, Force, and Effect. Just as in building construction (where diverse materials are assembled to provide a useful kitchen), when the MMF names, records, and references content from this perspective (hereafter called the Assembly Perspective), the organization within the **Level** is a decomposition into heterogeneous packages of diverse content. In the Assembly Perspective, a combined arms ground combat team would be specified in one **Level-2** branch, an aviation strike warfare package would be described in a distinct **Level-2** branch, and both would be described as Forces.

The MMF design employs the DoD Architecture Framework views to define the concepts, rules, constraints, and interfaces needed to assemble parts selected from the Stocking Perspective into packages in the Assembly Perspective. Using architectures, Purpose parts are assembled into Mission packages, Context parts into Environment packages, Task parts into Operation packages, Function parts into Capability packages, Component parts into Force packages, and Interaction parts into Effect packages.

The MMF uses the semantics and syntax of the Functional Descriptions of the Mission Space (FDMS) to organize Stocking Perspective part specifications into Assembly Perspective package specifications (Haddix, 2003).

Synthesis and Employment Operators

The framework has two distinct versions of each **Operator**: Synthesis (the blue [darker] arrows in Figure 1) and Employment (the red [lighter] arrows in Figure 1). An example of the nomenclature for Synthesis is $\mathbf{O_{1,2}S}$ and for Employment is $\mathbf{O_{1,2}E}$.

Synthesis is the top-down planning and decision-making process warfighters and analysts use to create, define, and design a military evolution to meet mission requirements. Employment is the bottom-up execution and adjudication of actual outcomes when own and opposing missions/means collide in the battlespace.

Synthesis and Employment **Operators** are **not** mathematical inverses (e.g., the $\mathbf{O_{3,4}S}$ Synthesis **Operator** is not the mathematical inverse of the $\mathbf{O_{3,4}E}$ Employment **Operator**). In the construction metaphor, the algorithms and procedures an architect uses to design a home are not inverses of those used by carpenters and electricians to build the home.

Layered Decomposition

The MMF uses a layered decomposition. Recommended practices are as follows: **Level-4** Tasks, Operations should be layered by the Universal Joint Task List (UJTL) level-of-war (Figure 2). **Level-2** Components, Forces should be layered by echelons (Figure 3). **Level-3** Functions, Capabilities layers are designed to provide efficient interfaces for the $\mathbf{O_{2,3}E}$ and $\mathbf{O_{3,4}E}$ execution. **Level-1** Interactions, Effects layers are designed to provide efficient interfaces for $\mathbf{O_{4,1}E}$ and $\mathbf{O_{1,2}E}$ execution.

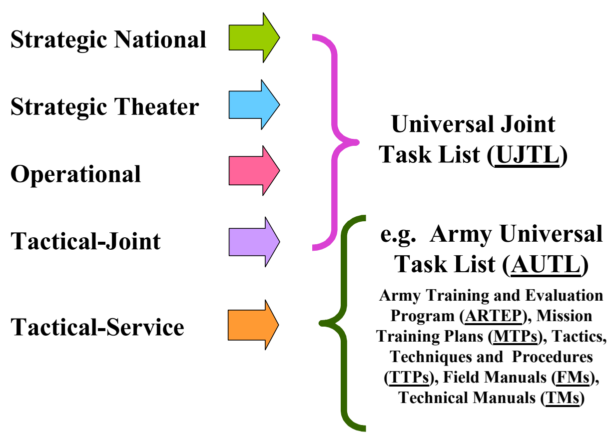

Figure 2. Task Semantics by Level of War

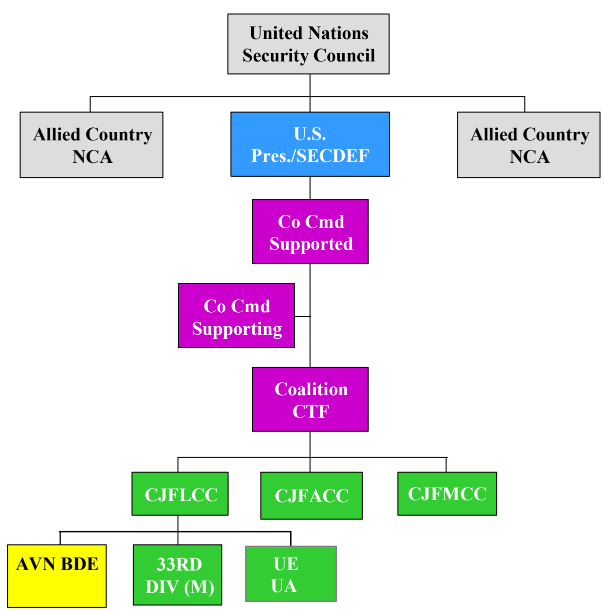

Figure 3. Components, Forces by Echelon

Element Definitions

Level-7: <u>Purpose, Mission</u> defines the "why" and "wherefore" of the military evolution. Definition 3 for mission in JP-1-02 captures the MMF Stocking Perspective intent for Purpose: "An assignment with a purpose that clearly indicates the action to be taken and the reason therefore." The corresponding Army definition for mission captures the MMF Assembly Perspective intent for Mission: "The essential activities assigned to a unit, individual or force. It contains the elements of who, what, when, where and the why (reasons therefore), but seldom specifies how." The focus of Mission within MMF is the "what," "why," and "wherefore" of the required outcomes, not the "who" and "how" to accomplish those outcomes.

Level-6: <u>Context, Environment</u> defines "under what circumstances" a Mission is to be accomplished. MMF employs the UJTL-defined and enumerated taxonomy for military, civil, and physical conditions. Individual conditions are captured as (Stocking Perspective) Context. Context becomes an Environment package specification when a collection of Context conditions is assembled into a consistent whole.

