MOOTW FAST TOOLBOX: SUPPORTING THE WARFIGHTER IN WINNING THE PEACE

Mr. John Cipparone, Mr. Wayne Randolph
Dynamics Research Corporation
571-226-8765, 407-380-1200
jcipparone@drc.com, wrandolph@drc.com

Mr. Curtis Blais
MOVES Institute-NPS
831-656-3215
clblais@nps.edu

Dr. Dean S. Hartley III
Hartley Consulting
(865) 482-9010
dshartley3@comcast.net

ABSTRACT

Current military operations are exceedingly complex, reaching far beyond direct combat operations into social, political, economic, and information dimensions. As our National Military Strategy continues to emphasize the importance of "military operations other than war" (MOOTW), the demands and expectations for warfighters to understand their shifting roles within dynamic and interrelated settings is likewise growing in importance. Accordingly, military leaders across the ranks require a comprehensive set of modeling, simulation, database, and other computational tools to rapidly represent the operational situation and to perform various analyses to assist in planning, course of action evaluation, decision support, mission rehearsal, and training.

In response to documented operational needs for modeling peace support operations as well as non-force-on-force and stability operations, the Defense Modeling and Simulation Office continues to explore flexible asymmetric simulation technologies (FAST) relevant to MOOTW. An initial prototype MOOTW "toolbox" has been developed comprising a collection of loosely integrated software capabilities to advance critical analysis across shifting civil-military operations in support of deliberate and crisis planning as well as to facilitate data and scenario re-use.

This paper will describe the current operational status of the MOOTW FAST Toolbox, providing a brief synopsis of functional capabilities and proposed additions to the tool set. Inclusive in this overview is an example of how to employ the toolbox in representing and analyzing an operational situation as well as continued science and technology initiatives designed to advance automated processes, especially those related to initializing/updating data for models and applications to use. Finally, the presentation will describe lessons-learned from application of the toolbox in an instructional setting at the Naval Postgraduate School as well as selective insights gained from supporting Service and joint user groups.

ABOUT THE AUTHORS

Mr. John Cipparone is the Program Manager of the DMSO OOTW Toolbox project for Dynamics Research Corporation (DRC). As a Staff Systems Analyst for DRC and a veteran with over 29 years in the U.S. Marine Corps, his expertise lies in instructional systems development and training. He holds a MS degree in Management and MA degrees in National Security/Strategic Studies as well as Guidance and Counseling.

Mr. Curtis Blais is a Research Associate in the Naval Postgraduate School's Modeling, Virtual Environments, and Simulation (MOVES) Institute. Principal research interests include multi-agent simulations and Web-based technologies for military M&S. Mr. Blais has over 30 years experience in development and management of M&S software. He holds BS and MS degrees in Mathematics from the University of Notre Dame and has advanced to candidacy in the NPS MOVES Ph.D. program.

Dr. Dean S. Hartley III is the Principal of Hartley Consulting whose expertise lies in modeling of combat and OOTW, verification and validation of models, psychopharmacology modeling, and simulation. A former Vice President of INFORMS and past President of Military Applications Society as well as Senior Member of the Research Staff at the Department of Energy Oak Ridge Facilities and previous Director of MORS, he received his Ph.D. from the University of Georgia in 1973.

Mr. Wayne Randolph is a Program Manager, Staff Systems Analyst and Systems Administrator at DRC. He served over 21 years in the U.S. Army's transportation/aviation branches. In addition to his logistics and aviation background, his expertise lies in instructional systems development, training/computer integration, and information technology. He holds MS degrees in Adult and Continuing Education and Computer Information Systems.

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BACKGROUND

As the Department of Defense (DoD) addresses the challenges of a multi-polar world environment created in the aftermath of the Cold War, the importance of "military operations other than war" (MOOTW) continues to grow as our military transforms itself to best support our U.S. National Security/Military Strategy. Correspondingly, old paradigms have been replaced in search of new ones as political and military leaders wrestle with a multitude of complex and diverse challenges that face a changing world order—challenges that are unique to conducting operations short of the historical meaning of war as cited in Presidential Decision Directive-56 (PDD-56):

> In the wake of the Cold War, attention has focused on a rising number of territorial disputes, armed ethnic conflicts, and civil wars that pose threats to regional and international peace and may be accompanied by natural or manmade disasters which precipitate massive human suffering. We have learned that effective responses to these situations may require multi-dimensional operations composed of such components as political/diplomatic, humanitarian, intelligence, economic development, and security. (quoted in Hayes & Sands, 1998)

Increasingly, demands are being placed on the military to perform open-ended missions unrelated to traditional military core competencies. These challenges manifest themselves in a number of ways, including the multidimensional nature of MOOTW and the growing frequency of their occurrence. Moreover, political goals and considerations permeate all levels, from strategic to tactical, in which the scope of military operations involves elements of both combat and non-combat operations. Since MOOTW focuses on deterring war, resolving conflict, promoting peace and supporting civil authorities in attaining stability, U.S. forces are often called upon to perform various types of operations. And most significantly, military forces conducting MOOTW often find themselves in a supporting rather than a supported role in which they represent only one partner of many, interacting with governmental agencies as well as nongovernmental organizations (NGO/PVO/IO).

