The DIME/PMESII Model Suite Requirements Project

R. Hillson
Information Technology Division

Introduction: By necessity and doctrine, the projection of "soft power" is becoming increasingly important to the U.S. Department of Defense. The elements of soft power are often abstracted as *Diplomatic, Information, Military,* and *Economic* (DIME) actions and their *Political, Military, Economic, Social, Information,* and *Infrastructure* (PMESII) effects. DIME/PMESII spans the range of operations other than combat, including humanitarian aid, disaster relief, and non-combatant evacuation operations (Fig. 1(a)).[1] DIME/PMESII operations are complex, with unpredictable effects and interactions. Under sponsorship of the Office of the Secretary of Defense, the Naval Research Laboratory (NRL) Adversarial Modeling and Exploitation Office (Code 5508) has completed an initial effort to document the requirements for an integrated suite of models to forecast the effects of DIME actions on the PMESII variables.[2,3] Also considered are the effects of DIME actions on the *Funding, Recruitment, Information,* and *Support* (FRIS) systems of non-state actors.[4] This proposed model suite would assist stakeholders in selecting appropriate mixtures of strategies for DIME/PMESII missions, and in planning for the acquisitions required to support such missions. We have also attempted to identify gaps and deficiencies within the domain of available models and their implementations, to provide direction for future research.

DIME/PMESII Requirements: Two types of model requirements were identified: 1) descriptive requirements (DRs) and 2) architectural or framework requirements.[2] The former define the kinds of DIME actions and PMESII effects that the models and simulations should represent. The latter define the requirements for a software framework and its possible architectural realizations, and are not discussed further here. The DRs specify "what" is to be done rather than "how" to do it, and do not suggest any specific algorithms or models.

Descriptive Requirements: The DRs attempt to articulate the ingredients necessary to represent DIME/PMESII features and processes. The requirements are indexed by category — DIME *actions* and PMESII/FRIS *effects* — and take into account *actor*, *context*, and *entity/organization* (Figs. 1(b,c)). The DRs were derived using a technical approach that combines a military scenario-based activities analysis and a definitional-based noun taxonomy development (Fig. 2(a)). Each

DR has a title, a descriptive phrase referred to as a *task statement* (Fig. 2(b)), and a list of task-specific *nouns* and *actions*. Two examples follow:

Descriptive Requirement A-D-9 (Action-Diplomatic-9):
Title: Refugee Assistance
Task Statement: The model suite will reflect actions associated with refugee assistance, and the effect those actions have on diplomatic efforts with the multinational community as measured across the PMESII elements.
Nouns: refugee, encampment, security, repatriation, sanitary facilities, food distribution,…
Actions: provide, secure, repair, construct,…
Action Links: Logistics, Refugee Info, Refugee Repatriation,…

Descriptive Requirement I-IS-1 (Impact-Infrastructure-1):
Title: Restoration of Essential Public Services
Task Statement: The model suite will reflect military actions to restore/provide public service utilities to the host nation population, and the effect those military actions have as measured across the PMESII elements.
Nouns: utilities, public services, capacity,…
Actions: restore, provide,…
Action Links: Consequence Management, Humanitarian Assistance, Non-combatant Evacuation Operation, Foreign Internal Defense,…

Measures of Merit: Representative *Measures of Merit* (MoMs) are defined for the descriptive requirements (Fig. 3(a)). Among these, *Measures of Action* (MoAs) and *Measures of Performance* (MoPs) describe the characteristics and target behavior of mission systems with respect to pre-defined criteria. *Measures of Effectiveness* (MoEs), in contrast, are mission-specific, and measure how effectively the mission is being executed. If a humanitarian aid task is to restore public facilities, an MoP might measure how many gallons per day of potable water is being produced relative to a facility's known production capability, while an MoE might measure whether sufficient potable water for physiological and medical purposes is being successfully purified and distributed to specific populations at specific locations.

