Functional Analysis of Army Constructive Simulations: A First Step in Evolving Approaches

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ABSTRACT

The inventory of DoD models and simulations (M&S) has many overlaps in terms of functional capabilities. In an increasingly resource constrained environment, the ability to perform functional assessments and analysis of currently fielded and planned simulations takes on greater significance. Under the sponsorship of the U.S. Army Center for Army Analysis (CAA) and the Army Modeling and Simulation Office (AMSO), an analysis of U.S. Army "Brigade and Below" constructive simulations was conducted in two phases. This paper describes the framework used for this analysis which can serve as a model for other simulation portfolio assessments. Phase I consisted of a functional review of OneSAF (One Semi-Automated Forces) capabilities and user needs across various communities enabled by M&S. These communities included acquisition, analysis, experimentation, intelligence, test and evaluation, and training. Phase II expands upon the insights gained in the Phase I effort to examine a focused set of U.S. Army Brigade and Below constructive simulations. The role of U.S. Army Warfighting Functions, Service Task Lists and associated taxonomical elements are discussed in this paper, as well as the methodology used for data collection and analysis of data. Details are provided that show how simulation functionality was contrasted and compared. This methodology addresses the fact that, for complex multi-resolution applications, more than one level of functionality may be supported with a single constructive simulation.

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INTRODUCTION

The U.S. Army (and the DoD in general) has a huge inventory of models and simulations, which have many overlaps in terms of functional capabilities. In today's resource constrained environment, DoD and the Services must make informed decisions about what models and simulations to continue to support. Thus the ability to perform functional assessments and analyses of currently fielded and planned simulations take on great significance. Although this paper describes assessments that were performed for U.S. Army simulations, the framework we describe can serve as a model for other simulation portfolio assessments.

The study activities described in this paper focus on the characterization and analysis of U.S. Army constructive simulations used for training, analysis, experimentation, test support, operational planning and intelligence analysis. While the data and outcomes generated by these simulations may have operational and strategic consequences, the referent of these simulations is tactical. The studies described in this paper focused on the ability of simulations to represent tactical engagements. According to Field Manual (FM) 3-0 (Operations), [tactical] "engagements are typically conducted at Brigade level and below…executed in terms of minutes, hours, or days." While some "functional" Brigade organizations are designed to accomplish missions within a single warfighting function, U.S. Army Brigade combat teams encompass all of the six warfighting functions described in FM 3-0: Movement and Maneuver, Intelligence, Fires, Sustainment, Command and Control, and Protection (Headquarters Department of the Army (HQDA), 2008).

Project Description and Background

In FY 2012-13, the U.S. Army Center for Army Analysis sponsored an analysis of U.S. Army Brigade and Below constructive simulations in two phases. Phase I consisted of a functional review of OneSAF capabilities and user needs across various communities enabled by M&S. These communities included acquisition, analysis, experimentation, intelligence, test and evaluation, and training. This study phase was led by the University of Texas at Austin Applied Research Laboratory (ARL:UT) and was supported by the Texas A&M University Center for Applied Technology (TCAT). Phase II expands upon the insights gained in the Phase I effort to examine a focused set of U.S. Army Brigade and Below constructive simulations. This study began with an examination of the full inventory of U.S. Army models and simulations used to represent tactical operations at Brigade and Below level, using a selection of entity-level simulations to evaluate their functional characteristics in depth. Phase II was also led by ARL:UT with support from TCAT and the Johns Hopkins University Applied Physics Laboratory (JHU/APL).

OneSAF Study

The Phase I Study was conducted from April through August 2012 and was the result of a OneSAF Senior Technical Review Board (STRB) tasking to describe OneSAF "at various levels (echelons) as to the systems… capabilities and functions represented as a basis for a detailed review to examine adequacy of functional representations and identify

gaps." This effort was intended to provide "a strategic view of OneSAF gaps in addressing user needs," as a complement to the OneSAF Requirements Integration Board (RIB). This effort utilized an integrated product team structure and approach and elicited user inputs from the respective communities enabled by M&S (Scrudder, et. al., Nov 2012). The Army recognizes these M&S communities as Acquisition, Analysis, Experimentation, Intelligence, Operations/Planning, Testing/Evaluation, and Training. All of these communities, with the exception of Operations/Planning, participated in the Phase I Study.