Given geopolitical factors referenced in PDD-56, together with continued technology proliferation and terrorists' attacks, the nature of MOOTW presents the military with unique challenges in planning, analysis, decision support, rehearsal, and training. Modeling and simulation (M&S) management and development communities are placing increasing attention to modeling asymmetric and non-traditional warfighting, most notably with operations in urban terrain. Whereas simulation systems over the past several decades have struggled with appropriate representation of combat on land, sea, and air, MOOTW presents wide-ranging questions regarding what to model, how to model, and for what purpose. Such questions, when scrutinized, will promote holistic political-military policies supporting our National Security Strategy.

DEFINING MOOTW NEEDS

As combatant commands (COCOMs) continue to confront the ambiguities associated with MOOTW M&S, the preparation of military leaders to "fight and win" on the MOOTW battlefield faces a range of related concerns. Foremost is recognition that "analysis tools to support decision-making for large-scale military operations (such as major regional contingencies) are relatively mature. In contrast, OOTW analysis tools are embryonic or non-existent." (Hartley, 1996) Supporting this assessment, the following COCOM comments extracted from the Defense Modeling and Simulation Office's (DMSO) Warfighter M&S Needs Database illustrate current shortfalls (Crain, 2002):

- M&S tools today to train joint task forces, 4-star lead joint task force (JTF): Current models do not provide the capability to train to all missions…particularly non-force-on-force, peacekeeping OOTW. (EUCOM)
- COCOM battle staffs currently lack a federated simulation that provides the detailed resolution

needed in today's asymmetrical warfare environment. (JFCOM)

- A standardized, collaborative and distributed crisis action planning tool for analyzing courses of action, especially in areas of OOTW and stability and support operations. (PACOM, TRAC)
- A model that can be used for missions involving disaster relief, refugees, peacekeeping, counterdrug and stability operations. (SOUTHCOM)
- OOTW simulation for special operations force missions. (SOCOM)

Complementing such findings, together with OOTW M&S deficiencies referenced in the Joint Warfare System Operational Requirements Document and PACOM MOOTW Requirements Analysis, the Office of the Secretary of Defense identified Stability Operations as a major M&S shortfall for DoD in Strategic Planning Guidance (SPG) 06-11. Correspondingly, DoD Directive 8206-1 of 6 December 2002 tasked the Chairman of the Joint Chiefs of Staff (JCS), in coordination with the Heads of DoD Components, to develop baselines for use in strategic analyses of current forces, based upon scenario priorities identified by the Under Secretary of Defense for Policy.

In response to these aforementioned operational needs, DMSO continues to explore ways to use flexible asymmetric simulation technologies (FAST) to bridge the M&S capability gaps between combat and MOOTW models. Advancing the initial vision that created a prototype MOOTW FAST Toolbox to advance planning and analysis for phase four operations, DMSO continues to refine its effort to enable an illustrative set of tools to share/reuse data described by a defined schema while conducting integrated analysis across the levels of war to hone leaders' decision-making processes. Complementing achievements involving the extraction of discrete C^4ISR data from selective DoD C^2 systems for ingest into the toolbox to initialize/update vignettes for applications use, this year's toolbox effort focused on supporting the JCS J-8 with operational insights gained from their Enhanced Strategic Success (ESS) Study.

Consequently, this paper describes the current status of DMSO's initiative to develop and field a toolbox that enables warriors to prosecute aspects of selective MOOTW mission areas across shifting civil-military operations. Inclusive in this article is an overview of the toolbox architecture that enables disparate tools to exchange data in Extensible Markup Language (XML), facilitating routine processes to provide leaders more time to think through symmetric and asymmetric interactions inherent in MOOTW. Moreover, lessons-learned from the toolbox's ongoing use in the ESS Study is discussed as they relate to ongoing and future opportunities in support of Service and joint operations. Finally, the paper describes application of the toolbox in an instructional setting at the Naval Postgraduate School.

ADDRESSING THE GAP

<u>Concept of Operations</u>. Given the realities described in PDD-56 and DoD Directive 8206-1 of 6 Dec 2002, the challenge for COCOMs remains: How to develop analytical baseline processes that provide M&S support to warfighters for planning and executing mission areas in MOOTW. To support COCOMs, DMSO's approach was to develop a Concept for Operations (CONOPS) document to provide a long-range vision for the development of FAST capabilities in a laptop to meet the needs of the warfighter on the MOOTW battlefield. Based upon complex geopolitical, social, cultural, and economic tensions associated with the various areas of MOOTW cited in JP 3-07, together with the continuous advancement of M&S technologies, the CONOPS is considered a dynamic document to remain relevant and useful.

<u>Toolbox Components</u>. As depicted in Figure 1, the components of the MOOTW FAST Toolbox are currently divided into four areas: Toolbox Catalog, Information Library, Tools, and Data Repository.