Applying the Descriptive Requirements: The DR set is representative, open, and extensible. It provides a starting point for assessing the capabilities of existing models, and for identifying research areas that may require the development of new models. Assume that a suite of models has been built and/or acquired that partially spans the DR set. A stakeholder would first select a set of DRs that span the domain of the projected DIME/PMESII mission, and would then select and run a subset of models that best address the descriptive requirements selected. Figure 3(b) illustrates the complete modeling process.
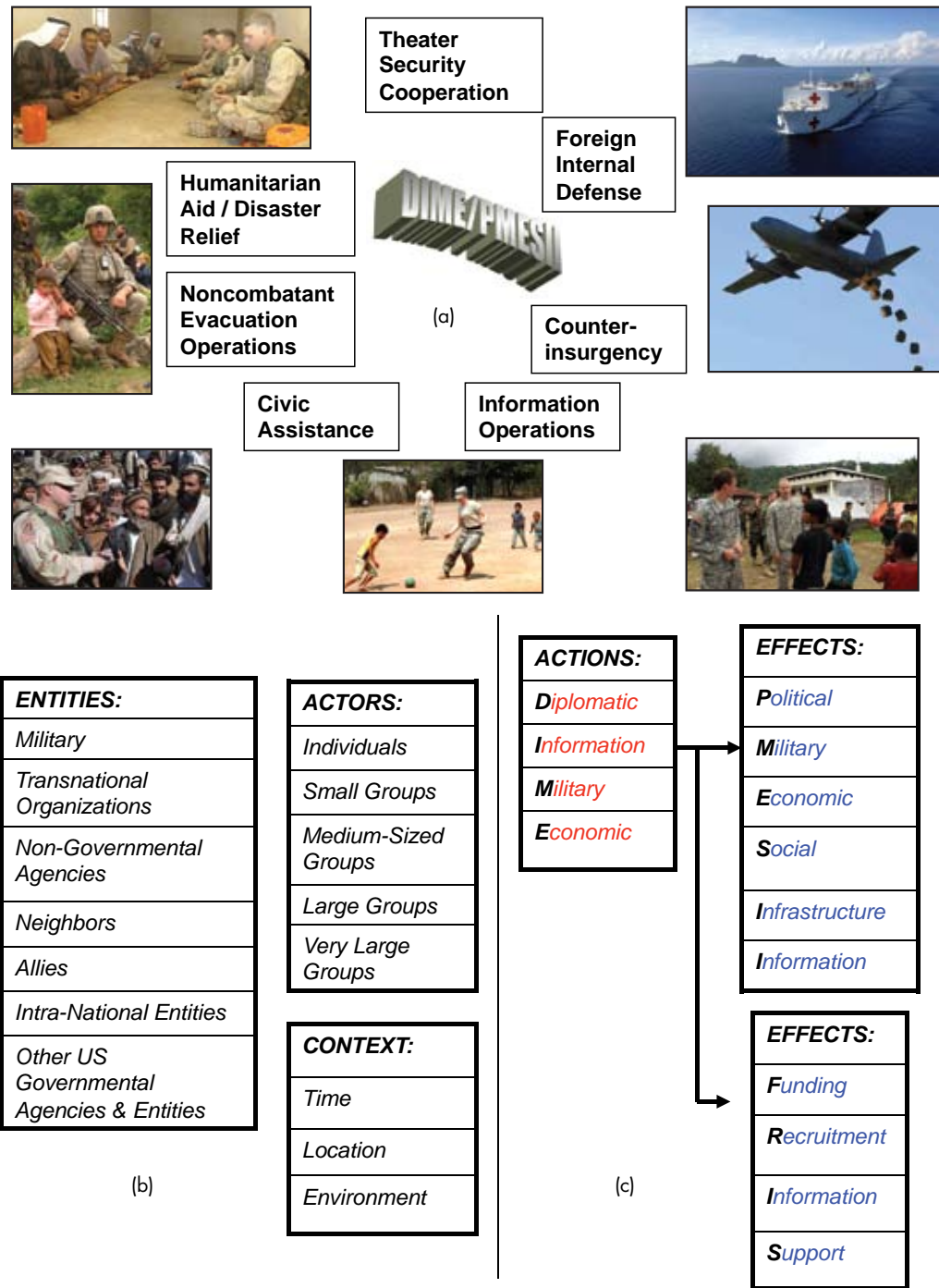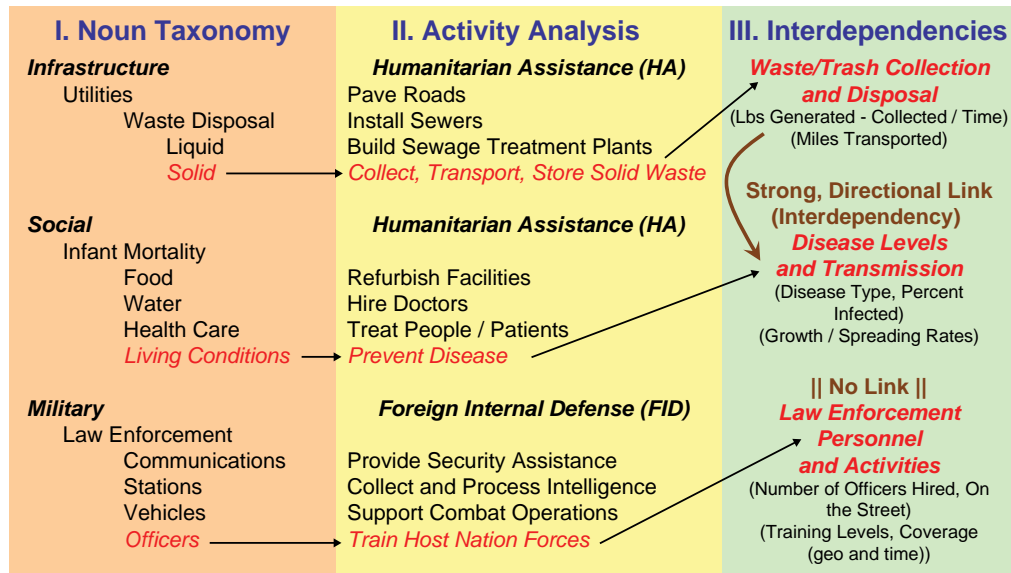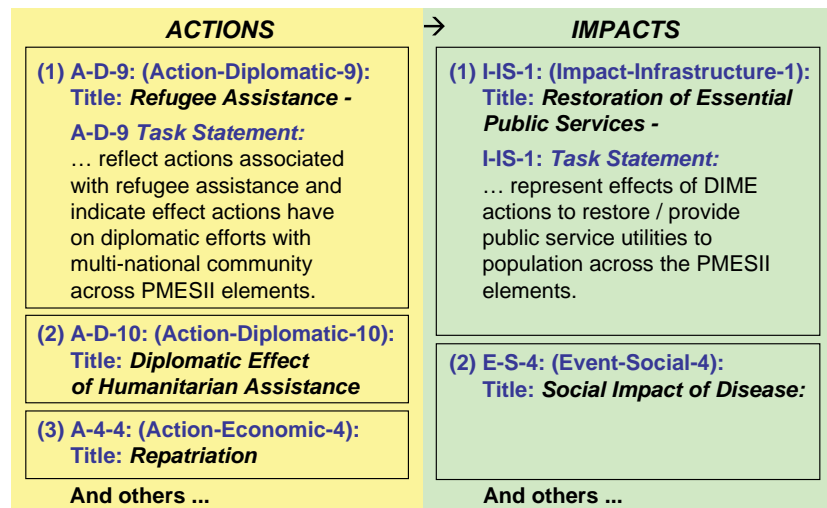
FIGURE 1

