"Fixing" the Military Decision Making Process (MDMP)

Michael J. Smith, Ronald B. Sprinkle
Leidos, Inc.
Orlando, FL
smich4@leidos.com, Ronald.B.Sprinkle@leidos.com

LTC(P) Johnny Powers
PEO STRI
Orlando, FL
Johnny.Powers@us.army.mil

James Xu
Adayana
Falls Church, VA
jxu@adayana.com

Michael Knapp
Aptima, Inc.
Orlando, FL
mknapp@aptima.com

ABSTRACT

The U.S. Army Military Decision Making Process (MDMP), used for planning operations, is a deliberate, time intensive, manual process. Critics state that MDMP Course of Action (COA) Analyses take too long to arrive at a single plan. COA analysis and Running Estimate (real time comparison of a running operation against the plan) require data to measure and compare combat actions. Many assert that the only viable way to automate and measure proposed COAs is to use data produced by simulation. Historically, simulations have been difficult to setup, require specially trained personnel and separate computing hardware to operate, making their application impractical in a tactical environment.

To address these problems, we developed a concept prototype and architecture to make practical use of simulation to support the MDMP. We believe that "fixing" the MDMP means increasing its speed through rapid automated decision support. During development of the prototype, we explored the technical barriers and military planning process updates that would help automate the MDMP with simulation support.

U.S. Army simulations require several major modifications to be practical in a Mission Command Information System (MCIS) environment. First, technical support requirements must be eliminated. Second, an interface that supports the input of plans and operations by Warfighting planners is needed. Third, Warfighters must be able to specify measurement of COAs, plans, and operations. In addition, recognizing the human/machine boundaries in the decision-making process, we must be mindful that simulation systems cannot present conclusions that can only be fully developed by experienced warfighters. This paper shows how these things can be done and addresses primary MDMP criticisms.

ABOUT THE AUTHORS

Michael J. Smith is a project manager and senior software engineer for Leidos, Inc. in Orlando, FL. He has worked as a software engineer in the simulation and medical fields for over 20 years. He currently works on multiple projects related to simulation and training such as the U.S. Army's One Semi-Automated Forces (OneSAF) program and Simulation to Mission Command Interoperability (SIMCI) projects. His current project development focus is on leveraging simulation use within Mission Command systems and how best to leverage cloud technologies to bring this capability to current operational systems. He has a B.S. and M.S. in Computer Science from the University of Central Florida

Ron Sprinkle works for Leidos, Inc. as the One Semi-Automated Forces (OneSAF) Production lead, and the Modeling, Simulation & Training (MS&T) Division Constructive Simulation R&D lead. In 27 years as a defense contractor, he has developed software and hardware systems on numerous simulation and simulation related programs in the roles of software engineer, systems engineer, technical director and architect. Ron intermittently supported Simulation to Mission Command Interoperability (SIMCI) as an architect from 1999 to 2011. As the first Global Force Management (GFM) Division Chief at Headquarters, Department of the Army, Strategy and Plans (HQDA G3/5) from 2007 to 2009, COL Sprinkle shaped the U.S. Army GFM Data Initiative (GFM DI) deployment strategy and wrote Army Regulation 25-29, Army Force Generation (ARFORGEN). Ron graduated Oregon State University with a B.S. in general engineering and Southern Methodist University with a M.S. in Computer Science engineering.

LTC(P) Johnny Powers currently serves as the executive agent for the Simulation to Mission Command Interoperability (SIMCI) Program in Project Manager Constructive Simulation (PM CONSIM), Program Executive Office, Simulation, Training, and Instrumentation (PEO STRI). LTC Powers served as an officer in Operation Able Sentry (Macedonia) and the Implementation Force (IFOR) Mission (Bosnia). He then served in various command positions before being assigned as an Active Component/Reserve Component advisor to the Arkansas Army National Guard and was deployed for Operation Iraqi Freedom as an advisor. After returning to the United States, he became the simulation officer for 5th U.S. Army/Army North, Fort Sam Houston, Texas, where he was the knowledge management officer for operations in support of the Hurricane Katrina relief effort. For the U.S. Army Staff, G-37, he served as the lead for the Mission Command Training Support Program responsible for Management Decision Package management for Army Constructive and Virtual training programs. Before assuming his current role, he was the contracting officer representative for Warfighter Focus Efforts 22 and 42, supporting operations for Operation Enduring Freedom in Afghanistan. LTC Powers attended the University of Arkansas at Little Rock. He received his master’s degree in modeling, virtual environments and simulations from the Naval Postgraduate School in Monterey, Calif.

Michael Knapp is a Principal Software Engineer at Aptima, Inc., who specializes in architecting and implementing distributed computing systems across varied platforms. He has a breadth of professional software engineering experience ranging from distributed service oriented architectures to real-time embedded systems. Mr. Knapp received a M.S. in Electrical & Computer Engineering with specializations in Communications and Machine Learning and a B.S. in Computer Science from the University of Florida.

James Xu is the Chief System Architect of Adayana and is responsible for designing and developing effective immersive and mobile solutions to meet the clients’ learning and training needs. Prior to taking his post at Adayana, James Xu led the efforts as the Executive Director of Software House at MedStar Health in bringing innovations in gaming and simulation technologies to medical and healthcare industries to improve training effectiveness and reduce costs. Before joining MedStar Health, he spent over 15 years in the software industry serving as Chief System Architect, VP of Software Development and Chief Technology Officer (CTO). During past several years, he has been concentrating on developing and applying emerging technologies, such as gaming, simulation, Virtual Worlds, mobile and other learning technologies, in the space of learning, education and training. James Xu is currently a professor at DeVry University teaching Computer Information Systems and Game & Simulation Programming. He holds a Master of Science degree in Mechanical Engineering.