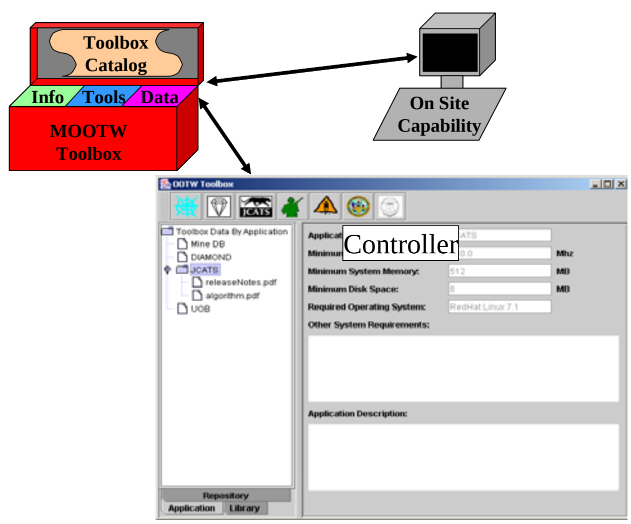

Figure 1. Toolbox Components

The *catalog/controller* integrates the features and enables the user to quickly search the toolbox contents to identify the available resources. The *information library* contains assorted data (i.e., documents, reports, briefings, studies, etc.) housed internally to the toolbox that can be easily accessed by the user. The *tools* are models, simulations and other enablers that the user is able to retrieve and execute as appropriate. The *data repository* contains scenario ready data to populate specific tools, and can also accommodate category specific data (e.g., environmental, demographic, military forces, systems, etc.) for use as desired.

Toolbox Functional Requirements. Designed initially for stand-alone operation to support either unclassified or classified operations, the toolbox can be operationally employed in a variety of settings. In garrison, it can reside in the respective headquarters of the user when not forward deployed. When deployed, the toolbox can reside in the respective user's operations center or tactical operations center in support of the COCOM in any of the geographic areas of operations specified in the Unified Command Plan.

Notwithstanding the vision for the toolbox to ultimately develop a reach-back capability in which a MOOTW Toolbox Server would house additional data (e.g., supporting information, M&S tools, etc.) as well as hyperlinks to external data repositories, the preliminary prototype version provides users a single point of entry for accessing FAST resources for modeling MOOTW. When the toolbox is populated with a range of tools to promote integrated analysis, it will provide COCOMs and service component commanders a capability to think through multifaceted and unstable variables inherent within the many dimensions of MOOTW.

SELECTED TOOLS

In addressing the needs of the warfighter, the toolbox includes a range of tools to advance the vision of the CONOPS requirements. The toolbox houses data consumer models and a data provider, as well as data repository applications, to facilitate data sharing germane to time management in response to crisis/deliberate planning and execution. This integrated approach includes the following initial set of tools that are representative of how the toolbox can be populated for MOOTW:

- Canadian Forces Landmine Database (CFLD)
- Unit Order of Battle Data Access Tool (UOB DAT)
- Interim Semi-static Stability Model (ISSM)
- Pythagoras
- Diplomatic and Military Operations in a Non-warfighting Domain (DIAMOND)
- Joint Conflict & Tactical Simulation (JCATS)

CFLD. Produced by the National Defence Mine/countermine Information Centre as an unclassified information tool for training the ground soldier on mine awareness, CFLD uses an SQL database to provide critical information and supporting imagery on approximately 350 mines. Capable of rapidly updating new information via the Internet to assist in timely installation of updated versions, CFLD provides a range of options (e.g., shape, color, mine type/name) to facilitate access by the soldier to enhance situational awareness. The tool can be readily adapted to current mission requirements, such as assisting in recognition of improvised explosive devices.

UOB DAT. A data management program, the UOB consists of three main components. First, as a data repository it serves as a library for classified and unclassified authoritative unit order of battle data sources, including selective approximations of various non-military organizations (e.g., NGO, PVO, IO). Secondly, the Data Access Tool features a graphical interface that allows users to retrieve and browse UOB data and associated information, as well as to select individual units easily and quickly across distributed networks. And lastly, the data interchange format (DIF) presents UOB information from all library sources in a consistent and standard format that enables users to rapidly initialize scenarios in their M&S systems.

ISSM. Inspired by Hayes and Sands' book *Doing Windows: Non-Traditional Military Responses to Complex Emergencies*, the ISSM is a civil stability and durable peace model that provides values for a set of factors within a single country. Applicable at the strategic and operational levels of war, it contains a range of measures of effectiveness (MOE) that can be linked to unified joint/service task lists and COCOM mission essential tasks associated with campaign plans.

ISSM is a PMESII (i.e., political, military, economic, social, information, and infrastructure) model applicable across all four phases of military operations. It depicts the complexities associated with OOTW by combining observations of aspects of the external situation into a unified picture of effects of what has gone right as well as graphically portraying trends of what has gone wrong.

Pythagoras. Originally developed in support of Project Albert (an international initiative led by the U.S. Marine Corps that is focusing on human factors in military combat and non-combat situations), Pythagoras is an agent-based distillation that introduces new M&S capabilities, such as soft decision rules, dynamics sidedness, behavior-change triggers, and non-lethal weapons (Bitinas, et. al., 2003). Suitable for analysis across the levels of war, Pythagoras can support a range of scenarios including peacekeeping.

DIAMOND. Developed by the UK's Defence Science & Technology Laboratory, DIAMOND is a high-level model designed to focus on OOTW issues arising from asymmetric relationships, operations and threats. A fast running, stochastic, object-oriented simulation applicable at the operational as well as tactical levels of war, DIAMOND models multiple independent sides, each with its own plans, perceptions and behaviors. Accordingly, command structures and nested missions can take on new significance, especially when combined with event triggers incorporated to advance additional planning and analytical insights.