(a) DIME actions and PMESII effects span the entire range of military operations other than combat. (b) DIME/ PMESII may involve both military and non-military entities and actors. (c) In the descriptive requirements developed for a proposed DIME/PMESII modeling and simulation suite, the PMESII effects have been augmented by the FRIS effects.

I. Noun Taxonomy

Infrastructure
Utilities
  Waste Disposal
    Liquid
    Solid ⟶

Social
Infant Mortality
  Food
  Water
  Health Care
  Living Conditions ⟶

Military
Law Enforcement
  Communications
  Stations
  Vehicles
  Officers ⟶

II. Activity Analysis

Humanitarian Assistance (HA)
Pave Roads
Install Sewers
Build Sewage Treatment Plants
Collect, Transport, Store Solid Waste

Humanitarian Assistance (HA)

Refurbish Facilities
Hire Doctors
Treat People / Patients
Prevent Disease

Foreign Internal Defense (FID)

Provide Security Assistance
Collect and Process Intelligence
Support Combat Operations
Train Host Nation Forces

III. Interdependencies

Waste/Trash Collection and Disposal
(Lbs Generated - Collected / Time)
(Miles Transported)

Strong, Directional Link (Interdependency)
Disease Levels and Transmission
(Disease Type, Percent Infected)
(Growth / Spreading Rates)

|| No Link ||
Law Enforcement Personnel and Activities
(Number of Officers Hired, On the Street)
(Training Levels, Coverage (geo and time))

(a)

ACTIONS → **IMPACTS**

(1) A-D-9: (Action-Diplomatic-9):
Title: *Refugee Assistance -*

A-D-9 *Task Statement:*
… reflect actions associated with refugee assistance and indicate effect actions have on diplomatic efforts with multi-national community across PMESII elements.

(2) A-D-10: (Action-Diplomatic-10):
Title: *Diplomatic Effect of Humanitarian Assistance*

(3) A-4-4: (Action-Economic-4):
Title: *Repatriation*

And others ...

(1) I-IS-1: (Impact-Infrastructure-1):
Title: *Restoration of Essential Public Services -*

I-IS-1: *Task Statement:*
… represent effects of DIME actions to restore / provide public service utilities to population across the PMESII elements.

(2) E-S-4: (Event-Social-4):
Title: *Social Impact of Disease:*

And others ...

(b)