Level-5: <u>Index, Location/Time</u> defines "where" in terms of geo-spatial/materiel geometry and "when" in time. Index is a list of individual items, such as the Global Command and Control System (GCCS) GEO-file of 50,000+ key locations in the world. When assembled into a Time-Phased Force Deployment Data (TPFDD) execution matrix, these elements become a Location/Time package specification.

Level-4: <u>Tasks, Operations</u> are the Task-based, outcome-centric specification of the Operations that provide the Means to accomplish the Mission. Tasks and Operations are the "do what" named-with-a-verb "playbook" of military evolutions. Mission analysis, depicted in Figure 4, is applied to the **Level-7** Mission package (and referenced **Level-6** and **Level-5** package) specifications to identify specified and implied Tasks and to assign conditions (Environment), measures (of Mission accomplishment), and standards (measure thresholds).

The fundamental purpose of **Level-4** is to organize Task outcomes, then evaluate Mission effectiveness. **Level-4** is designed to be a compatible extension of the Mission Essential Task List (METL) methodology defined in the JTS. The Joint Capability Integration and Development System (JCIDS) promulgated in Myers (2003) terms this procedure a Functional Area

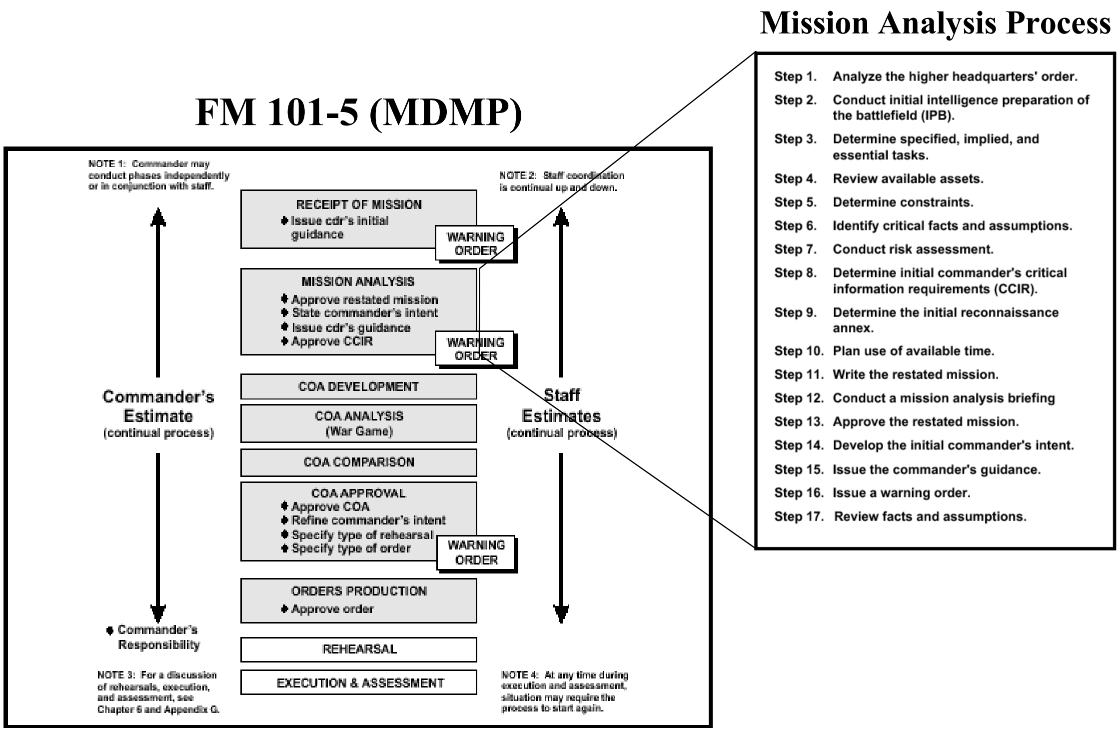

Figure 4. Specified, Implied, Essential Tasks

Analysis (FAA), documented as mission essential tasks, conditions, and standards.

$O_{3,4}$S is the inverse (i.e., time-backward) planning process the warfighter uses to determine the Functions, Capabilities required to complete Tasks, Operations. The warfighter iterates recursively between mission analysis and course of action development and analysis (Figure 4). Mission analysis organizes Tasks into Operations packages to achieve measures of Mission outcome. Course of action development uses measures of performance (MoPs) to assign Capability packages to Operations. Course of action analysis uses measures of effectiveness (MoEs) to determine if the assigned collection of Capabilities enables Task execution to meet Mission requirements. JCIDS terms this procedure Capability Assessment.

The output is a collection of required **Level-3** Capability package specifications including (especially) required performance. Recommended practice is to focus on the performance required to enable Tasks to accomplish Missions and to state these required Capabilities as agnostically as possible ("what" is needed without reference to the "how" of specific Service, unit, or weapon implementations).

$O_{3,4}$E is the forward execution and adjudication process that takes the actual performance that the specified **Level-3** Capability delivered and then determines **Level-4** Task outcomes. Outputs include Capability MoEs for use in a subsequent invocation of the **$O_{3,4}$S** inverse planning process. Recommended practice is to use Task-based fault trees where the delivered Capability is compared to the standard established in the Mission analysis for that measure.

Level-3: <u>Functions, Capabilities</u> are the Function-based, performance-centric "how well" specification of the Capabilities that enable Forces to conduct Operations. Move, sense, communicate, engage, and restore are physical Capabilities. Observe, orient, decide, and act are cognitive Capabilities. At the Strategic National level-of-war, move is the Capability to deploy a Marine Expeditionary Force (MEF). At the lowest Tactical levels-of-war, move is the Capability to crawl out of the trench. Capabilities describe the external value provided; Functions specify the internal necessities required to deliver Capabilities.

The fundamental purpose of **Level-3** is to organize Function performance for **$O_{3,4}$E** evaluation of Task outcome. JCIDS terms this procedure Functional Needs Analysis (FNA).