JCATS. JCATS is a high resolution model of small unit (or individual) activities developed by the Lawrence Livermore National Laboratory. Its capabilities span the ground, air, and naval domains in support of joint training, analysis, planning and mission rehearsal. Applicable to both combat as well as non-combat operations, JCATS is an interactive, entity-level simulation that provides a range of views especially effective for military operations in urban terrain (e.g., crowd control, raids, hostage rescue, etc.)

Tool Coverage. Figure 2 provides a graphical representation of the principal FAST tools relative to frequency of use by analysts and tool complexity. Simply put, analysts in the field tend to employ tools that can be learned quickly and used easily. Generally speaking, the more complex the tool, the less frequently it is used, even though it may have great value in the analysis of particular situations. The CFLD, while easy to learn (i.e., within 30 minutes), is not depicted since its frequency rate was not considered applicable to integrated tool usage as represented by the other products.

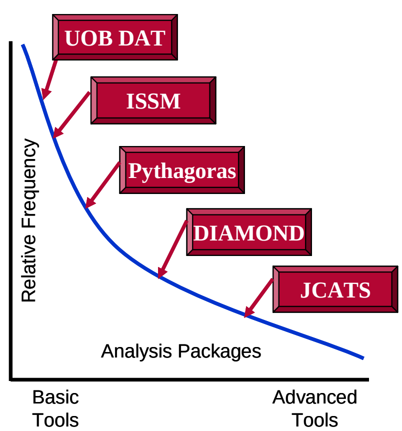

Figure 2. Frequency Rate vs Tool Complexity

WORKING SCENARIOS AND VIGNETTES

Although the CONOPS focuses on stability and support operations (SASO) in support of corps and below echelons of command, the long-term vision of the toolbox is to support planning and analysis as well as training and education across the levels of war for the varied types of MOOTW missions. In attaining this goal, humanitarian assistance (HA) and peace operations (PO) were initially selected as representative of frequently encountered activities involving military and interagency coordination during MOOTW. Within this context, a Kosovo scenario, Afghanistan excursion, and Iraq vignette were employed to demonstrate the capabilities of an illustrative set of applications housed in the toolbox. When used in a complementary manner, these tools provide a synergy for assisting warfighters to address the complexities associated with the OOTW environment.

In consonance with the CONOPS to provide quantifiable metrics supporting a commander's priority/critical information requirements, the following tools were employed to derive measures of merit within the context of HA and PO instance data:

- Strategical: ISSM/DIAMOND to evaluate peace & stability
- Operational: DIAMOND to assess HA relief delivery at endpoints & NGO/Coalition casualties
- Tactical: JCATS to assess convoy times on lines of communication or losses from ambushes

INTEGRATED ANALYSIS

Unequivocally, the JCS J-8 study provided the catalyst for verifying how best to use the toolbox in advancing integrated analysis (SPG 06-11 and DoD Directive 8206-1 refer). Figure 3 shows the basic connections among the tools used in this study, including the general scenario and the ending report of the study's results.

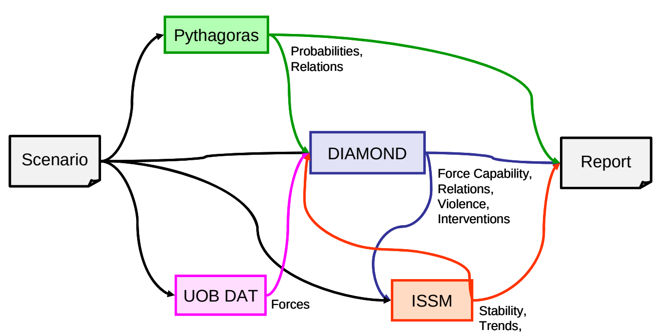

Figure 3. Tool Integration

The UOB DAT is used to generate the forces employed in the study. Pythagoras is used to generate certain probabilities and other information. DIAMOND is the tool used to simulate reality, the activities of the forces and their interactions, in the study. The ISSM is used to evaluate the OOTW MOEs of the simulated situation over time.

Technical Considerations. As tool dependencies were defined and tool inputs/outputs were developed, the following technical considerations refined the study:

- DIAMOND/ISSM lash-up requires
  - ✓ DIAMOND outputs every 30-days of simulated time
  - ✓ Capability to incorporate ISSM results as situational changes to DIAMOND scenario every 30-days (with scripted scenario changes)
    - o Single, theater/country-level scenario
    - o Multiple parallel (operational area) scenarios
- Authoritative sources for ISSM inputs that cannot be generated from DIAMOND
- Importance of capturing universality of changes in party relationships (all parties/entities in a single scenario) versus reasonable accommodation in these changes among separate, more detailed scenarios designed to generate meaningful MOEs for ISSM
- Level of unit aggregation needed by mission by phase by operational area
- Frequency & detail of review needed by ESS working group (WG) members to approve results to date and to determine reasonableness of mission/task organization changes over the campaign (i.e., execution of branches or sequels)

Methodology. Based upon the above considerations, the following approach was developed to advance integrated analysis using the toolbox:

