

Methods, Models, and Simulations for the Analysis of Stability Operations



Military Operations Research Society
Irregular Warfare II
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Purpose and Bottom Line

- **Purpose.**

- **Present results of research efforts.**
 - **Research methodology.**
 - **Selection process and tool.**
 - **Viable methodologies, models, & simulations (MM&S).**
 - **Insights from application and gaming.**
- **Discussion/Q&A.**

- **Bottom Line.**

- **Developed and applied a stability operations (SO) MM&S selection process and tool.**
- **Developed a database of 30 applications.**
- **Assessed and ranked them on functionality and utility.**
- **Applied and/or gamed two highly ranked models.**

Agenda

- **Background.**
- **Problem definition.**
- **Constraints, limitations and assumptions.**
- **Research methodology.**
- **Assessment cross-walk (issues, tasks, functionalities).**
- **Assessment results.**
- **Application and gaming insights.**

Background

- **TRADOC Standard Scenarios.**
 - **Corps/Division Southwest Asia Stability Operations scenario (SWA SO).**
 - **Irregular Warfare (IW) scenario.**
- **TRAC Stability Operations Functional Area Analysis (FAA).**
- **HQDA Stability, Security, Transition, and Reconstruction (SSTR) gap analysis.**
 - **TRAC and CAA partnership with HQDA to conduct Army capability and capacity gap analysis for SO functions.**
- **TRAC SO MM&S research.**
 - **What should we model?**
 - **What can't we model in our M&S?**
- **IW Modeling methods and Analysis Working Group (MmAWG)/ IW Working Group Methods Models and Techniques (MMT).**
- **Agent Based Modeling TRAC-MTRY.**

Problem Definition

- **Purpose of research/specified task: Determine usable MM&S to support the analysis of SO and conduct trial applications.**
- **Implied task for the research team: Examine existing MM&S to the degree that **an assessment is possible in determining the utility of the MM&S for the intended analysis purpose.****
- **Accuracy of the answer. Deliverable(s) must have **viable applicability in addressing issues of interest**, emphasizing the capability of portraying cause and effect relationships.**
- **Research scope. Focus is on MM&S capability and utility in support of operational level SO analyses.**

Bauman's Law: Assess no model and compare no model to another model outside the context of its intended purpose and applications.

Constraints, Limitations, and Assumptions

- **Constraints.**
 - Stability operations (SO) scenario development drove desired MM&S functionalities.
 - TRAC will not use a MM&S without access to underlying code and supporting data (no black box).
- **Limitations.**
 - Research effort is focused on MM&S that support operational level analyses.
 - Limited TRAC experience and knowledge of available SO MM&S; reliant on MM&S point of contact (POC) feedback on questionnaires and surveys. Must consider POC possible bias.
 - Research effort does not include a formal cost analysis.
 - MM&S capabilities assessed using potential issues (not actual study specific issues).
 - MM&S assessment based only on a subset of the tasks in the Functional Area Analysis for SO (i.e., original task list from SO scenario development).
 - The MM&S assessment did not include federated combinations of candidate MM&S.
- **Assumptions.**
 - MM&S POC responses/feedback are accurate and form a sufficient basis for the assessment.
 - Formal VV&A of every MM&S against both potential and current issues is too resource-intensive and is infeasible.
 - The SO scenario development issues and attendant tasks are reasonable sets to derive required MM&S functionalities.

Research Methodology

- **Identify candidate MM&S; retained 26 of 30 for assessment.**
- **Assess functionality.**
 - **Stability operations scenario development.**
 - Five Potential Issues.
 - Tasks in eight capability categories.
 - **Identify required MM&S functionalities.**
 - 66 functionalities in support of 124 tasks.
 - **Create and distribute functionality survey.**
 - **Synthesize input – create and apply selection tool.**
 - **Determine results (relative ranking) by issue and as a collective issue set.**
- **Assess utility.**
 - **Create and distribute utility questionnaire.**
 - MM&S attributes (supportive of utility criteria).
 - Narrative assessment (eight capability categories).
 - Team rated POCs' narrative responses.
 - **Apply utility criteria across candidate MM&S.**
- **Integrate survey results and determine relative rankings.**
- **Conduct trial applications and/or gaming with leading candidates.**

Potential SO Issues

Issue #1 What Army and civilian personnel are required to conduct SO?

Issue #2* How does the Army develop a secure environment and transition security activities to host nation authorities?