$O_{2,3}S$ is the inverse (i.e., time-backward) planning process used to select Components and define Forces to implement Functions and deliver Capabilities required in the **Level-3** specifications. Warfighters call this task-organization, strike package development, or task force design. Engineers call this functional allocation of required operational capabilities. Components are selected based on MoPs (e.g., a C-130J can transport this cube/weight this many miles in this many hours) and assembled into Force package specifications based on MoEs (this deployment task force can deliver the specified brigade cube/weight to the theater in this many lifts over this many days).

The output is a selection of organization, equipment, and network connectivity stated as a collection of required **Level-2** Force package specifications (referencing the associated **Level-6** Environment and **Level-5** Location/Time packages), including (especially) measures and standards for personnel and materiel readiness.

$O_{2,3}E$ is the forward execution/adjudication process that takes the actual readiness the specified **Level-2** Force packages deliver and determines **Level-3** performance Capability. Outputs include Force MoEs for use in a subsequent invocation of the **$O_{2,3}S$** inverse planning process. Recommended practice is to use Component-based fault trees where the delivered states are compared to the readiness standards set in the Capability analysis for that measure. Traditional readiness measures focus on materiel repair state and number of available personnel by grade and military occupation skill. As directed by Wolfowitz (2003b), recommended practice is to use METL-based readiness measures/standards explicitly tied to the Mission, Task, Environment, and Location/Time specifications.

Level-2: Components, Forces are the Component-based, state-centric specifications of the Forces that provide the Means to accomplish a Mission. Components, Forces are the "by whom," named-with-a-noun network of physically and virtually integrated units, personnel, and equipment that are the "players" in military evolutions. **Level-2** defines physical networking (mechanical attachment, communications link) as well as logical networking (command and supporting relationships).

At the National Command Authority layer, individual Services are Components. At the aircraft flight layer, lead and wing are Force packages. A warfighter is a human Component just as a circuit board is a materiel Component.

The fundamental purpose of **Level-2** is to organize Component states for **$O_{2,3}E$** evaluation of Function performance. JCIDS terms this procedure Functional Solution Analysis (FSA).

$O_{1,2}S$ is the inverse (i.e., time-backward) planning process used to select Interactions to achieve state changes in **Level-2** Components that will have the intended Effects on **Level-2** Force packages. Warfighters call this target-weapon pairing and Effects-Based Operations. Engineers call this technology selection. Interactions are selected based on MoPs (target X has Y vulnerability to blast) and assembled into Effects package specifications based on MoEs (weapon A can deliver Z lethality > Y vulnerability to target X).

The output is a prioritized list of targets each with associated (hard or soft) engagement/resolution methods. These are stated as a collection of required **Level-1** Effects package specifications (referencing the associated **Level-6** Environment and **Level-5** Location/Time packages) including (especially) measures and standards for delivery and for restoration or damage.

$O_{1,2}E$ is the forward execution and adjudication process that takes the actual Interaction conditions that the specified **Level-1** Effects packages deliver and then determines **Level-2** Component state outcomes. In acquisition programs, this amounts to the actual execution of developmental, operational, and life-fire testing. Outputs include Effects package MoEs for use in a subsequent invocation of the **$O_{1,2}S$** inverse planning process.

Level-1: Interactions, Effects are the Interaction-based, phenomena-centric specification of the Effects that Operations have on Forces. Interactions specify how Task execution changes the state of Forces. Interactions are organized by the phenomena (physics, chemistry, biology, psychology, sociology) that generate them. Effects packages organize Interactions based on outcomes they impose on own or opposing forces (sustain, protect, motivate, demoralize, destroy, suppress, neutralize, disrupt, and deceive).

The fundamental purpose of **Level-1** is to organize Interaction phenomena for **$O_{1,2}E$** evaluation of Component state changes.

$O_{4,1}S$ is the inverse planning process used to identify Tasks, which, if executed to standard, will generate **Level-1** Effects that will lead to Mission accomplishment as supplied by **Level-4** to **Level-7**.

$\mathbf{O_{4,1}S}$ is the "what if" part of the Mission analysis that generates alternative concepts of operation for use in course of action development and analysis.

The output is a **Level-4** specification of Tasks and Operations implied if a particular concept of operation is selected to accomplish the Mission by imposing the stated Effects. Measures and standards are assigned with reference to the associated **Level-6** Environment and **Level-5** Location/Time package specifications.

$\mathbf{O_{4,1}E}$ is the forward execution and adjudication that takes the actual **Level-4** Operations package specifications, both OWNFOR and OPFOR, and determines which Interactions will actually occur at which Location/Time and under what Environment. The output is a **Level-1** Effects package specification. Operation MoEs for use in a subsequent invocation of the $\mathbf{O_{1,2}S}$ inverse planning processes are also produced.

Traditional MoE practice has focused on forces-based, materiel-centric measures such as loss-exchange-ratios, force-ratios required to achieve an objective, or time required to complete an operation. The MMF recommended practice is to focus on Mission-centric, Task-based MoEs. Here, MoE measures and standards are the codification of how planned/delivered Task outcome affects Mission success. In many cases, the required Task outcome often involves setting a desired condition that enables a key subsequent Task.

For example, suppose an Operations package calls for a maneuver unit to block a withdrawing enemy force by occupying a choke point along the enemy line of retreat. Within this Operations package, the required outcome for an Intelligence-Surveillance-Reconnaissance (ISR) Task may be to set the condition that the enveloping OWNFOR unit can complete its maneuver in road march formation rather than assault formation. In that case, the recommended MoE measure and standard should be based on whether or not the resulting Common Operating Picture (from the ISR Task report) was sufficiently credible, timely, and affordable for the unit commander to decide to use the faster road march. Setting this condition provides the additional time necessary for the unit commander to set the subsequent conditions for and execute the desired branch Task "defend a prepared position" rather than the less desirable conditions (imposed by later arrival) where the unit commander must execute the branch Task "hasty attack on a maneuvering enemy."