- Develop parallel DIAMOND scenarios
  - ✓ One global common operating picture (COP) scenario
    - o Major muscle moves portrayed
    - o Holds forces not part of the priority Area of Operations (AO) missions
    - o Portrays selected entities executing missions outside of priority AOs
    - o Shows only static major unit aggregations within the priority AOs
  - ✓ More defined scenarios in DIAMOND supporting multiple AOs
    - o Address range of MOEs
- All AO scenarios run in parallel for at least 75 days of simulated time, capturing results for ISSM input at days 30 & 60
- ISSM results from each 30-day input are used to scope scripted changes in DIAMOND for the next 30 days
- WG reviews results & derives consensus on key decision points (KDP) for locking results
  - ✓ Provides guidance for follow-on scenario revision as applicable
- DIAMOND & ISSM results locked at last 30-day point before or equal to KDP date
  - ✓ Task organization & mission changes made for subsequent 75-day scenario runs (i.e., from point previous scenarios were locked)
  - ✓ Process continues until campaign complete

In using the toolbox to conduct integrated analysis in this manner, monthly (simulated time) reporting of status would flow from within DIAMOND to ISSM, which in turn would be followed by aggregation of simulation results to the theater level in ISSM.

Though the aforementioned approach was designed for tools to interact within phase four operations, Figure 4 expands upon the methodology to provide a high-level illustration of how tools could be integrated across all five phases of operations (i.e., from shaping through stability operations).

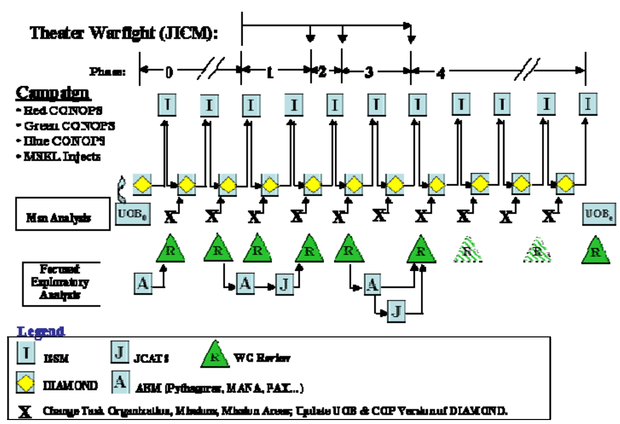

Figure 4. Integrated Methodology TOOLBOX ARCHITECTURE

Accordingly, a campaign can be defined by multi-sided goals and objectives in which multiple tools are used. As an example, the Joint Integrated Contingency Model (JICM) and JCATS can be used for combat phases in which the UOB and Pythagoras are employed intermittently to modify the situation. Moreover, the ISSM as a PMESII model can also be used throughout the combat phases to track a range of variables. Portrayed in such a holistic manner (i.e., use of M&S capabilities that link all five phases supporting political-military National Security/Military Strategies), leaders involved in crisis and deliberate planning are afforded the opportunity to better "see" and "define" the desired end state (i.e., peace and stability goals associated with phase four operations) prior to commencing combat operations.

The FAST Toolbox hosts software programs executing under different operating systems; both Microsoft Windows (e.g., DIAMOND) and Linux (e.g., JCATS) applications coexist on the same piece of hardware (laptop). This capability is enabled by the VMWare Workstation to advance the interaction of disparate applications within the prototype environment. VMWare enables multiple operating systems to run on a single physical computer by creating virtual machines that isolate the software applications to their respective execution environments. Moreover, the VMWare Workstation exposes all the hardware devices to each virtual machine, enabling operating systems and applications access to networking and other system services. With VMWare as an integral part of the toolbox environment, the warfighter is able to run FAST applications that are hosted on different operating systems in a side-by-side environment.

Data Interchange Formats. The toolbox environment hosts two DIFs--a scenario DIF and a Force Structure DIF. Because the controller stores data based on the defined DIFs in XML, applications within the toolbox are capable of ingesting XML tagged data and creating XML tagged data for the controller to store based on a family of DIFs developed for the toolbox. XML schemas define the respective application data formats and XML Style sheet Language Transformations (XSLT) files are used to transform data formats across applications.

Architecture. In order to efficiently implement FAST decision-support tools in a common environment, data and the interchange of data between applications needed to be designed to advance automated/semi-automated processes. Figure 5 illustrates the FAST Toolbox architecture, identifying the tools that have XML data formats that can be used for interchange through the DIF. The Toolbox Controller serves as the central location for the warfighter to catalog and organize the data and the associated family of data interchange formats.