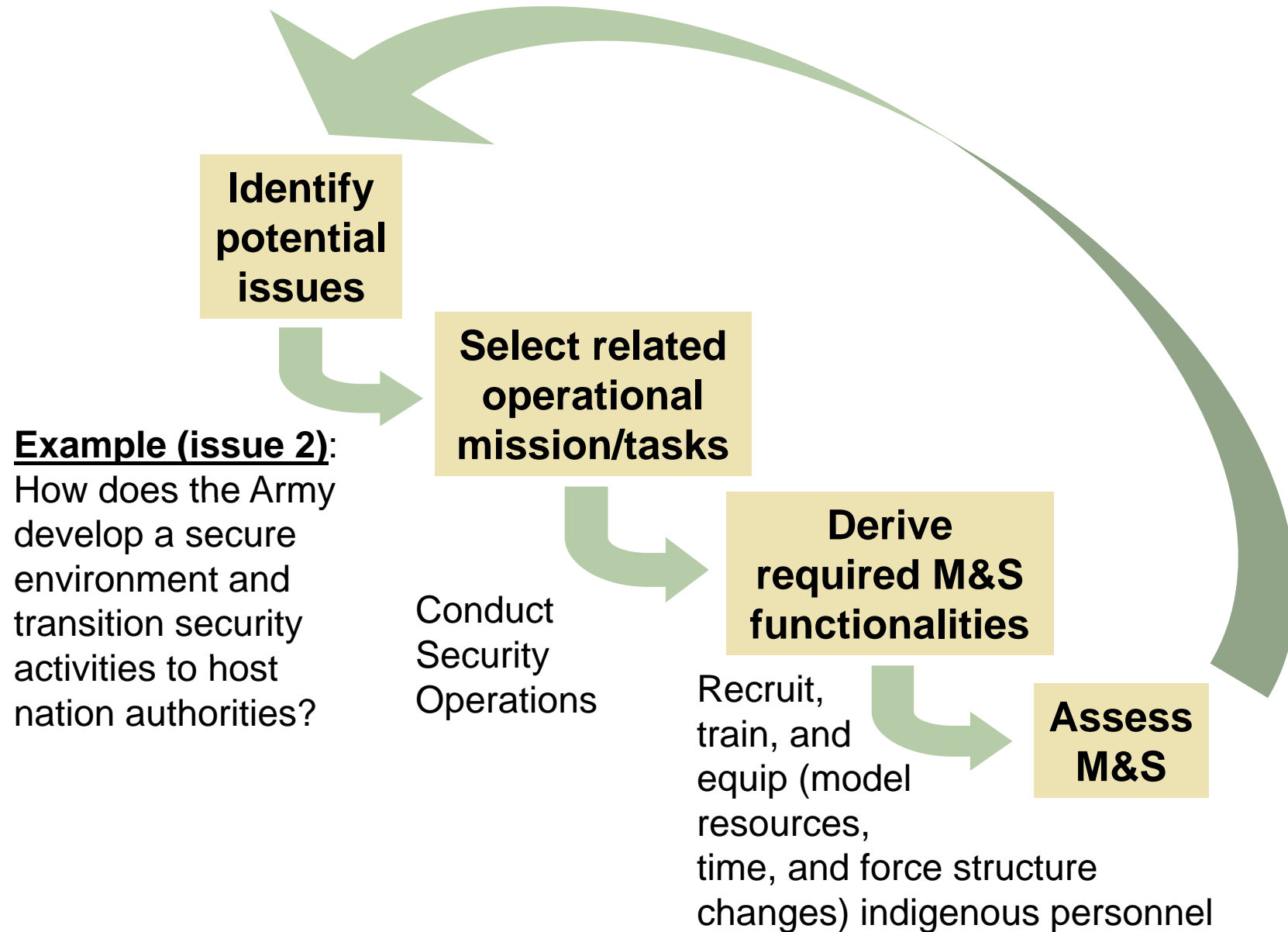
Issue #3 How can the Army share information with other government agencies, coalition forces, International Organizations, NGOs and host nation authorities supporting SO?

Issue #4 To what degree are Army, Corps, and Division staffs capable of commanding and controlling simultaneous combat and SO?

Issue #5 How does the Army evaluate host nation personnel?

***highlighted to illustrate assessment approach**

Assessment Approach: Functionality



Functionality Assessment Results

- MM&S developers self-scored their abilities to address each functionality (0 - 4).
- Data reflects relative score ranking in addressing an issue.
- Total is a sum of issue scores (possible 5.0).
- Unweighted tasks, issues, and functionalities.