FIGURE 2
(a) Nouns, activities, and interdependencies related to the descriptive requirement I-IS-1 (Impact-Infrastructure-1, *Restoration of Essential Public Services*) for two concurrent DIME/PMESII missions, Humanitarian Aid (HA) and Foreign Internal Defense (FID). Each DR lists *Nouns* and *Actions* relevant to the requirement. *Interdependencies* may exist between different types of actions. *Restoration of Essential Public Services* will affect the *Infrastructure*, *Social* structure, and the host nation *Military*. There is a clear interdependency between the adequacy of waste disposal and the level of disease, but neither type of activity is linked to law enforcement. (b) To model a humanitarian aid (HA) mission, simulations must be developed and run that satisfy diverse descriptive requirements, many of which are interconnected. In this example, three representative descriptive requirements for modeling HA actions are mapped onto two representative requirements for modeling the HA impacts.
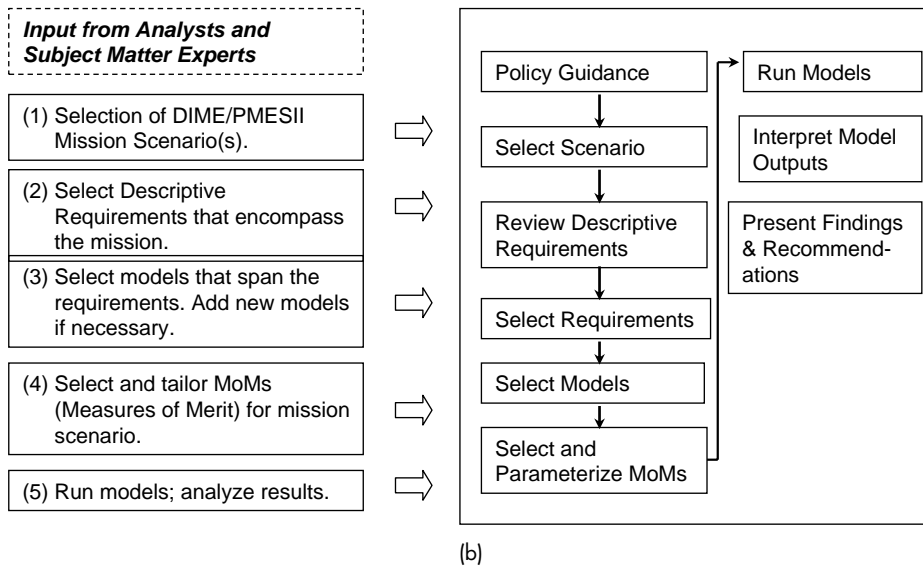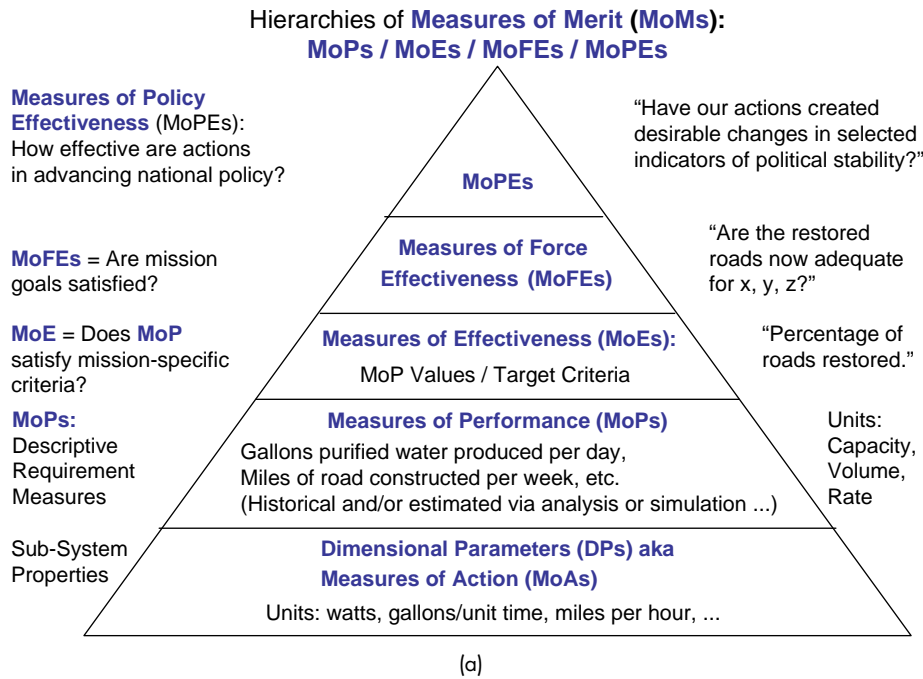
Hierarchies of **Measures of Merit (MoMs):**
MoPs / MoEs / MoFEs / MoPEs

Measures of Policy Effectiveness (MoPEs): How effective are actions in advancing national policy?

"Have our actions created desirable changes in selected indicators of political stability?"

MoPEs

MoFEs = Are mission goals satisfied?

Measures of Force Effectiveness (MoFEs)

"Are the restored roads now adequate for x, y, z?"

MoE = Does **MoP** satisfy mission-specific criteria?

Measures of Effectiveness (MoEs):

MoP Values / Target Criteria

"Percentage of roads restored."

MoPs:
Descriptive Requirement Measures

Measures of Performance (MoPs)

Gallons purified water produced per day,
Miles of road constructed per week, etc.
(Historical and/or estimated via analysis or simulation ...)

Units: Capacity, Volume, Rate

Sub-System Properties

Dimensional Parameters (DPs) aka
Measures of Action (MoAs)

Units: watts, gallons/unit time, miles per hour, ...

(a)

Input from Analysts and Subject Matter Experts

(1) Selection of DIME/PMESII Mission Scenario(s).

(2) Select Descriptive Requirements that encompass the mission.

(3) Select models that span the requirements. Add new models if necessary.

(4) Select and tailor MoMs (Measures of Merit) for mission scenario.