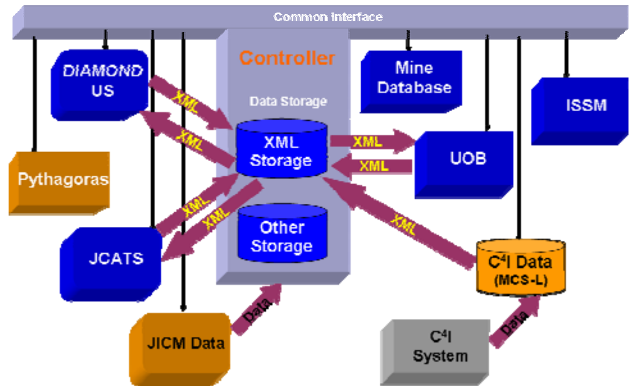

Figure 5. Architecture Structure for Tool Integration

Note that the CFLD (SQL database) and ISSM (series of linked Excel spreadsheets) are standalone applications within the toolbox environment, whereas DIAMOND and JCATS ingest data from the toolbox DIF in defined schema. To promote near real-time data update/reuse, data from C^4I systems and JICM underwent a proof of concept whereby data was ingested into the toolbox to either initialize or update scenarios. Pythagoras, newly added to the toolbox, will be used as a standalone application until benefits for transferring data in XML can be further evaluated.

XPOD MANIPULATION TOOL

The purpose of the FAST DIF is to facilitate data transfer from different simulation systems. It is a very robust data structure that encompasses most, if not all, of the data elements and attributes related to simulation technologies described in this document. The UOB DAT, DIAMOND, JCATS, Joint Common Data Base (JCDB), and (most recently) JICM data structures were examined to develop the FAST DIF. The method of analysis was focused on the transfer of information about military units (e.g., their names, locations, resources, and where they are in the military hierarchy).

Figure 6 depicts the relationships between the FAST DIF and data producers and consumers. The arrows depict the direction of the data flows. XSLT files are used for most of the data transfers between the tool-specific data files and the FAST DIF. However, because the JCDB stores its data in a Microsoft Access database, XSLT was not used to extract the data directly from the database. Instead, Java code was developed to extract data from JCDB in a format conforming to the FAST DIF XML schema.

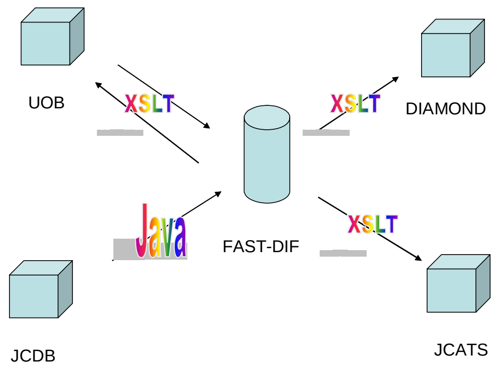

Figure 6. Current Data Exchange

In promoting the holistic methodology referenced in Figure 4 to use tools for integrated analysis across multiple phases of operations, JICM places and links were imported as arcs and nodes to initialize data for DIAMOND. Though initial efforts focused on ingesting data from JICM as depicted by a portion of the XML schema representation in Figure 7, an assessment for exporting DIAMOND arcs and nodes into JICM is ongoing since operational phases referenced in Figure 4 are not always sequential.

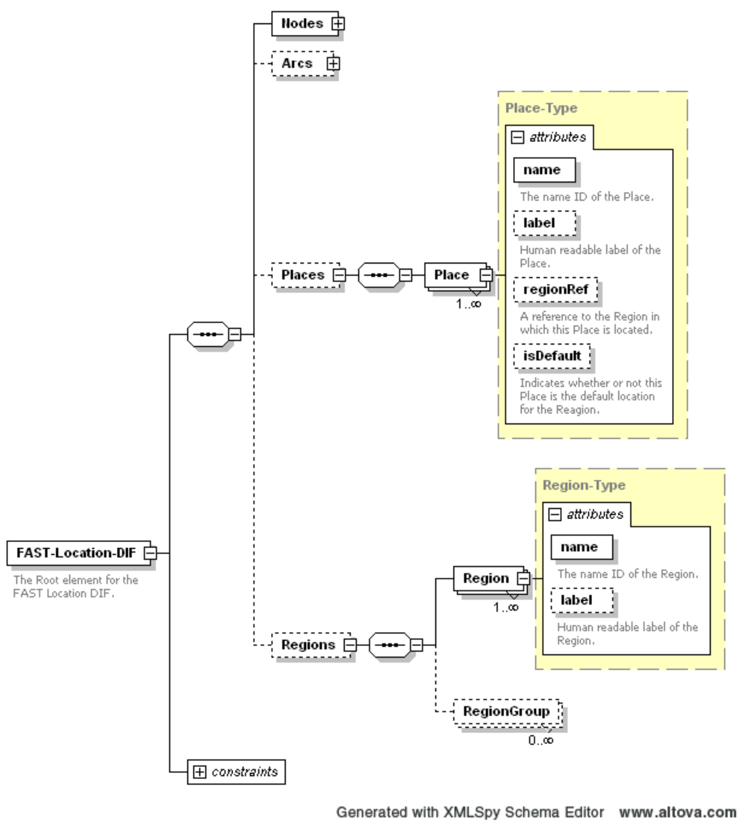

Figure 7. JICM Place Type Schema

The other data producer, the UOB DAT, facilitates the creation of custom scenarios. This tool allows for two-way data transfer, making the UOB DAT both a data producer and data consumer (i.e., unit task organization data for scenarios can be imported as well as exported). For a scenario to be successfully imported into UOB, it must be validated against the UOB schema. After a scenario is created or modified in the UOB it can be exported as an XML document and an XSLT can be applied against the scenario file to transform the data into an instance XML document conforming to the FAST DIF schema. Once in XML conforming to the FAST DIF, an additional XSLT can be applied to transfer the data to JCATS or DIAMOND formats.