Shaded – top 5

<i>Model Number</i>	<i>Issues</i>					<i>Total</i>
	<i>Personnel</i>	<i>Security</i>	<i>Information</i>	<i>C2</i>	<i>Host Nation</i>	
Fourteen	0.74	0.75	0.76	0.75	0.72	3.71
One	0.69	0.66	0.69	0.69	0.70	3.43
Twenty three	0.68	0.66	0.66	0.65	0.70	3.35
Twenty seven	0.65	0.70	0.64	0.69	0.65	3.33
Twenty one	0.63	0.63	0.58	0.64	0.64	3.13
Seventeen	0.57	0.56	0.56	0.54	0.57	2.79
Five	0.46	0.53	0.44	0.49	0.49	2.41
Twenty nine	0.42	0.53	0.48	0.45	0.48	2.37
Seven	0.46	0.46	0.41	0.44	0.42	2.19
Four	0.42	0.40	0.46	0.41	0.45	2.12
Thirteen	0.42	0.40	0.46	0.41	0.45	2.12
Twenty five	0.43	0.40	0.36	0.36	0.37	1.91
Twenty eight	0.40	0.41	0.28	0.43	0.33	1.85
Nineteen	0.32	0.32	0.32	0.32	0.33	1.61
Twelve	0.35	0.32	0.31	0.29	0.34	1.60
Two	0.30	0.31	0.27	0.28	0.34	1.50
Twenty six	0.26	0.33	0.26	0.27	0.29	1.41
Six	0.23	0.30	0.29	0.27	0.22	1.32
Twenty	0.25	0.16	0.24	0.19	0.19	1.02

Utility Criteria

A. Capability to aggregate.

- None to user defined.

B. Maturity.

- Established track record.

C. Run time (real and/or faster than real time).

D. Data input requirements.

- Number of variables and sources.

E. Required resources.

- Personnel, training, HW/SW.

F. Output flexibility.

- Standard/pre-built reports; user definable.

G. Availability.

- Access, proprietary, acquisition (product or services).

H. Portrays public opinion and its relationship with other areas of the model.

I. Impact of political, military, economic, social, infrastructure, information (PMESII) interactions (on popular support).

**Scoring
based on
0 to 3
scale***

**Stability
operations-
specific**

Utility Assessment Results

Shaded – top 5 M&S from functionality

Utility Criteria

	<i>Model Number</i>	<i>Agg</i>	<i>Mature</i>	<i>Run Time</i>	<i>Data</i>	<i>Res Reqd</i>	<i>Flex</i>	<i>Avail</i>	<i>Public Opin</i>	<i>PMESII</i>	<i>Total</i>
②	One	2	3	3	3	3	3	3	3	2	25
⑤	Twenty one	3	3	3	3	3	3	3	2	2	25
	Five	3	3	2	2	2	2	3	3	3	23
	Seventeen	3	3	3	1	2	3	3	3	2	23
	Twenty eight	3	3	3	3	2	3	3	0	1	21
	Seven	2	3	3	2	3	3	2	2	0	20
	Twelve	2	3	3	1	2	3	3	3	0	20
④	Twenty seven	2	3	2	2	2	3	3	3	0	20
③	Twenty three	3	3	2	2	1	3	1	3	2	20
	Two	3	2	2	2	2	1	3	3	2	20
	Thirteen	2	1	2	2	2	2	3	3	2	19
	Twenty five	2	3	1	2	2	3	3	3	0	19
	Twenty nine	3	1	3	1	3	2	2	2	2	19
	Nineteen	2	3	1	2	2	3	3	1	1	18
	Twenty	3	1	2	2	2	3	1	3	0	17
	Four	3	3	3	1	1	1	1	1	2	16
①	Fourteen	2	1	2	2	2	3	2	1	1	16
	Six	2	3	1	3	2	2	3	0	0	16
	Twenty six	1	3	1	2	2	1	1	1	1	13

Rank order of potential MM&S based on the total (unweighted).