Brigade and Below Simulation Functional Analysis

The Phase II Study began in July 2012 and continues on through FY 2013. This effort includes two main tasks. The first task identifies Army models and simulations: (1) representing tactical operations at Brigade and Below levels; (2) supporting entity-level resolution; and (3) currently in use as identified by sources such as the DoD M&S Catalog, the Army Modeling and Simulation Resource Repository (MSRR), and stakeholder input. The second task, which is most relevant to this paper, includes a functional assessment and comparative analysis of selected simulations identified during the first task. For the purpose of this analysis, "entity-level" is defined as the ability to instantiate, control, and model individual soldiers and platforms. While numerous combat simulations represent individual combatants and weapons systems as aggregated groupings – occupying the same location, with the same field of view, and having the same cover and concealment posture, an entity-level simulation must be able to operate with entities dispersed in time in space, located in unique positions where appropriate (e.g., infantry and supplies occupy separate locations from their carriers when dismounted or unloaded, but may occupy the same space as the carrier when loaded). The definition of "Brigade and Below" simulations includes all simulations that are capable of representing all the individual combatants and systems organic to a Brigade combat team at entity-level. (Scrudder, et. al., Jul 2012)

ONESAF FUNCTIONAL ASSESSMENT

In Phase I, a combination of qualitative and quantitative measures was used to gather user inputs in survey form. Participating organizations were requested to provide one or more use cases describing the purposes and environment in which simulations are used. Thirty four (34) distinct use cases were identified by this process. The entity counts specified by these use cases ranged from a few dozen to over 50,000 entities. To ascertain how well OneSAF met the needs of each M&S community, survey questions were used. Survey questions were organized in a four-part discrete response questionnaire using a six-point Likert scale. During the Phase 1 Study effort, OneSAF capabilities were characterized by the following criteria:

- Mission function by echelon assessment
- Entity representation assessment
- Physical and operational environment representation and effects assessment
- Other factors affecting adoption of OneSAF

Responses from Communities Enabled by M&S

One of the explicit tasks for the OneSAF functional assessment was to complement the domain-centric RIB process to identify Army-wide strategic gaps from across M&S communities and functional representatives. Because this functional analysis included an assessment of suitability and satisfaction among a wide range of users, it was important to have a classification system where responses from "like users" could be aggregated within different user categories. The initial consideration was to use the traditional domains of Training, Evaluation, and Military Operations (TEMO); Analysis, Concepts, and Requirements (ACR); and Research, Development, and Acquisition (RDA).

It became apparent early on that the traditional domains of TEMO, ACR, and RDA did not provide a sufficient level of resolution to appropriately assess the uniqueness of the wide range of users and to identify areas of suitability/unsuitability and alignment with both mission types and echelons. Consequently, the organization structure of the communities enabled by M&S was used. TEMO participation was subdivided into training and intelligence operations, ACR was broken out into experimentation and analysis, and RDA was separated into acquisition and test communities.

Each community was invited to submit responses from individual organizations within their community. In addition, each community was asked to submit a "roll-up" response that represented the overall assessment of how OneSAF met the needs of their community. To ensure that the study team was giving equal weight to each community, the roll-up responses were used in the analysis and provided the results described in this paper.

Mission Functions Assessment

The warfighting functions recognized by U.S. Army doctrine provide a useful, systemic context for the characterization, comparison and functional analysis of capabilities embodied in legacy, developing and planned constructive simulations. As such, establishing traceability to U.S. Army warfighting functions is a necessary step towards the elaboration of a framework for functional analysis that is objective, comprehensive, and relevant to warfighters' needs and concerns. The analysis performed in both of the studies described in this paper shared this common grounding, with essential elements of analysis linked directly or indirectly to U.S. Army warfighting functions.

The mission functional analysis was designed to cover a functional decomposition of the U.S. Army Mission Functions with primary focus and level of analysis targeting Brigade and Below operations. The Phase I OneSAF Study Team conducted an extensive review and assessment of selected contemporary functional DoD taxonomies. The primary taxonomies examined during this effort were the Army Warfighting Functions (WFFs) and the Joint Capability Areas (JCAs) with a secondary assessment of coverage against Full Spectrum Operations. An Army Warfighting Function is defined by FM 3-0 Operations as a group of tasks and systems (people, organizations, information, and processes) united by a common purpose that commanders use to accomplish missions and training objectives. Army forces use the warfighting functions to generate combat power (HQDA, 2008).