By incorporating such an automated process into the toolbox environment, the needs of the warfighter to process data quickly can best be met. While the capabilities of XPOD Manipulation Tool (XMT) depicted in Figure 6 are representative of a prototype tool, it does advance data regeneration—an enduring requirement critical when confronted with time constraints associated with crisis response.

EDUCATION AND RESEARCH

The FAST Toolbox provides a unique capability for introduction of MOOTW challenges in the instruction and training of military analysts. Under sponsorship of DMSO, the Naval Postgraduate School (NPS) introduced a new course, "Modeling and Simulation for Military Operations Other Than War," into the Modeling, Virtual Environments, and Simulation (MOVES) curriculum in the Spring Quarter of the 2005 Academic Year (April-June 2005). The course was designed to explore issues, challenges, and opportunities for application of modeling and simulation to MOOTW. The course considered application of M&S for MOOTW from the perspectives of analysis, training, acquisition, and mission planning/rehearsal. Students were given hands-on experience with a number of current and emerging simulations and computational tools relevant to MOOTW.

The course was presented as a series of lectures and open discussions with a significant portion of time spent in a laboratory setting devoted to learning, exercising, and assessing a number of tools sponsored by DMSO and the U.S. Marine Corps. Grading was primarily based on an end-of-quarter project involving student presentation of the design and analysis of a relevant mission using one or more of the available tools. Necessary software and reading materials were provided by the instructor or made available online for download. The only prerequisite for the course was an intense interest in making M&S relevant to today's warfighters. During the course, MOOTW M&S requirements, issues, and lessons learned from class discussions and student activities were compiled from class discussions to inform DoD M&S management and developers. A portion of this work is summarized in this paper. Student project work is described in a separate set of papers prepared by the students for future course use and possible publication.

Class Composition**.** Besides being a leading academic institution in the conduct of military research, a unique quality of NPS is the diversity of its student population. Of the 1,552 students enrolled in the school for Academic Year 2005, 1,257 are US military (687 Navy, 117 Army, 214 Air Force, 6 Coast Guard, 196 Marine Corps) and civilians (37) and 295 are foreign military and civilians representing 60 different countries. Table 1 provides a summary of the composition of the M&S for MOOTW course. The course was primarily advertised to students from the Information Science, C4I, Computer Science, Operations Research (OR), Operational Logistics (OL), and MOVES curricula. Clearly, the make-up of the class reflected the diversity found at NPS.

Table 1. Student Ranks, Nationalities, and Services Represented in the M&S for MOOTW Course

Rank	Service	Country	Curriculum
MAJ(2)	Army	US	MOVES
MAJ	Army	US	OR
CPT	Army	US	MOVES
Civilian	--	US	MOVES
LCDR	Navy	US	OR
LCDR	Navy	US	OL
LT	Naval Reserve	US	MOVES
Maj	Marine Corps	US	MOVES
1LT	Army	Turkey	MOVES
LT	Navy	Germany	MOVES
Maj	Air Force	Tunisia	MOVES
Civilian	--	Norway	OR

Introduction to MOOTW. Early lectures/discussions in the class provided an introduction to the nature and types of operations other than war facing our military forces today. The Hayes & Sands text, Dr. Hartley's 1996 analysis tools research report, and Joint Publication 3-07 were the primary sources of information for this introduction. In addition, the students identified and made observations on numerous references found through an Internet search for information on the variety of missions categorized as MOOTW. One specific assignment entailed student review of the 16 mission areas described in JP 3-07. Each student selected an area of interest (first-come, first-serve), read the description of the mission, and provided their considered opinions into how M&S could be used to support analysis or training relevant to that mission. A full course summary providing student observations and other information about the course is available in a separate paper.

Tools Explored**.** A major challenge in conducting the course was providing the students an opportunity to not just hear about a number of current models dealing with MOOTW issues, but to also permit them significant hands-on experience operating the tools. This entailed a significant amount of instructional time introducing model capabilities through demonstrations and structured training (when such materials were available). It was not possible to achieve full proficiency in application of the models in the time available in the course (a total of 44 hours of instruction time and 11 hours of laboratory time). For example, the Training Plan for the FAST Toolbox (Blais & Cipparone, 2005) estimates instruction time to achieve basic familiarization with tool capabilities at 88 hours for DIAMOND (160 hours to reach proficiency in use) and 8 hours for ISSM (24 hours to reach proficiency in use). Clearly such time commitments were not possible in the course, particularly since the goal was to explore a number of different tools. Student selection of a particular product for use in their final project permitted additional time for them to develop stronger skills with a specific tool, but these skills were acquired outside the structured instructional environment.