Application

- **Integrated Gaming System (IGS) and Peace Support Operations Model (PSOM) ranked among top 5.**
 - Met access to code constraint.
 - Met availability and required resource criteria.
- **Obtained IGS and conducted an initial trial.**
- **Participated in PSOM gaming and obtained PSOM for further gaming and analysis.**

IGS Trial

- **Approach.**

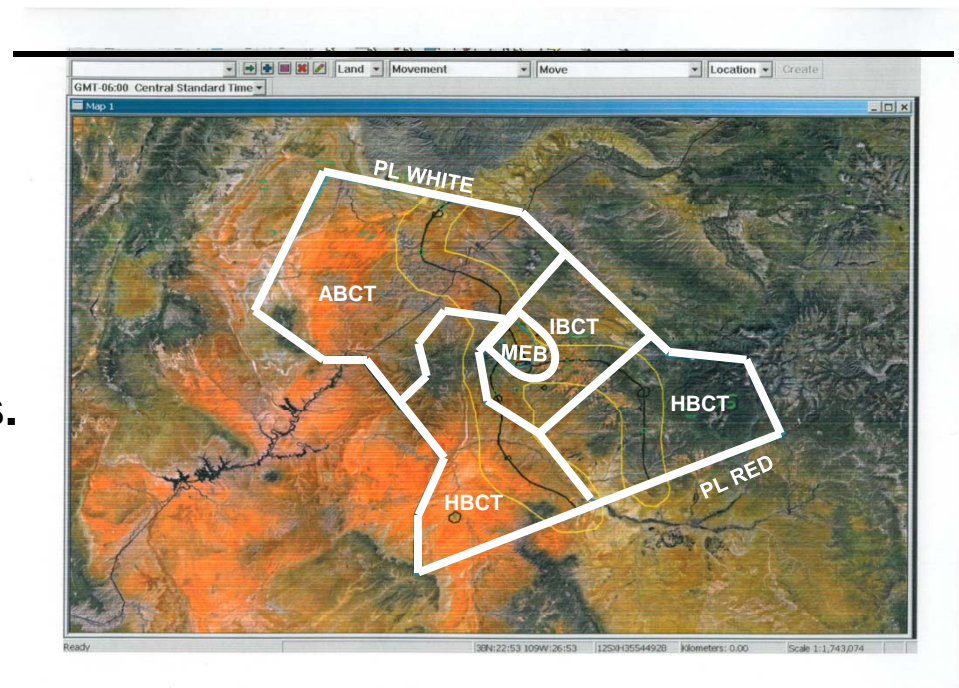
- **Given a TRADOC-approved SO scenario and the latest version of the IGS software and documentation, the simulation analysis team loaded and gamed the scenario in IGS.**
- **The team documented outcomes and insights consistent with applicable measures of merit.**

- **Resources applied.**

- **Contract support for training in IGS.**
- **Four simulation analysts.**
- **One scenario analyst (consultation).**
- **One threat representative (consultation).**

IGS Tools

- Has 3 parts - Scenario Tool, Campaign Planning & Rehearsal System (CPRS) and Entropy-Based Warfare (EBW) Model
- Scenario Tool:
 - Uses 4 display sections: Map, Logistics, Communication Networks, and Task Organization
 - Build an order of battle (OOB)
- CPRS:
 - Build a plan using the .oob file created in the Scenario Tool.
- EBW:
 - Load specific .pln and .oob files.
 - Run Simulation.



Host Nation Representation

- **Regions**
 - Heavy BCT (HBCT)
 - FCS BCT (replaced with HBCT)
 - Maneuver Enhancement BDE (MEB)
 - Infantry BCT (IBCT)
 - Australian BCT (ABCT)
- **Infrastructure**
 - Agriculture
 - Hospital
 - Imports
 - Power Plants
 - Security Forces
 - Water Facility
- **Resources**
 - Government
 - Non-Governmental Organizations (NGOs)
 - International
 - Regional
 - Private Sector
 - United States
- **Factions**
 - A (40.3%)
 - B (15.9%)
 - C (25.5%)
 - D (9%)
 - E (9.3%)
 - Information Exchange (communication network)
- **Agendas**
 - Presence of coalition troops
 - Support for Government
 - Support for insurgency
 - Legitimacy of government
 - Quality of life
- **Civilians, est. population**
 - Southeastern (HBCT), est. 333,675
 - Southwestern (FBCT), est. 51,277
 - Central (MEB), est. 276,610
 - Northeastern (IBCT), est. 770,395
 - Northwestern (ABCT), est. 48,723
 - Total Regional Population= 1,480,680
 - National Population est. 65,875,224

Measures

- **Factions**

- Faction's degree of Satisfaction depends on their expectations and how well their respective needs are met. Needs can be weighted for priority, expectations can be temporarily adjusted using IO, and there is a built-in delay between changes.
- Agenda Resonance is a numerical rating between 0 and 100 showing a faction's stance on a particular issue. 0 means total opposition, 100 means total support, and -1 signifies no stance.