JCAs are defined as "collections of like DoD capabilities functionally grouped to support capability analysis, strategy development, investment decision making, capability portfolio management, and capabilities-based force development and operational planning (DTIC, 2007)." Whereas WFFs are described in brief paragraphs, the JCAs are defined in a taxonomy going as deep as six levels, with concise definitions of the capabilities at each level. Furthermore, the study team found that the JCAs encompassed all the WFF (See Table 1), as well as identify additional mission areas of interest. As such, the JCAs were selected as a well-defined and authoritative structure to provide the basis for the extraction of relevant mission functions in the Phase I Study. Table 1 also provides the corresponding mappings from JCAs to WFFs. Thus a subset of the JCA (excluding non-warfighting functions such as business operations) was used as the basis of the mission function analysis.

Table 1. Mission Function Taxonomy

Joint Capability Areas (JCAs)	Army Warfighting Functions (WFFs)
Force Support	Sustainment
Battlespace Awareness	Intelligence
Force Application - Maneuver	Movement and Maneuver
Force Application - Engagement	Fires
Logistics	Sustainment
Command and Control	Mission Command
Net-Centric	Mission Command
Force Protection	Protection
Building Partnerships	*Not covered*

It should be noted here that while the "Building Partnerships" capability area has no direct counterpart in the FM 3-0 WFF, there is ongoing discussion of introducing the "Human Domain" as a seventh WFF in emerging doctrine. (Martin, 2013)

For the mission function assessment, each respondent rated OneSAF's capability to meet the needs for each cross-product of mission function by echelon. Echelons were defined from Echelons Above Corp (EAC) down to individual soldier (ten total) with a provision for the user to define additional echelons (e.g., convoy). Ratings were assigned using the scale shown in Table 2. It is important to understand that OneSAF was constructed to be

customized and tailored by the user community. Configuration on OneSAF (including modifying data, and even user modification of and addition of models and behaviors) is part of the design. Thus all of the ratings - "Fully Capable Out of the Box," "Fully Capable with Configuration," and "Partially Capable" - represent an intended use of OneSAF.

Table 2. OneSAF Functional Assessment Scoring Criteria

Assessment	Description
Fully Capable Out of the Box	Meets the need for the intended past or future use case(s) without modification or configuration.
Fully Capable with Configuration	Can meet the need for the intended past or future use case(s), but requires modification of data (e.g., changing default values) that can be performed by the using organization.
Partially Capable	Can meet the need for the intended past or future use case(s), but requires minor functional and/or interface modification of OneSAF that can be performed using the expertise and resources of the using organization.
Potentially Capable	Does not meet the need for the intended past or future use case(s) applying the expertise and resources of the using organization, but could potentially meet the need via PD OneSAF additions and modifications.
Not Applicable	OneSAF not used by the respondent organization to model the mission function at the echelon for the intended past or future use case(s).
Unknown	The respondent does not know if OneSAF has the capabilities needed for the past or future intended use case(s).

However, when a large number of respondents assess an area as "Potentially Capable" it can be an indication that more capability could be delivered "Out of the Box." Providing the capability might then discourage multiple users from making the same customizations. Those areas rated as "Potentially Capable" identify when users are unable to use OneSAF to accomplish their mission without additional support from the OneSAF program. In addition to the ratings, each respondent could enter open-ended comments for each individual mission function – echelon combination, for each echelon across all functions, and for each mission function across all echelons.

Figure 1 illustrates the mission functional assessment for the rollup-responses provided by each community enabled by M&S. The color coding scheme matches that in Table 2. Considering that any rating except "Potentially Capable" represents the ability for the user to independently employ OneSAF, the visual analysis shows that in the vast majority of cases, OneSAF can meet the users' needs. A similar presentation method was used for visual analysis for the Entity, Environment, and Other Factors effects on OneSAF Adoption assessment described in this paper, although these details are not included for brevity.