APPLICATION OF THE MMF

As depicted by Figure 5, the MMF first Synthesizes top-down and then Employs bottom-up. This section provides an example of the processes.

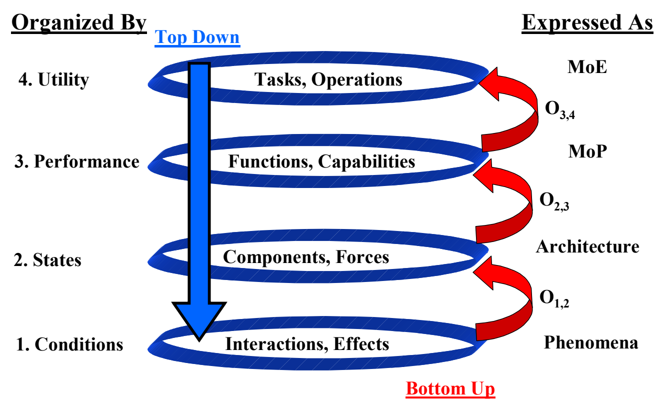

Figure 5. The Synthesis and Employment Processes

As noted previously, portions of the MMF are already being used in the development and testing of requirements for the Army's planned FCS-equipped Unit of Action (UA). To illustrate, an actual vignette from the scenario used to demonstrate the applicability of the methodology has been selected to describe a strategic situation that ultimately drives the need to plan and conduct an attack at the tactical level. The scenario is as follows.

A legitimate, pro-Western government of a Country of Interest is overthrown by radical elements and forced into exile. Radical elements, supported by a neighboring Hostile Country, form a new government and seek to force United Nations recognition. A majority of Country of Interest conventional military forces are loyal to a new government.

The United States believes its national interests and regional stability are threatened. Thus, it takes military action to deter the Hostile Country involvement in the Country of Interest, remove radical elements from power, restore the legitimate, pro-Western government, and stabilize the region and protect U.S. vital interests.

Deployed forces, organized as a Joint Task Force, have started offensive ground operations in the Country of Interest to establish conditions to return the legitimate government by defeating conventional forces loyal to the radical government and isolating the rebel government leadership inside the capital. The Joint Force Land Component Commander (JFLCC) intends to help isolate the rebel government by defeating conventional forces defending the approaches to the capital and preventing them from retreating inside the capital before the capital is surrounded.

Figure 6 shows the synthesis part of the MMF to perform top-down analysis via the planning and decision-making process. Starting at the top left, we identify a set of mission objectives for each level of war in terms of the overall mission Task (or what is to be done [**Level-4**]) along with the mission purpose (or why it is to be done [**Level-7**]). The why is expressed as the desired effect at each level from strategic national to tactical for both OWNFOR and OPFOR. In this case, the overall strategic effect desired by the OWNFOR is to restore the legitimate government to power. Conversely, the opposing force's desired strategic effect is to keep the rebel regime in power. Note that the mission objectives for each succeeding level of war are derived from and support the mission objective(s) at the preceding level of war. For example, the tactical-Joint objective Task of "prevent reinforcement of capital" for the UA becomes the objective purpose at the tactical-Service level for the Combined Arms Battalion (CAB). This "nesting" of Task and Purpose is precisely what military planners try to accomplish to ensure that operations are properly synchronized and focused on meeting the overall commander's intent for accomplishing the mission.

Supporting Tasks that must be performed to achieve the mission objectives are derived from authoritative task lists by applying the commonly used and accepted mission-to-operations-to-tasks decomposition process described in CJCSM 3500.03A, to determine the appropriate Tasks for each operation. Sample Tasks are illustrated in the box immediately below the mission objectives box in Figure 6. Because these Tasks are derived in a specific mission context, taking the Environment (**Level-6**) and Location/Time (**Level-5**) into account, each objective Task and supporting Task can be associated with a relevant set of conditions, measures, and standards. Conditions are determined using Intelligence Preparation of the Battlefield (IPB) products and the results of wargaming during Course of Action (COA) analysis. Standards are likewise determined through wargaming and commander's guidance and may reflect both the qualitative purpose or the desired effect (**Level-7**) of the Task (MoE) and the quantitative performance (MoP) required to achieve the purpose under the anticipated interaction conditions (**Level-1**). The Task with associated conditions and MoPs drives the determination of the capability (**Level-3**) required to achieve the Task MoE (**Level-7**).

The combatant command headquarters employs the components (**Level-2**) that provide the strategic-level capabilities (**Level-3**) required to achieve the desired strategic effect. Included here are some of the broad categories of capabilities that would be needed at each level, such as move, engage, and sense to achieve the desired effects for that level.

How the mission is executed can be described by depicting the complex combination of Operations and individual Tasks, which must be performed in a logical and doctrinally correct sequence. One of the challenges inherent in this process is the management of the proliferation of Tasks that are generated during Task decomposition. When these Tasks are strung together, the number and complex relationship of the Tasks to each other and time can be overwhelming. For example, Figure 7 represents an early attempt to graphically represent the string of Tasks required to conduct one operation from this vignette.

To help resolve this issue in situations where individual Tasks are habitually performed in sequence as part of a process, we have formalized the sequence in the form of an Operations Package (Figure 8) (see Haddix, 2003). Some Tasks (e.g., passage of lines) may stand alone and be represented as a process because they are not habitually connected to other individual Tasks. Operations Packages help model the derived behavior without resorting to complex wiring charts of individual Tasks such as the one in Figure 6. In fact, the entire derived specification can be modeled as one larger Operations Package that fits into the larger scenario. The modularity of Operations Packages facilitates editing the model and depicting continuous or iterative processes.

Another advantage of the Operations Package construct is the ability to save Operations Packages in the form of Formalized Data Products containing the Operations Package description, Tasks (with associated conditions and standards) included in the Operations Package, and a detailed description of their event or time-driven relationship to each other. These saved packages now become modular data packets that can be used as building blocks in the rapid development of "machine-parsable" scenarios/ vignettes.