- **Infrastructure**

- Capability is the industrial output of each sector (infrastructure) of the economy. Rate of change is set to default unless specified by user.
- Effectiveness is the actual or current level of infrastructure. The effectiveness initializes to zero (unless steady state is selected) and max is 100.

IGS Impressions

- **Well designed for capturing player actions and adjudicated effects.**
- **Allows for detailed system (equipment, weapons, personnel, munitions) identification in units.**
- **Generates playback, database of unit status, and several reports.**
- **Simulation is flexible in defining infrastructure, factions, agendas, and resources.**

PSOM Gaming

- **PSOM is a UK/MOD Defence Science Technology Laboratory (DSTL) model that began in 04 as the “Stabilisation Study”**
 - **Area of Operations is divided into 50km squares**
 - **Three terrain types**
 - **Open/Desert**
 - **Urban/Suburban**
 - **Dense terrain (Wooded/Mountainous)**
 - **Each square contains**
 - **Value of Consent and Security**
 - **Population Density**
 - **Infrastructure & Human Capital values.**
- **Measures**
 - **Consent of the indigenous population.**
 - **Security to enable normal societal activity.**
 - **Stability (national functionality) for sustained reconstruction.**
- **US gaming experience**
 - **Ginger Junction**
 - **Iraq (2004-2006)**
 - **Africa Study**

PSOM Impressions

- **Appears suited for Strategic and Operational level training and assessment.**
- **Quick response for game intervals.**
- **Gamer friendly with minimal training requirements.**
- **Social behavioral response algorithms incorporated in code.**

Study Support Requirements

The following are needed to support a study using either IGS or PSOM:

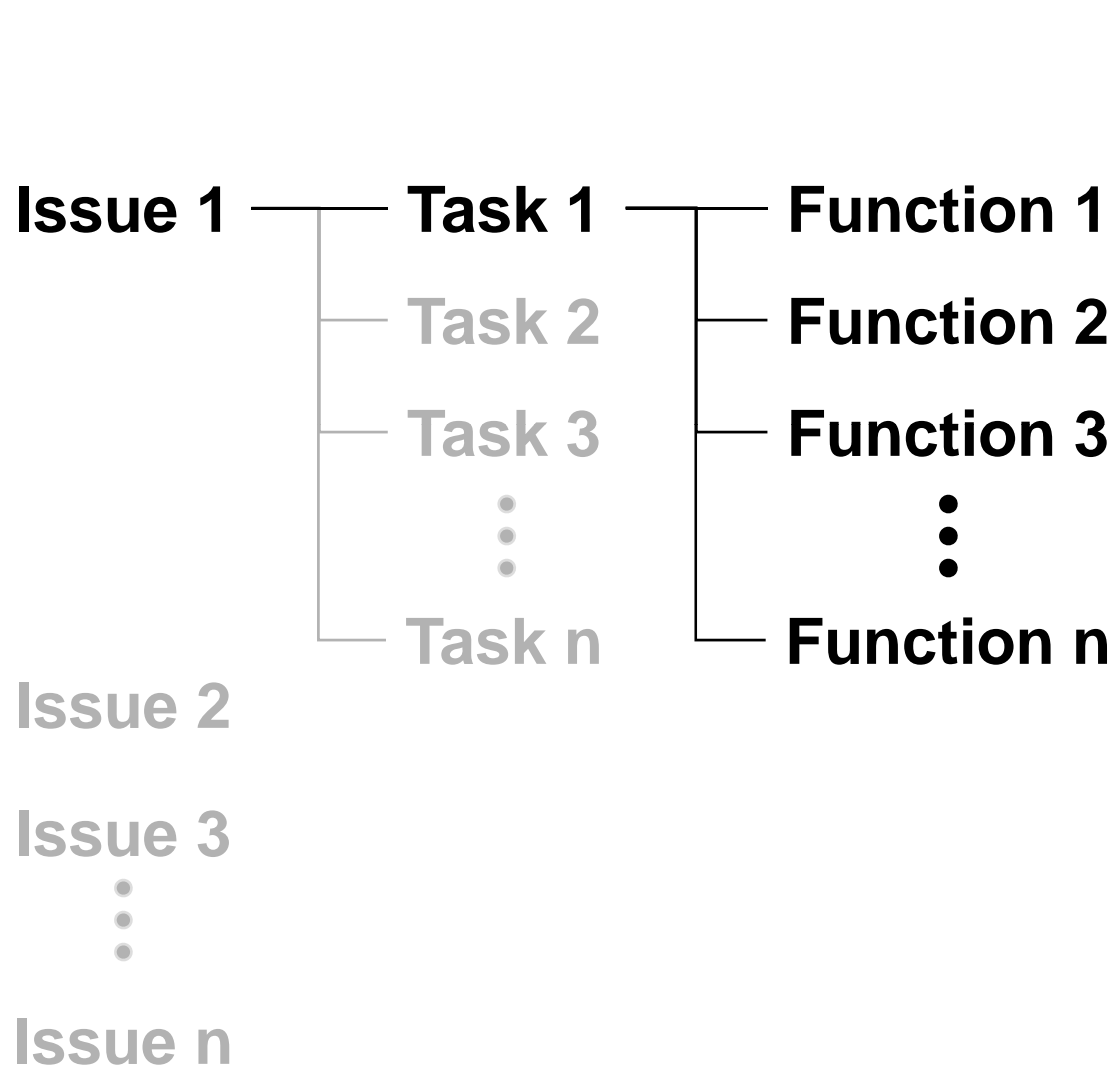
- **Requires modeler support for technical enhancements and analysis products.**
- **Requires friendly, threat, and social science Subject Matter Experts (SMEs) to develop high level strategy that drives operational gaming.**
- **Requires data support**
 - **Certify data for unit / system performance, region-specific cultural data, and operational environment.**
 - **Research data sources for updates and develop database maintenance process or tools.**