In addition to the graphical analysis, a numerical analysis of results was performed. This analysis focused on those areas where potential improvement was most evident. Each "Potentially Capable" rating was assigned two points, and each "Partially Capable" rating was assigned one point. Examining these results and summing them for echelons and mission functions, the following was evident:

- Intelligence and Fires show the highest potential for improvement. These two areas are where the most communities rated OneSAF as partially or potentially capable.
- There is little demand for improvement in mission command or non-combat (building partnerships) modeling. For the most part, only one community identified these functions as of interest, and for the part, rated them highly.
- There is consistent use and demand for improvement at the Individual through Brigade level; slightly higher at Battalion level. The majority of community responses were at this level.
- There is little demand for improvement at the Division or higher level. Only one community provided ratings at these levels.

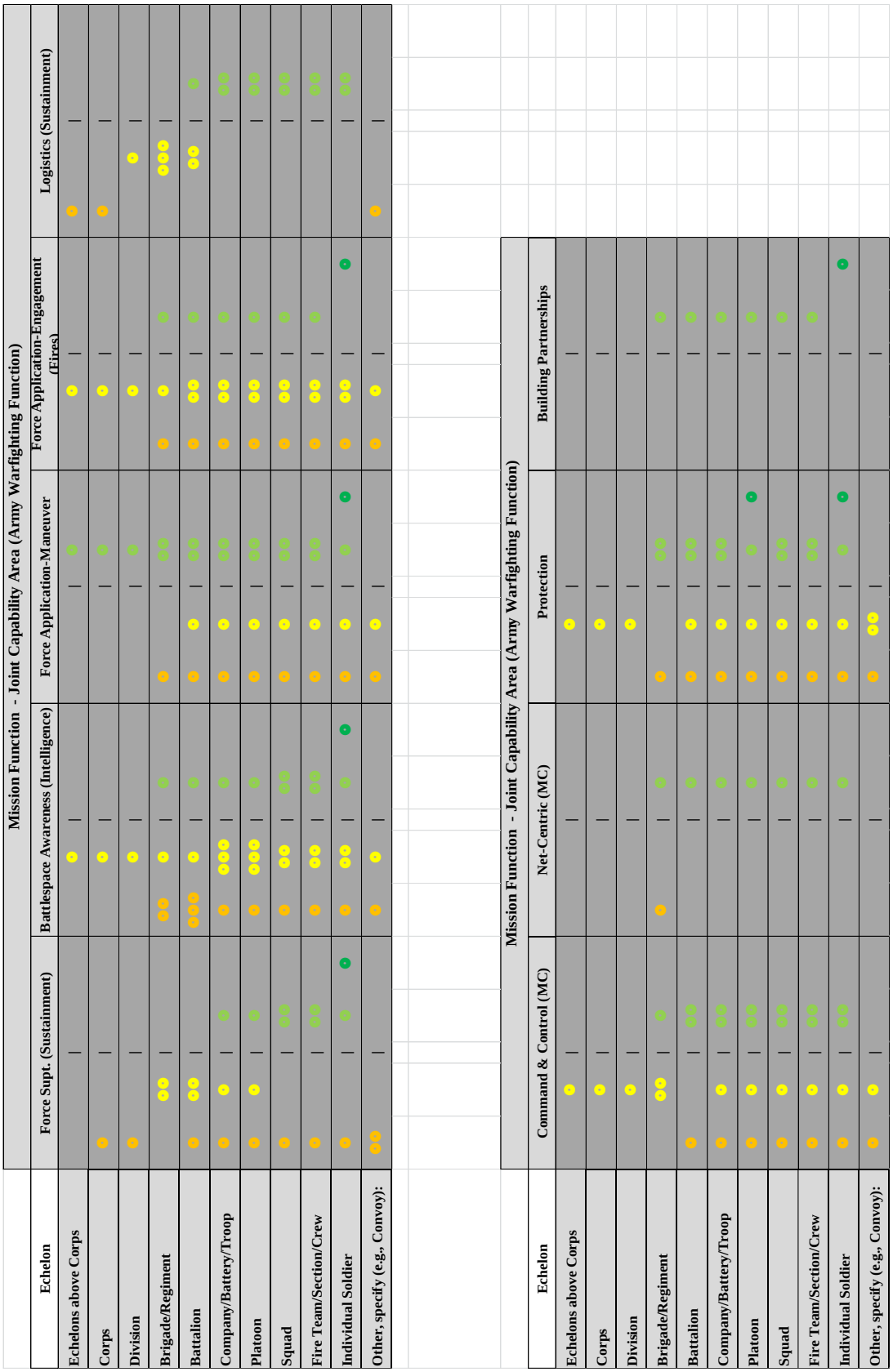


Figure 1. Example Survey Results Rollup

Entity Representation Assessment

For the entity representation assessment, each respondent rated OneSAF's ability to represent different entity types. The full list of entity types was: direct and indirect fire weapons/vehicles, air defense weapons/vehicles, small arms weapons, fixed and rotary wing aircraft, signal-communications systems, electronic warfare systems, radar systems, other combat vehicles, combat service support vehicles, engineer vehicles, civilian/commercial vehicles, infrastructure, and lifeforms. The assessments used the scale shown in Table 2. Separate assessments were provided for force type -- (BLUEFOR/OPFOR/non-combatant) where appropriate. Also, separate assessments were provided for physical and behavioral representation of the entity. Respondents could add entity types, and provide comments at any level.

The same type of visual and tabular analysis described for the mission function assessment was applied to this data. Based on these assessments, the following observations were noted:

- Signal-communication, electronic warfare systems, radar systems, fixed and rotary wing for all force types and OPFOR engineering vehicles showed most opportunity for improvement.
- Rankings were fairly consistent across force type (Blue, OPFOR, non-combatant) and between physical and behavioral models.

Physical and Operational Environment Representation and Effects Assessment