As previously noted, the MMF employs the DoD Architecture Framework views to define the concepts, rules, constraints, and interfaces to assemble Stocking Perspective parts (in this case, Tasks) into Assembly Perspective packages (in this case, Operations). The specific semantics and syntax for the assembly is drawn from the FDMS (Haddix, 2003).

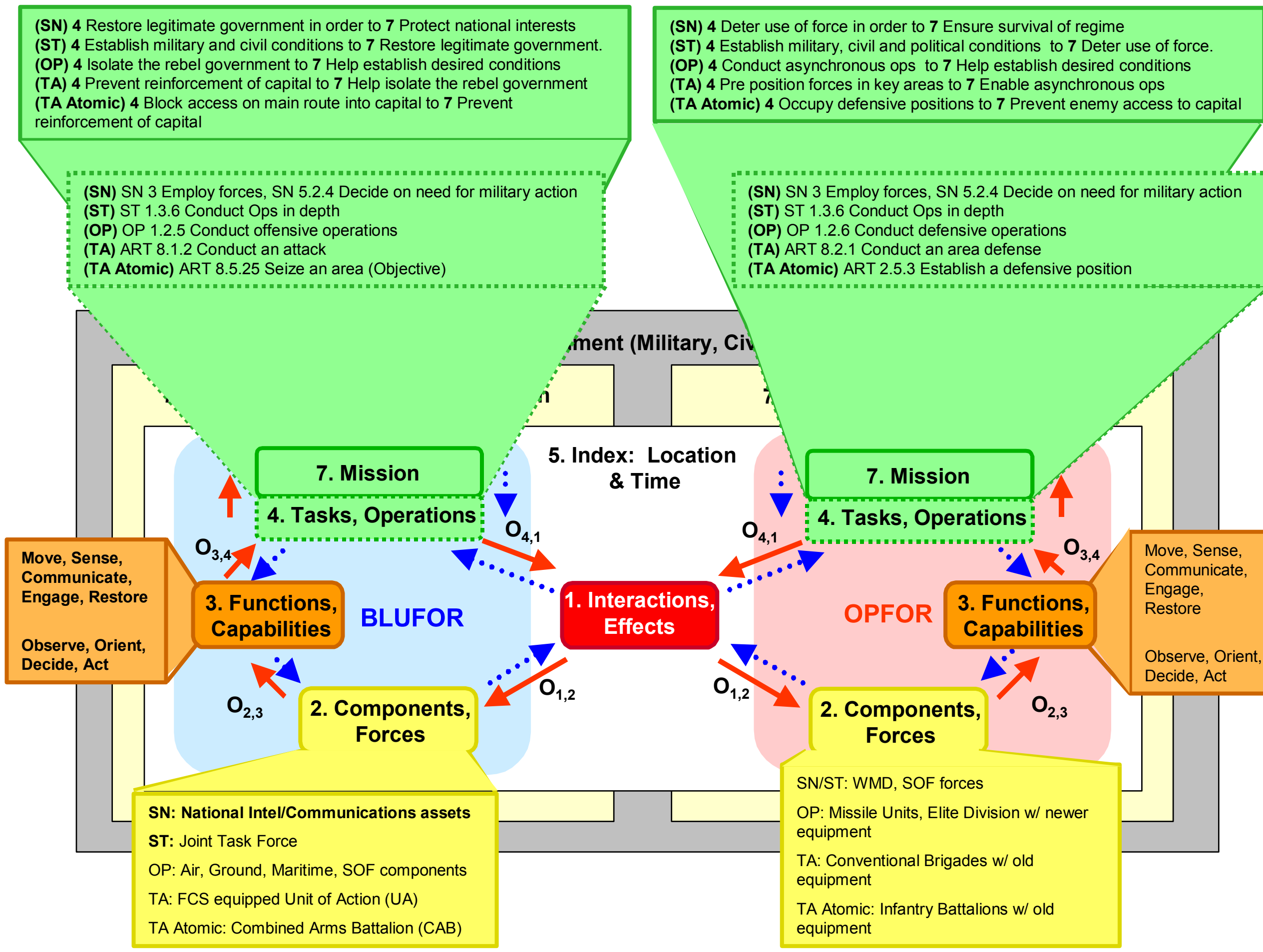

Figure 6. Illustration of the Synthesis Component

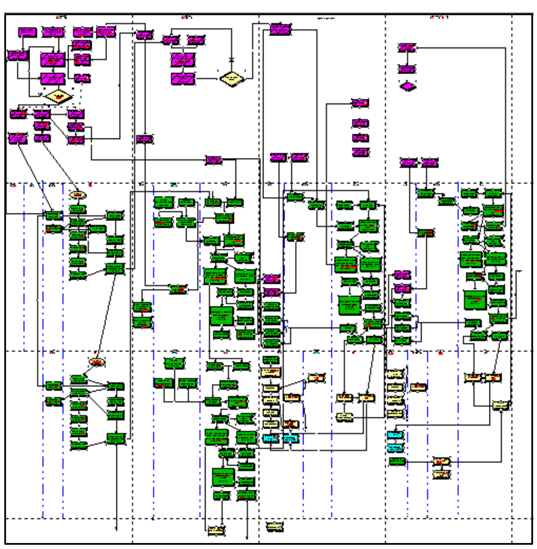

Figure 7. Task Explosion

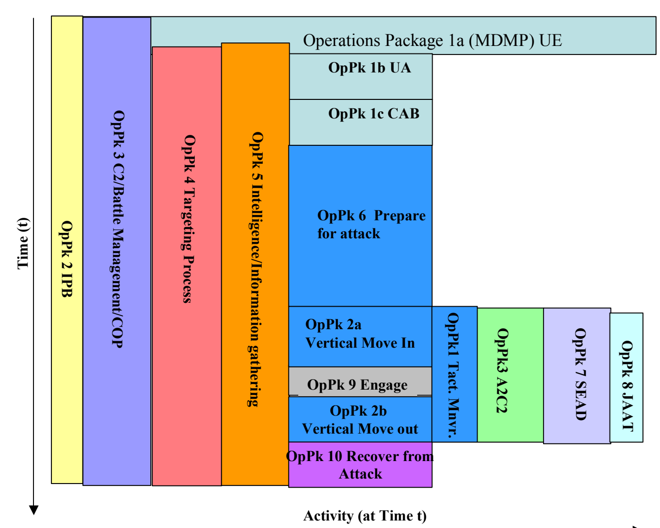

Figure 8. Attack Operations Package

As shown in Figure 8, the Operations Package construct allows us to illustrate the major components (depicted as subordinate processes or Operations Packages) of the specification of behavior at a glance as well as the relationship of the major components to each other over time and to the desired effect—or MoE (the why)—for the top-level mission objective.

As seen in Figure 9, the assembly of these Operation Packages from their component Tasks defines the relations needed to construct the Task-based fault trees that are essential to achieving the aim of relating performance to effectiveness by mapping MoPs to MoEs. By measuring the execution of each Task and subordinate Operations Package against associated MoPs, we ultimately reach the point where we can trace the performance of each subordinate Operations Package to the overall Operations Package's success or failure in achieving its associated MoE.

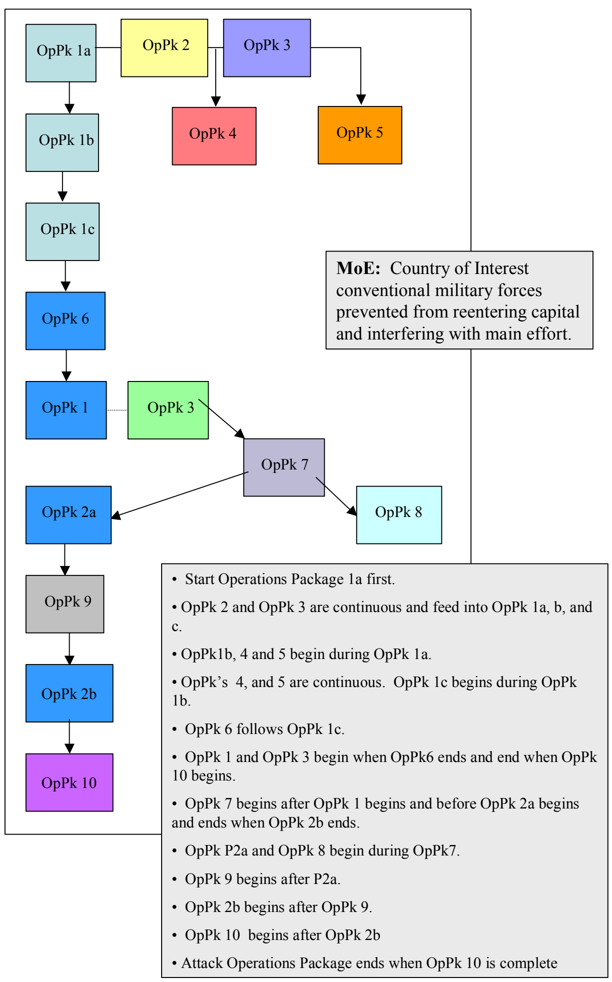

Figure 9. Attack Operations Package Sequencing

As illustrated in Figures 10–12, the framework's iterative synthesis procedure explicitly links measures of performance (MoPs) to measures of effectiveness (MoEs) via METL-based tasks, conditions, and standards. Within the Attack Operations Package, Figure 10 illustrates the Task-based linkage between MoPs and MoEs for one constituent package (Operations Package 3, C2/Battle Management).