Summary / Way Ahead

- **Summary.**
 - **Developed and applied a stability operations methodology, model, and simulation (SO MM&S) selection process and tool.**
 - **Developed a database of 30 applications.**
 - **Assessed and ranked them on functionality and utility.**
 - **Conducted trial applications.**
- **Way Ahead.**
 - **Implement IW scenario in PSOM at TRAC and assess alternative forces.**
 - **Monitor other ongoing IW M&S initiatives.**

Questions?

Functionality Assessment Cross-Walk



M&S
A B C ... Z

Assessment

[See spreadsheet](#)

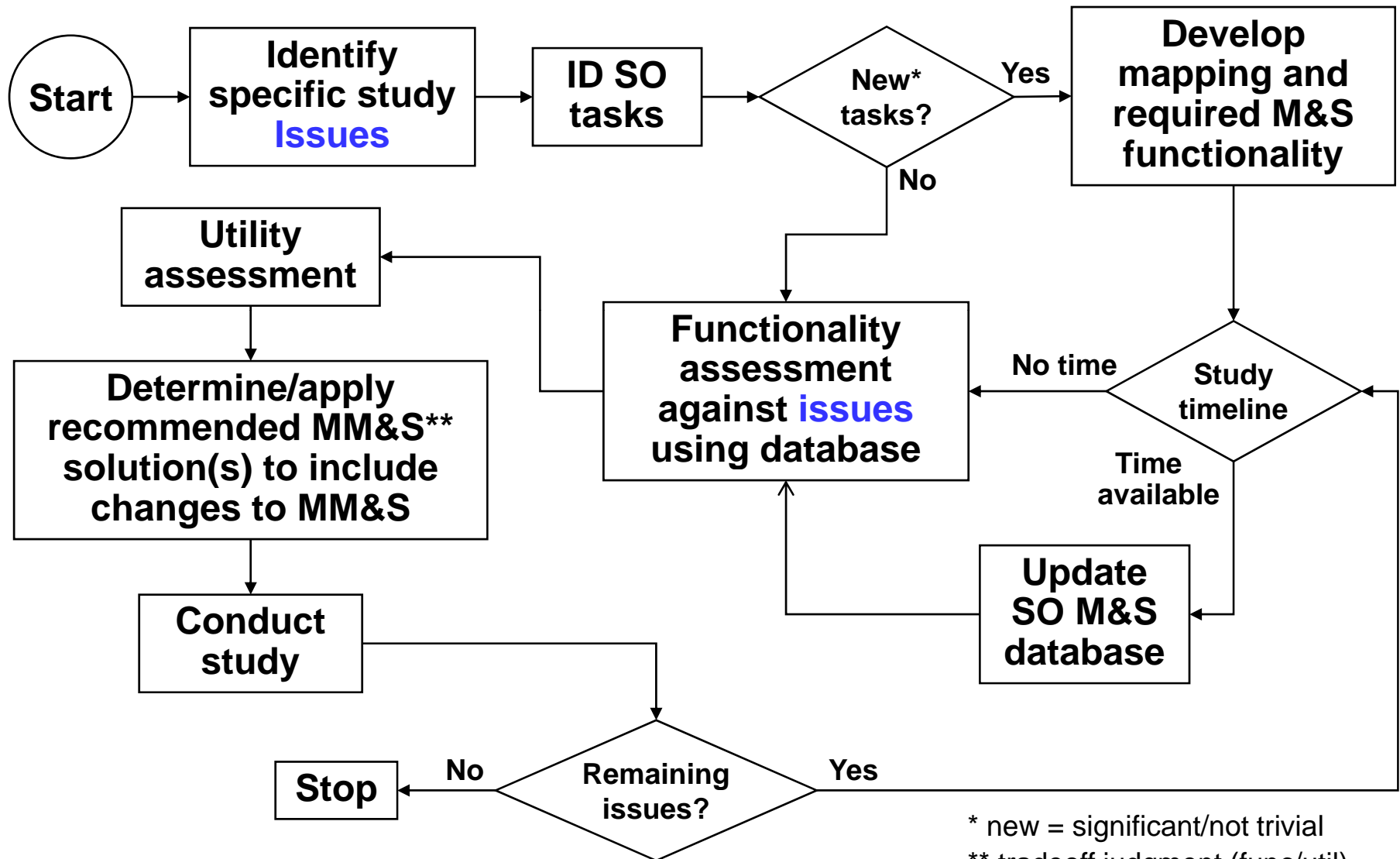
Spreadsheet Example 1 of 2

PotentialStudyIssueNumber	2				
PotentialStudyIssues	How does the Army develop a secure environment and transition security activities to host nation authorities?				
		Model_Number			
		Two		Twenty eight	
Task_Title	Model functionality	Model Score	Max score	Model Score	Max score
Conduct Security Operations	Coordination with EOD to clear areas of unexploded ordnance	0	4	1	4
	Determine and assign security for entities (including work teams and sites) at different force protection levels	1	4	4	4
	Effect of nominating and striking operational targets (e.g. insurgent elements) that are threatening the general population	4	4	4	4
	Entities consume resources depending on requirements (supplies, security, training and infrastructure)	2	4	4	4
	Establish Internment Camps/Prisons (manpower, training, and construction)	0	4	0	4
	Install and maintain a presence within neighborhoods to provide basic security until locals assume responsibility	4	4	0	4
	Monitor and respond to actions taken by indigenous groups against one another	0	4	1	4
	Portray capture and internment of key persons (leaders, criminals, etc) and effect on populace	0	4	0	4
	Portray different levels of Essential Services (SWEAT-MS)	3	4	0	4
	Portray different levels of SSTR support and effect on communities	2	4	0	4
	Portray simultaneous combat / stability ops and interactions	2	4	1	4