For the physical and operational environment assessment, each respondent rated (using the scale in Table 2) OneSAF's ability to both represent environmental factors (i.e., were they sufficiently present in the simulation) and in the case of physical factors, their ability to realistically influence entity behaviors. Physical environment elements that users were asked to assess were terrain (surface and subsurface), dynamic terrain (weapons effects and runtime engineering (e.g., building berms)), sea state, atmospheric (weather and obscurants), cultural features (buildings and other manmade features), and vegetation. Operational environment factors that were assessed were chemical-biological-radiological-nuclear (CBRN), political, social, economic, infrastructure, and information. In addition to defined environmental factors, respondents were given the opportunity to provide additional factors and open-ended responses for factors not provided.

The same type of visual and tabular analysis described for the mission function assessment was applied to this data. Weather, dynamic terrain (both weapons effects and runtime engineering) and obscurants were the representation factors most commonly rated as opportunities for improvement. In terms of the representation of effects, the areas identified for improvement, in descending priority order were weather, political environment, social environment, information environment, infrastructure environment, dynamic terrain - runtime engineering, vegetation, CBRN environment, dynamic terrain - weapons effects, obscurants, terrain - subsurface, and economic environment

Assessment of Other Factors Affecting OneSAF Adoption

Respondents assessed a wide range of "other factors" relating to OneSAF use and/or adoption. A taxonomy of factors rated is as follows:

- Usability: developer and user training, learnability, efficiency, intuitiveness, memorability, adaptability, stability
- Supportability: installation, hardware and software resources required, manpower, information assurance, technical support
- Planning, setup, and analysis
- Interoperability
- Policy requiring use
- Confidence in results
- Familiarity with similar simulations

For each of these factors and subfactors, a series of one or more statements were provided, and the respondent was asked to respond using the Likert scale shown in Table 3. For example, for usability-memorability, the statement "It

is easy to reestablish proficiency in using OneSAF to perform my mission functions, even if there are long periods between OneSAF use." In addition, the respondent was asked to respond (using the same scale) to the statement "*xxx* is an important factor in my organization's OneSAF adoption," where *xxx* is the element from the taxonomy above.

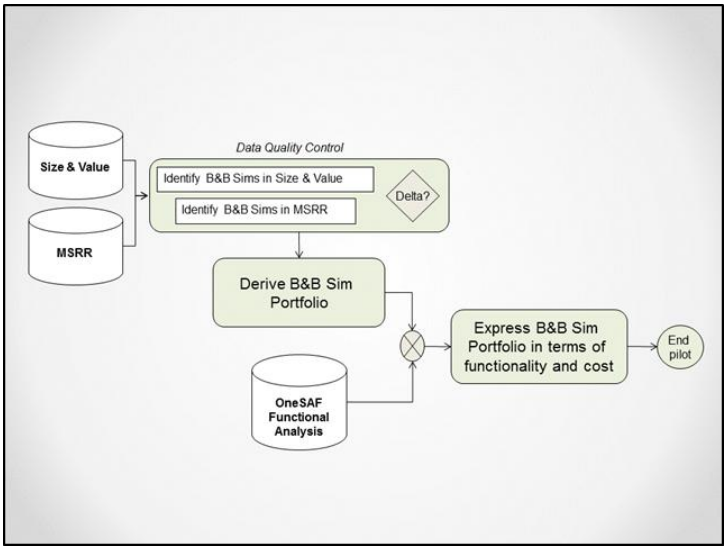
Table 3. OneSAF Adoption Factors Assessment Scoring Criteria