(5) Run models; analyze results.

Policy Guidance

Run Models

Select Scenario

Interpret Model Outputs

Review Descriptive Requirements

Present Findings & Recommend-ations

Select Requirements

Select Models

Select and Parameterize MoMs

(b)

FIGURE 3
(a) The DIME/PMESII descriptive requirements include representative Measures of Merit. Measures of Action (MoAs) and Measures of Performance (MoPs) can be completely defined a priori, but Measures of Effectiveness (MoEs) are mission-specific, and cannot be completely defined in advance of the mission specification. (b) The DIME/PMESII-FRIS modeling process.

Gaps and Deficiencies: Hundreds of DIME/PMESII models exist. In this study, we were able to contrast and compare the properties of a small subset of existing models against the descriptive requirements and the framework requirements.[2] We provisionally identified certain gaps and deficiencies in the current model domain, although we did not attempt to rank these. Notable gaps include the following:

Lack of model integration scheme. Integration of several models is required to richly represent the complexity and interdependencies of the DIME/PMESII problem space. Each model may have its own formats for internal data representation, but the models must be capable of exchanging diverse data types transparently, while interpreting the data accurately within each model. To facilitate this, flexible middleware capable of bridging together any arbitrary collection of models is required.

Absence of models that cover the full range of military activities (Fig. 1(a)). The military operations that are typically modeled represent the realm of conflict. Modeling of other specific operations such as the effectiveness of the training of host nation security forces by U.S. military personnel, or the effects of U.S. operations to provide for infrastructure security are currently not modeled.

Lack of "return on investment" (ROI) assessment. Current DIME/PMESII models provide sophisticated projections of "possible futures." What is lacking is a model, or methods, that will permit us to confidently relate these possible futures to quantitative predicted changes in indicators that are historically correlated with desirable outcomes — for example, increases in the legitimacy and effectiveness of a host nation's government performance.[5] This capability would permit us to compare the relative cost effectiveness of different proposed combinations of DIME actions, while allowing for constraints imposed by budget, schedule, and mission. In summary, a complete ROI approach would let us design experiments to (1) systematically alter different combinations of model input parameters and (2) observe the correlations, both positive and negative, in the contingent forecasts (possible futures) in the solution space.

Summary: The U.S. military is playing an increasing role as a co-provider of humanitarian aid and civic services, as well as being tasked with additional non-combat roles in support of national policy. NRL has written top-level requirements for the development of an integrated suite of DIME/PMSEII models to assist in planning these kinds of missions. This work has resulted in descriptive requirements, framework requirements, a comparison of a small set of existing model capabilities with respect to the descriptive requirements and framework requirements, proposed measures of effectiveness, sample scenario analysis, and gaps and deficiencies analysis. NRL's efforts provide a roadmap for evaluating current and future developments in this area.

References
[1] DoD Directive Number 3000.05, "Military Support for Stability, Security, Transition, and Reconstruction (STTR) Operations," 28 November 2005; Number 3000.07, "Irregular Warfare (IW)," 1 December 2008; Number 2205.2, "Humanitarian and Civic Assistance (HCA) Activities," 2 December 2008.
[2] "DIME/PMESII Requirements Project," Final Report, submitted by the Naval Research Laboratory to OPNAV N81, December 2008.
[3] NSAD-R-08-016, "Naval Research Laboratory (NRL) Diplomatic, Information, Military, Economic (DIME) Political, Military, Economic, Social, Information, Infrastructure (PMESII) Modeling Requirements Workshop, held 5 December 2007 - Final Report," prepared by National Security Analysis Department, Johns Hopkins University Applied Physics Laboratory. For Official Use Only (FOUO).
[4] Kris A. Arnold, *PMESII and the Non-State Actor: Questioning the Relevance*, School of Advanced Military Studies, Ft. Leavenworth, Kan., 25 May 2006.
[5] U.S. Agency for International Development (USAID), "Measuring Fragility: Indicators and Methods for Rating State Performance," prepared for USAID by ARD, Inc., June 2005.