The Attack Operations Package represents one piece of the overall military scenario puzzle. By assessing the execution results of this one attack against the given MoE, we can determine the contribution this particular instance of the attack makes to overall mission utility. To further illustrate, we begin this example with Figure 11 at the lowest level by seeing how the successful performance (as measured by a MoP) of a lower-level Task of the Conduct Surveillance Operations Package contributed to the ability to achieve the attack MoE.

In this portion of the scenario illustrated by Figure 11, a UAV is in position and observes the Targeted Area of Interest (TAI) along the enemy's line of communication back to the capital. The CAB is able to observe the enemy moving out of defensive positions and returns to the capital without exposing friendly forces to enemy observation and fires. Thus, the CAB could engage with direct and indirect fires without exposure and prevent the enemy from reaching a key bridge on the way back to the capital.

Consequently, a significant enemy force is unable to return to the capital to reinforce defenders there. This in turn allowed other forces to surround the capital with less enemy resistance, contributing to the ability of the JTF to isolate the capital, which is one of the key conditions required by the combatant commander to restore the legitimate government to power.

As Figure 12 illustrates, the impact of failure can also be traced. Failure to achieve the desired effect results in an undesirable set of conditions that can potentially start a chain of events leading to mission failure unless the situation is recognized and action is taken in the form of a new course of action to establish more favorable conditions.

Transformation Support

Rumsfeld (2003), Wolfowitz (2003a,b,c), Myers (2003), and Chu (2003) provide transformation guidance and promulgate acquisition reform for the DoD. The MMF provides a disciplined procedure to execute this guidance and reform as follows.