Assessment	Description
Highly Agree	Statement is very much in agreement with organization's position or use
Agree	Statement is in agreement with organization's position or use
Neutral	Organization's position is neutral on this statement
Disagree	Statement is in disagreement with organization's position or use
Highly Disagree	Statement is very much in disagreement with organization's position or use
N/A	Not applicable to organization's position or use

The same visual analysis technique described previously was applied, as well as a numerical analysis. In the case of these results, each "Highly Disagree" rating was assigned two points and "Disagree" ratings were assigned one point. Overall, approximately 30% of the ratings were "Disagree" and less than 5% were "Highly Disagree." Importance and factor assessment ratings varied widely across the communities. The areas that were cited most frequently as problem areas and/or were identified as a key factor in considering adoption were: intuitiveness of use, ease of configuration, stability, speed to become proficient, ability to add models and behaviors, verification and validation documentation, set-up level of effort, scenario development environment, after-action review, user training, error diagnosis, familiarity with similar simulations, and whether OneSAF was mandated for use.

BRIGADE AND BELOW CONSTRUCTIVE SIMULATION ANALYSIS

The Phase II Brigade and Below Constructive Simulation Analysis builds on the insights and lessons learned from the Phase I OneSAF Study effort. In addition to capturing cost considerations, which are not discussed in this paper, the Phase II effort focuses on the detailed functional characteristics of the simulations under study, seeking to answer the question, "what does this simulation do?" By contrast, the Phase I Study focused on the question "does OneSAF meet your Community's needs?" The Phase II effort leverages the JCA/WFF functional decomposition, using this taxonomy as a point of departure to characterize Brigade and Below level constructive simulations.



The Phase II Brigade and Below Simulation Functional and Cost Analysis (BBSFCA) effort follows the process depicted in Figure 2. A unified list was developed from the relevant simulations identified through a search of the relevant resource repositories. This list included 198 distinct constructive models and simulations relevant to Brigade and Below operations. From this pool, 20 entity-level simulations were identified that are capable of simulating one or more warfighting functions. Further characterization identified simulations that supported virtual, real-time 3D environments, stimulated C4ISR devices, or acted as effects servers in a distributed simulation environment or federation. This methodology identified candidate constructive simulations for further assessment described in the remainder of this paper.

Figure 2. BBSFCA Methodological Approach

Analysis Framework and Associated Taxonomies

The Phase II effort defined 23 simulation functions as depicted in Table 4.

Table 4: Top Level Constructive Simulation Functions

Entity Movement	Construct Representation	Optical Sensors	Non-Kinetic Effects
Unit Movement	Fuel Resupply	Imaging Sensors	Terrain
Fire Control	Ammunition Resupply	Radar Sensors	Scalability
Fire Distribution	Equipment Sustainment	Acoustic Sensors	Architecture
Fire Support Coordination	Soldier Sustainment	Communication	System Support
Weapons Effects	Ballistics Modeling	Missile Fly Out	

Table 5 illustrates how these simulation functions relate to the JCA/WFF taxonomy used in Phase I. Each functional category was further decomposed into one or more factors (133 factors/questions total). Each factor represents a range of simulation functionality from least to most complex representation. The intention was to capture a sufficient range of constructive simulation functional representations to enable an objective comparison of any potential combination of simulations under study. In order to capture different combinations of functionality as might be encountered in a set of complex multi-resolution simulation environments, this Functional Analysis Framework (FAF) included the use of multiple choice answers and an open-ended comment block to capture unanticipated representations. This methodology enabled users and analysts to better characterize the functional characteristics of each simulation under study. The factors/questions were structured to allow for single or multiple responses depending on the nature of the question with an "Other" response in the event that all possible responses were not covered. ("Other" responses were directed to the comment block for completion.)