	Portray threat attempts to destabilize institutions	4	4	0	4
	Portray transition to indigenous security forces and effect on security operations	4	4	0	4
	Recruit, train, and equip (model resources, time, and force structure changes) indigenous personnel	4	4	0	4
	Seize, secure and dispose of weapons or other sensitive materiel	0	4	0	4
Conduct Security Operations Total		30	60	15	60
Provide EOD Support	Acquire or generate dynamic Terrain data	0	4	3	4
	Coordination with EOD to clear areas of unexploded ordnance	0	4	1	4
	Portray simultaneous combat / stability ops and interactions	2	4	1	4
	Seize, secure and dispose of weapons or other sensitive materiel	0	4	0	4
Provide EOD Support Total		2	16	5	16
Coordinate Host Nation Support		15	44	8	44
Essential services (SWEAT-MS): Security, Water, Electricity, Academics, Transportation Network, Medical, Sanitation (Trash and Sewage); need Academics, Tr		32	68	21	68
Resettle Refugees and Displaced Civilians		20	52	21	52
Assist Host Nation in Populace and Resource Control		26	112	25	112
Conduct Local Security Operations		23	60	24	60
Provide Protection for Operational Forces, Means and Non Combatants		26	56	21	56
Provide Protective Services for Selected Individuals		16	32	14	32
Conduct Internment Activities		13	32	10	32
Provide Refugee/Displaced Civilian Movement Control		5	32	17	32
Provide Support to Civil Law Enforcement		31	92	22	92
Provide Support to DOD and other governmental agencies		16	48	15	48
Determine National/Agency Capabilities and Limitations		16	32	15	32
Provide Support to Allies, Regional Governments, International Organizations or Groups		9	56	21	56
Conduct a Relief in Place		17	28	12	28
Identify/Transition logistical frameworkd for local security forces		27	56	22	56
Mark, Report and Record Obstacles		2	24	11	24
Establish and Conduct Coordination and Liaison		11	44	11	44
Coordinate plans with Non-DOD organizations		24	60	11	60
Perform Non Combatant Evacuation Operations		7	48	22	48
Advise Commander of Obligations to Civilian Population		27	60	16	60