MoE: Attack planning, coordination and execution is not adversely affected by inaccurate or outdated information concerning environmental conditions, friendly unit location and status or reported enemy activity, location, strength and intentions. (Y/N)				
Sequence #	Task #	Task Title	**MoP**	Unit
3.8	ART 7.3.2.3	Conduct Risk Management	1) No offensive tasks executed that exceed maximum residual risk established by commander. 2) No casualties as a result of failure to manage risk.	All
3.9	ART 7.6.3	Make adjustments to resources, concept of ops or mission	Adjustments are made to exploit opportunities or resolve problems occurring during execution effectively. (Y/N)	Commander
3.10a	ART 7.5.4	Revise and refine the plan	Revision and refinements to the plan completed in less than one third of time available before execution	Commander and Staff
3.10b	ART 7.6.1.2	Adjust Graphic Control Measures	1) Adjustment of graphic control measures accurately reflected changes in METT-TC (w/in 100 meters) 2) Lag time between operations and adjustment of graphic control measures. (< 5 minutes)	Operations and Intelligence Cell

Figure 10. Operations Package 3 (C2/Battle Management)

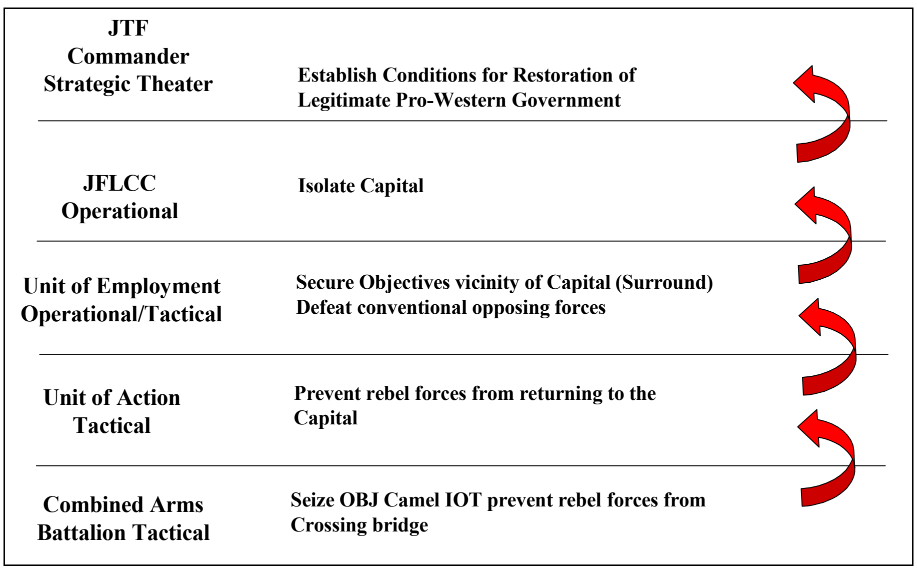

Figure 11. Mapping Effects to Utility

Mission Definition: At the Joint level, JCIDS requires a formal statement of national security strategy, strategy and overall concept for accomplishing, and Joint operational concepts. The traditional process does this in an ad hoc, implicit manner but does not explicitly structure the reference mission sets or the operational scenario. The MMF records this in the multi-sided (OWNFOR and OPFOR) specifications of **Level-7** Purpose/Mission referencing **Level-6** Context/ Environment and **Level-5** Index/Location/Time. For the Army's FCS-equipped UAs, this would be the top-level definition of the reference mission sets and scenarios (e.g., Caspian Sea, Balkans, Northeast Asian, etc.) in the context of national security objectives.

Mission Analysis: JCIDS terms this FAA. The JTS calls this METL-based readiness requirements. The MMF employs the Military Decision Making Process (MDMP) to derive the specified and implied tasks, identify conditions, select measure, and assign standards. MMF records this as **Level-4** Tasks/Operations decomposition (e.g., see the mission

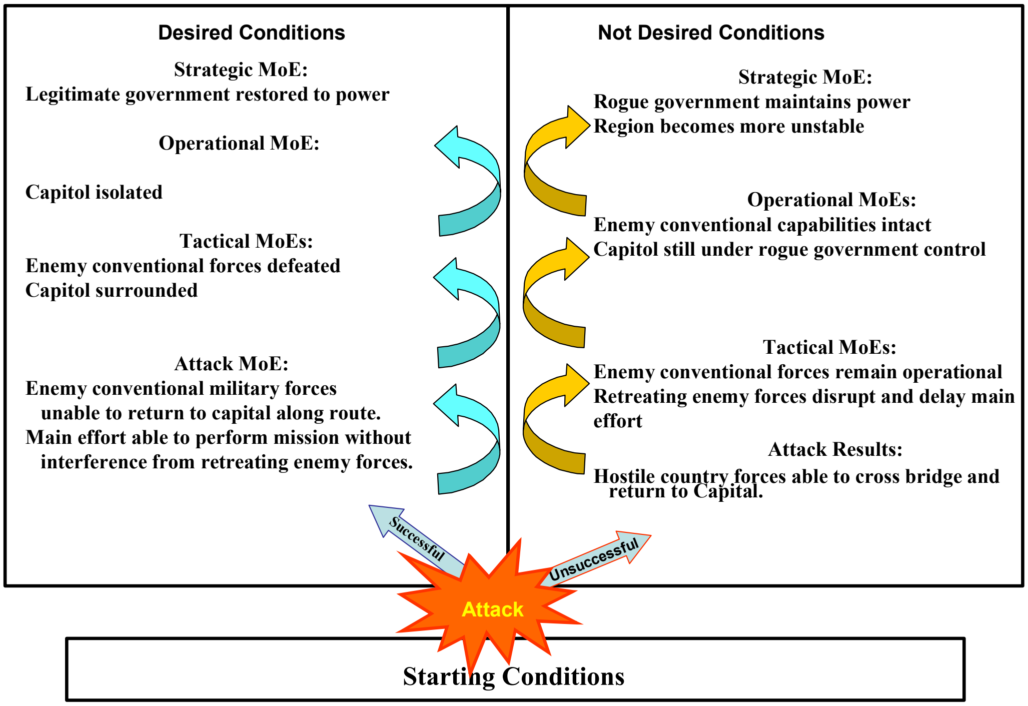

Figure 12. Relating MoPs to MoEs

decompositions referenced in the FCS Operational Requirements Document [ORD]) (U.S. Army, 2003).