ISSM, DIAMOND, and Pythagoras, described earlier, were selected from the FAST Toolbox for hands-on use by the students. ISSM provided a theater-level view of SASO planning and progress monitoring to introduce the variety of interrelated factors analysts must be aware of and deal with in planning and conducting these operations. DIAMOND provided an operational to tactical level view of the battlespace with representation of numerous non-traditional concerns, such as shelters, medical treatment, food, and water for civilian populations, movement of refugees, and road block negotiations. Pythagoras provided an example of capabilities of general agent-based simulations to represent the complexity that emerges from interactions of a number of agents operating under a set of relatively simple behaviors. Briefing materials prepared by the FAST project were used to introduce ISSM and DIAMOND capabilities to the students. The ISSM Users' Manual (Hartley, 2005a) and Analysts' Guide (Hartley, 2005b) were the primary sources of detailed information about ISSM; briefings and example scenarios were the primary means of instruction for DIAMOND. Pythagoras documentation and sample scenarios provided in the software distribution served as the basis for instruction in this product's functional capabilities

Pythagoras is available through the U.S. Marine Corps' Project Albert Program. A second agent-based simulation from Project Albert, the Map Aware Non-uniform Automata (MANA) model, was also introduced to the students. MANA has significant conceptual similarities to Pythagoras, but has a simpler user interface and tutorial documentation that made its capabilities more readily accessible to the students. Of all the products introduced in the course, the students were able to construct new scenarios most rapidly with MANA (of course, this was possibly assisted by the earlier exposure to the other tools, so there was a significant conceptual foundation for learning the capabilities of MANA). MANA was developed by New Zealand's Defence Technology Agency for use as a scenario-exploring model to address a broad range of problems. The developers sought to create a model that would enable analysis of the value of factors like situational awareness, command and control, and information warfare that are not treated explicitly by all models (Galligan et. al., 2005). Like other Project Albert goals, MANA seeks to represent the effects of the "intangible" aspects of warfare that have been too frequently disregarded in traditional models.

In addition to the above tools used for hands-on learning in the course, guest lecturers introduced the students to EINSTein, PAX, and the OneSAF Objective System (OOS). In general, the students did not have opportunity to work directly with these models, unless they chose to do so for their class projects (e.g., a Turkish officer using PAX and a US Army officer using OOS).

<u>Student Projects</u>. The culmination of course activities was an end-of-quarter project. The students were instructed to select a problem of interest relevant to the various MOOTW missions that had been studied and explored during the course. Their work needed to reflect the typical steps in an analysis; namely: (1) select a problem of interest and state the problem; (2) describe the operational scenario for conduct of a study; (3) define measures of effectiveness or measures of performance to be computed in the study; (4) design an experiment, reflecting nearly-orthogonal Latin hypercube techniques documented in (Cioppa, 2002) for dealing with high-dimensional response surfaces (i.e., many factors, many levels); (5) select a model (e.g., ISSM, DIAMOND, Pythagoras, MANA, etc.) to support conduct of the study; (6) represent the scenario in the chosen model; (7) execute the model and collect data (at a minimum, given time constraints, execute a number of runs to provide demonstration of the soundness of the scenario implementation); (8) perform analysis of the data and report results (to the extent possible under time constraints); (9) report conclusions, recommendations for follow-on work, lessons learned, and comments on the course, including a critique (benefits, limitations) of the model(s) used in the study.

Project topics included the following:

- Patrolling national waters
- Aggressiveness and population control
- Pier-side Force Protection
- Force allocation in protection of relief operations
- Protection of polling places in elections

- Protection of shipping
- Embassy reinforcement
- Oil infrastructure protection
- Border patrol
- Non-lethal weapons and crowd control
- Methodology of studies using multiple tools

Student reports are available in separate papers.

ROAD AHEAD

As noted in the discussion of the CONOPS, the MOOTW FAST Toolbox effort is dynamic rather than static. User feedback will dictate ongoing initiatives and the future course of the project. Moreover, such a linkage is critical as DMSO addresses the requirement for multi-dimensional operations described in PDD-56 and advances a MOOTW FAST Toolbox designed to strategically think through historic lessons-learned described below (from Chas W. Freeman, Jr.):

> Military triumph does not necessarily equate to political victory. Wars end only when the defeated accept defect, not when the victor declares victory. A victory that does not produce peace can be much more costly than protracted confrontation that accomplishes deterrence. Arrogant daydreams that inspire military actions can become humiliating nightmares that produce political debacles.

Near-term efforts on the prototype toolbox will continue to focus on developing user-defined scenarios/vignettes, and incorporating toolbox capabilities into academic curriculum in such settings as the Naval Postgraduate School and the U.S. Military Academy. In the mid-term, the MOOTW FAST Toolbox can serve as a well-developed capability to be incorporated into future M&S development, including the pursuit of a reach-back capability identified in the CONOPS to optimize the timely addition of M&S tools as well as links to external repositories supporting the evolution of such missions as DoD's Global War on Terrorism. In the long-term, the MOOTW FAST Toolbox provides an opportunity to lend structure to operational, technical and systems architectures for MOOTW M&S capability development.

ACKNOWLEDGEMENTS

This paper represents a collective effort involving the following personnel: Dr. W.F. Crain; LTC Jon Lockey, JCS J-8; Mr. Richard Montera and Mr. Dave Holdsworth, Alion; Mr. John Mericle, Northrop Grumman-Information Technology; Mr. Christian Farrell, Computing Technologies; Mr. Edmond Bitinas and Ms. Donna Middleton, Northrop Grumman-Mission Systems; Mr. Robert Senko, consultant; and Master WO T. Stewart, Canadian National Defence HQs.

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