Table 5. Mapping Simulation Functions to Warfighting Functions

Warfighting Function	**Maneuver**	**Fires**	**Mission Command**	**Intelligence**	**Sustainment**	**Protection**	
JCA Topic(s)	**Force Application-Maneuver**	**Force Application-Engagement**	**Command & Control Net-centric**	**Battlespace Awareness**	**Logistics Force Support**	**Protection**	**Building Partnerships**
Entity Movement	●						
Unit Movement	●						
Construct Representation	●	●	●				
Fire Control		●					
Fire Distribution		●					
Fire Support Coordination		●					
Ballistics Modeling		●					
Missile Flyout		●					
Communication			●				
Weapons Effects						●	
Non-Kinetic Effects				●			●
Terrain	●	●	●	●		●	
Fuel Resupply					●		
Ammunition Resupply					●		
Soldier Sustainment					●		

Table 5. Mapping Simulation Functions to Warfighting Functions (continued)

Warfighting Function	Maneuver	Fires	Mission Command	Intelligence	Sustainment	Protection	
JCA Topic(s)	**Force Application-Maneuver**	**Force Application-Engagement**	**Command & Control Net-centric**	**Battlespace Awareness**	**Logistics Force Support**	**Protection**	**Building Partnerships**
Equipment Sustainment					●		
Optical Sensors		●		●			
Electro-Optical Infrared Sensors		●		●			
Radar Sensors		●		●			
Acoustic Sensors				●			
Architecture	●	●	●	●	●	●	●
Scalability	●	●	●	●	●	●	●

The FAF was structured to be administered as a stand-alone questionnaire. The questionnaire was composed of questions to gather respondent information, demographics, and simulation usage metrics, as well as the 23 functional categories. The execution plan for administering the questionnaire incorporates a four stage approach:

- Stage 1 consisted primarily of internal team efforts to research and analyze warfighting functions and derive functional categories and sub-factors. These categories and sub-factors were then vetted through immediate leadership for guidance and concurrence.
- In Stage 2, the questionnaire is being presented to knowledgeable sponsor level organizations to seek validation of structure and initial assessments of functional decomposition. Stage 2 includes a parallel validation of the structure and decomposition, but directed at simulation proponents.
- With the survey instrument/questionnaire validated, Stage 3 is to commence with the analyst team assessment based on available documentation. A prerequisite to this stage is extensive and detailed documentation; the intent is that the team assessment is to be based solely on the published documentation and details of low level functions.
- Stage 4 seeks to gather input from experienced users of two or more of the simulations. The ideal situation is the identification of technically qualified users who have had extensive and deep experience with the simulations under study. The objective is to utilize the subject matter experts (SMEs) knowledge of similar functionality that may exist in two or more of the simulations (to contrast and compare) or where functionality did not exist.

Traceability to Army Universal Task List

The functional decomposition shown in Table 5 is traceable to the Army Universal Task List (AUTL) based on the hierarchy of missions and tasks described in FM 7-15, which provides an echelon-independent description of missions and tasks for each WFF area (HQDA, 2009). JCA topics can likewise be traced to the joint parent document to the AUTL, the Uniform Joint Task List (UJTL). The UJTL is published online and in hardcopy form, representing strategic, operational and tactical missions and tasks applicable across the joint force, and linked to JCA topics (Joint Staff 2009). Both UJTL and AUTL tasks are references used by unit commanders to build their own unit-specific Mission Essential Task List, as applied to their unit organization, current and contingent operational role and mission. The missions and tasks defined in the AUTL and UJTL include stability operations and operations other than war, as well as major combat operations. FM 7-15 breaks out non-kinetic activities operating in the "Human Domain" as part of Chapter 7, which encompasses Full Spectrum Operations, Tactical Mission Tasks, and Operational Themes.

As Table 6 shows, the non-kinetic simulation functions trace to these tasks through the JCA/WFF Battlespace Awareness/Intelligence Functions, as well as the JCA Building Partnerships function. Table 6 illustrates the metrics utilized to assess unit performance when conducting an Establish Protected Areas task as part of a Stability Operations mission (HQDA, 2009). In order to successfully simulate this task, a constructive simulation must be capable of representing the measurable actions associated with its execution.