Capability Assessment: JCIDS requires a functional concepts decomposition. Training Transformation calls this capability (to do what) based readiness. The MMF employs the $\mathbf{O_{3,4}S}$ synthesis operator to derive a "catholically agnostic" (specifies what, not who/how) decomposition of **Level-3** Functions/Capabilities based on essential Level-4 Tasks/Operations. JCIDS uses an FNA to determine the ability of current/ programmed/proposed capabilities to accomplish the METL under given conditions and standards. This is forward execution of the $\mathbf{O_{3,4}E}$ employment operator. JCIDS records the **Level-3** capability requirements in an Initial Capabilities Document (ICD).

Integrated Architectures: JCIDS and the recently promulgated DoD 5000.2 require integrated Operational, Systems, and Technical standards architecture views. The traditional approach derives the solution (the System of Systems specification) directly from the ORD (with implicit rather than explicit mission analysis, capability assessment, and architecture) and then documents the de facto solution in architecture views.

This is backwards twice removed. The FAA (**Level-4** Task/Operation decomposition) and FNA (**Level-3** Function/Capability gap analysis) defined the required operational capabilities. The purpose for architecture is to design-in required composability/interoperability from the start. Hence, the Architecture Perspectives should be derived from the **Level-4** and **Level-3** content and associated $\mathbf{O_{3,4}E}$ and $\mathbf{O_{3,4}E}$ operator relationships. Then the solution (systems of systems specification) should be derived to comply with the All, Operational, Systems, and Technical standards view defined description of architecture concept of operations and systems engineering decomposition.

The current practice of documenting the full solution in architecture views overloads the intent of architecture. In the spirit of Occam's razor, for the same definition of function/form, a concise architecture is best.

Recall that the MMF has two names each for the seven Levels. The Stocking Perspective part-types are Purpose, Context, Index, Task, Function, Component, and Interaction. The Assembly Perspective package-types are Mission, Environment, Location/Time, Operations, Capabilities, Forces, Effects. And the MMF has two versions of each operator: Synthesis (planning and decision-making perspective) and Employment (execution and adjudication perspective). Within the JCIDS construct, MMF employs integrated architectures (as expressed in All, Operational, Systems, and Technical standards views) to provide the concepts, rules, and technologies to assemble Stocking Perspective parts into Assembly Perspective packages.

When designing/developing a plan, alternative, or solution, the MMF Synthesis operators use architectures to enable/constrain the assembly of Tasks into Operations, Functions into Capabilities, Components into Forces, and Interactions into effects. When employing a plan, alternative, or solution, the MMF Employment operators determine state changes imposed on Stocking Perspective parts by the execution of Assembly Perspective packages and use architectures to determine the state change effect on packages constituted from the affected parts.

Mission Evaluation: JCIDS requires an FSA to determine the degree to which alternative DOTMLPF solutions do/do not remove the FNA-identified capability gaps. In the MMF, the FSA is conducted as follows. The $\mathbf{O_{1,2}E}$ Employment operator provides the degraded (or enhanced) states generated by **Level-1** Effects packages on **Level-2** Component parts. The $\mathbf{O_{2,3}E}$ Employment operator uses architectures to determine **Level-3** Capability package performance based on **Level-2** Component part states and the appropriate architecture rules and constraints.

SUMMARY

The MMF provides the necessary rigor to successfully define and execute a process to evaluate the capabilities and associated mission utility of alternative DOTMLPF solutions. This rigor is required for the DoD to successfully transform from a forces-based, materiel-centric Cold War posture to a capabilities-based, mission-centric asymmetric warfare posture.

REFERENCES

Chu, D.S.C. (2003). Improved DoD Readiness Reporting, Office of the Under Secretary of Defense for Personnel and Readiness, 11 April 2003.

Deitz, P.H., & Ozolins, A. (1989). Computer Simulations of the Abrams Live-Fire Field Testing. BRL-MR-3755, U.S. Army Ballistic Research Laboratory, May 1989.

Deitz, P.H., Sheehan, J.H., Harris, B.A., Wong, A.B.H. (2002). Testing, Training, and Analysis: Relating Force Capabilities to Mission Utility. NDIA 5th Annual Testing and Training Conf., August 21, 2002.

Deitz, P.H., Sheehan, J.H., Harris, B.A., Wong, A.B.H., Bray, B.E., & Purdy, E.M. (2003). The Nexus of Military Missions and Means. 71st Military Operations Research Society Symposium, June 11, 2003.

Deitz, P.H., & Starks, M.W. (1999). The Generation, Use, and Misuse of “PKs” in Vulnerability/Lethality Analyses. *The Journal of Military Operations Research,* Vol. 4, No. 1, 1999, pp. 19-33.

Haddix, F. (2003). The Functional Descriptions of the Mission Space (FDMS) Data Interchange Format (DIF) version 2.0. Defense Modeling and Simulation, May 2003.

Hughes, W.J. (2003). FCS Acquisition and Evaluation Teaming. National Experimentation, Testing, Training and Technology (NET3) Conference & Exhibition, July 23, 2003.

Klopcic, J.T., Starks, M.W., & Walbert, J.N. (1992). A Taxonomy for the Vulnerability/Lethality Analysis Process. BRL-MR-3972, U.S. Army Ballistic Research Laboratory, May 1992.

Myers, R. (2003). Joint Capabilities Integration and Development System. CJCSI 3170.01C, June 2003.

Rumsfeld, D. (2003). Transformation Planning Guidance. Office of the SECDEF, April 2003.

U.S. Army (2003). Operational Requirements Document for the Future Combat System. Change 3 (JROC approved), 14 April 2003.

Wolfowitz, P. (2003a). Operation of the Defense Acquisition System. DoDI 5000.2, 12 May 2003.

Wolfowitz, P. (2003b). Department of Defense Readiness Reporting System. DoD Directive 7730.65, 3 June 2003.

Wolfowitz, P. (2003c). DoD Architecture Framework. Version 1.0, draft DoD Instruction 8800.x.