Spreadsheet Example 2 of 2

		Model_Number			
		Two		Twenty eight	
Task_Title	Model functionality	Model Score	Max score	Model Score	Max score
Conduct Civil-Military Operations		27	68	14	68
Provide interface/liaison between US military forces and local authorities/NGOs		22	68	11	68
Conduct Foreign Internal Defense Operations		16	44	15	44
Provide Public Safety Support		16	52	15	52
Provide Law Enforcement and Prisoner Control		20	56	7	56
Coordinate Passive CBRNE Defense in the JOA		5	20	9	20
Conduct Attack on Operational Targets using Non-lethal means		7	24	21	24
Combat Terrorism in an AO		15	44	18	44
Provide NBC Protection to Friendly Forces		3	24	7	24
Integrate Host-Nation Security Forces and Means		14	24	4	24
Provide Operationally Significant Defenses		23	40	18	40
Combat operations (to address the simultaneity of SO and offense/defense) against organized armed resistance, down to individuals; patrolling; urban ops; non-l		18	92	67	92
Portrayal of levels of force protection		12	36	22	36
Conduct Electronic Attack		0	16	13	16
Provide Combat Assessment		8	28	20	28
Conduct Joint Force Targeting		6	32	29	32
Employ Close Air Support		4	20	20	20
Attack Operational Targets		6	36	30	36
Employ Fire Support Coordination Measures		11	32	20	32
Provide Intel Support to Civil-Military Operations		2	60	36	60
Communication with Non-English-Speaking Force and Agencies		13	44	10	44
Locate, tag, and track hostile elements; ISR		9	56	43	56
Conduct Combat Operations in Support of Foreign Internal Defense		15	48	31	48
Sharing of intelligence with security forces		2	44	27	44
Establish foreign disclosure program		4	20	10	20
Grand Total		673	2140	876	2140
		0.314		0.409	

Application Process and Selection Tool



SO~stability operations MM&S~methodologies, models & simulations

Turn 1 (D+60 to D+120)

- **Blue tasks**
 - Security
 - Attacks (clear remnants in city)
 - Helo/UAV patrol routes
 - Engineer repair bridges in cities
 - Convoys on Main Supply Routes (MSRs)
 - Message to HN to lower expectations for goods/services
- **Green tasks**
 - Temporarily lowers expectations for goods and services
- **Red tasks**
 - Reduce signature within HN population
 - Surveillance (monitor blue movement)
 - Destroy bridges
 - Insert IED (51 locations)

Turn 2 (D+120 to D+180)

- **Blue tasks**
 - Continue tasks in turn 1
 - Devote forces to re-building infrastructure where secure
 - SOF avoid direct engagements except when witness IED emplacement
 - Information Operation (IO) to target factions
- **Green tasks**
 - Civilians riot in cities requesting food/water
 - NGOs respond to food/water crisis
- **Red tasks**
 - Continue Surveillance of blue movement and destroy bridges
 - Insert IED
 - in Northwestern Sector
 - between bridges on MSR
 - In cities when Blue sends supplies
 - Car bombs (approximately 25)
 - Obj Bear
 - Border checkpoints

Turn 3 (D+180 to 240)

- **Blue tasks**
 - Security
 - Rebuild infrastructure where secure
 - Informed NGOs that Blue unable to provide them security
- **Green tasks**
 - NGOs continue response to food/water crisis
- **Red tasks**
 - Add regional NGO icons
 - Surveillance (monitor blue movement and NGO locations)
 - Kidnap a few NGOs, hold for 30 days, execute one or two
 - IO telling factions not to cooperate with Blue
 - IO telling factions Coalition can't protect them
 - Support provided to Hospital/Clinics caring for civilian injuries
 - Auto-generate insurgents starts after D+240