Table 6. Stability Operations Task 7.3.1.2.4 Establish Protected Areas

No.	Scale	Measure
01	Yes/No	Unit surveyed and identified area.
02	Yes/No	Unit developed the rules of engagement and the memorandum of understanding for the safe area.
03	Yes/No	Unit disarmed and demobilized the safe area.
04	Yes/No	Unit was supported with information operations.
05	Yes/No	Unit established checkpoints and control measures.
06	Yes/No	Unit established a quick reaction force.
07	Yes/No	Unit planned for extraction or reinforcement.
08	Yes/No	Unit supported humanitarian efforts in safe area.

The traceability described in this example is also applicable to "kinetic" missions and tasks, which are associated with the JCA/WFF functions described in Table 5.

Criteria and Scoring

Table 7 illustrates the Phase II Functional Analysis Framework scoring mechanism previously discussed. In this example, the simulation function traces to the Stability Operations measures 7.3.1.2.4-02 and 7.3.1.2.4-03, which includes the establishment of a "safe area." The constructive simulation under study does support assignable return on investment (ROE), including geospatially defined safe areas, as required in 7.3.1.2.4-02.

Table 7. Example Non-Kinetic Effects Simulation Functional Factor

11.D Adherence to ROE	
Context: This question deals with how well simulated units comply with rules of engagement.	
Q11D1 - Does the simulation account for rules of engagement? If so, how well do simulated units and entities follow the rules of engagement assigned to them? Select all that apply.	
	R11D1 – ROE not explicitly modeled.
X	R11D2 - Simulated units and entities always follow the ROE assigned by the scenario or user.
	R11D3 - Simulated units or entities may deviate from assigned ROE based on automated (e.g. reactive) behaviors.
X	R11D4 - Simulated units or entities may deviate from assigned ROE based on combination of morale level and random variation.
	R11D5 - Other; please explain.
Comments: Less well-trained units are more prone to fratricide, potentially engaging neutral (e.g., civilian) targets. Safe areas are defined by a point and effective radius to implement mission-specific ROE.	

As this example illustrates, verbal comments provide insight to the analyst, assisting in the interpretation of the discrete answer results. In this particular instance, two positive responses are recorded, indicating either complex constructive behaviors, or support for multiple methods of representing the simulated function.

SUMMARY AND CONCLUSIONS

As the title of this paper suggests, the available methodologies for the comprehensive, accurate and objective characterization of Army constructive simulations are evolving and will continue to evolve as both the Current Operational Environment changes and as simulation technology improves. It is the authors' contention that the assessment methods described in this paper have broader applicability to a range of government and commercial simulation tools relevant to tactical simulation of current and future operations. Of particular concern is the need to separate the facts about simulation functionality from valuation of the usefulness of one or more simulations in the context of numerous intended uses associated with the respective communities enabled by M&S. The Phase I

results showed a range of responses across communities with respect to how well OneSAF currently meets needs. This appears to validate the OneSAF program decision to offer not a single simulation product, but rather a product line that different communities can use to compose the OneSAF configuration that best meets their needs without providing unnecessary functionality. The Phase I results were briefed to the OneSAF Senior Technical Review Board, which includes representatives from the domains (ACR, TEMO, and RDA) that constitute the OneSAF Requirements Integration Board (RIB). While these results were never intended to supplant the OneSAF RIB process, they do provide valuable insights and long-term opportunities for meeting multiple communities' needs.

The continued successful employment of a functional taxonomy based on a combination of Joint Capability Areas and U.S. Army Warfighting Functions suggests that it is possible to establish and reuse a durable framework for functional decomposition and functional assessment, even as the details of the simulation referent may vary or change over time. For example, the Phase I results showed a shift in the acceptance of OneSAF in terms of Battlespace Awareness by echelon; the higher the echelon simulated, the lower the scores. This implies the existence of a potential gap that may be addressed either by enhancements to OneSAF itself, or by federating OneSAF with another simulation that provides the requisite functionality. Likewise, the discussion of the Phase II methodology addressed the traceability of constructive simulation behaviors to AUTL task standards. This insight is useful, since it suggests that the results of earlier analyses may continue to maintain relevance and inform sponsor decisions with respect to the enterprise level management of constructive simulation assets.

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