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LTC(P) Johnny Powers
PEO STRI
Orlando, FL
Johnny.Powers@us.army.mil

INTRODUCTION

The U.S. Army planning process, called the Military Decision Making Process (MDMP), has remained unchanged since 1968. During the same period, planning support tools have gone from paper maps and acetate overlays to computers overlaying digital data within the Ozone Widget Framework (OWF) on common 3D terrain. Until recently, there existed no technology to actually decrease the cognitive challenge of conducting a detailed planning session and the burden of issuing clear orders to subordinate units. Supporting the planning process with computers simply amounted to digitizing the products of the labor intensive analog process. While digital versus paper plans make it easier to share and collaborate, computers are not leveraged for what computers do best – computing solutions and supporting data analysis. This paper reports about the first practical use of computer supported planning in a tactical environment, how that removes significant impediments and materially improves the application of the uniquely human MDMP.

To do that, the authors first describe the MDMP challenges. Then we briefly explain the unique planning and analysis technology called the Mission Planning Course of Action (COA) Analysis Tool or MP-CAT. We describe how MP-CAT can automate portions of the MDMP. Then, in our primary focus of the paper, we identify changes in planning, analysis and execution resulting from the availability of information at critical moments in the MDMP. Finally, we draw conclusions from our work and look into plans for the future, beyond the near term changes.

PROBLEM STATEMENT

While the name "Military Decision Making Process" (MDMP) was first coined in 1960 (Michel, 1990), the process has been maturing since the U.S. Revolutionary War. The MDMP organizes the commander's staff to deliberately develop plans to execute a mission. It familiarizes the staff with the complexity of the enemy, friendly, geopolitical situations, terrain, and encourages development of options to fulfill the mission. This process involves the development and publication of a plan which directs friendly forces in the execution of an operation to effect desired state changes of the forces in conflict. The MDMP is used to inform and cement the mission's multiple dimensions and potential variations in the minds of the commander and staff so that they can rapidly adapt to achieve the mission in the face of changes that occur during mission execution.

The MDMP, primarily used for force-on-force direct engagement, has languished since 2001 during the Counter Insurgency (COIN) operations in Afghanistan and Iraq. Development of a discrete engagement solution was found to be insufficient for the continuous geopolitical shaping required of COIN operations, for which the Lines of Effort (LOE) (Edwan, 2009) were used. Now, as the U.S. Army forces refocus their training to address the full threat spectrum, the MDMP is once again a tool considered to develop discrete engagement plans.

The MDMP is used to develop plans, while friendly forces are preparing for mission execution. It can be conducted with a sand table, white boards, paper or digital maps, but is essentially an analog process that creates and solidifies different mission execution options that are down selected to a single plan. The Command Post of the Future (CPOF) Mission Command Information System (MCIS) digitally facilitates this process by providing software collaboration tools for leaders to develop and share emerging plans over a network. The thought process and its steps have remained essentially unchanged from the paper and acetate overlay-based process of the 1970s and 1980s.

The MDMP, pictured in Figure 1, has its detractors, who essentially state that it is a linear process to build a single dimensional solution for a nonlinear, multidimensional problem. Dr. Gary Klein in 1989 said "It is time to admit that the theories and ideals of decision making we have held over the past 25 years are inadequate and misleading, having produced unused decision aids, ineffective decision training programs and inappropriate doctrine." (Klein, 1989, p. 56) The new U.S. Army Field Manual (FM) 6-0 says "Performing all steps of the MDMP is detailed, deliberate, and time-consuming." (HQDA, 2015, p. 9-4) The bottom line is that the process, as currently implemented, takes too long to develop a solution whose critical assumptions may be invalid upon enemy first contact.

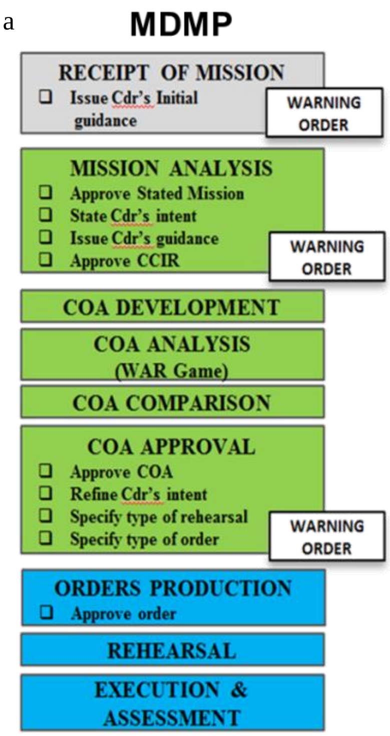

Figure 1 - Military Decision Making Process

So we have to ask, "If we have known for over half a century that the MDMP has issues, why hasn't it changed?" The authors believe that the Army has been stuck in the tension between the desire for critical thinking for a superior mission solution, and rapid, decentralized decision-making. This tension exists while technology has struggled for over 20 years to achieve a digital "common map" to attain the information integration at least as good as the paper map and acetate overlays of the 70's and 80's. Without a common digital map, it has been impossible to invent any practical technical digital solution that brings agility to the deliberate MDMP.

However, in the last few years, Program Executive Office for Command, Control, and Communications – Tactical (PEO C3T) has succeeded in implementing a digital common map using the Ozone Widget Framework (OWF) and the Common Map Application Programming Interfaces (APIs), opening the door to technical solutions integration and making the MDMP more practical.

INCREASING MDMP FLEXIBILITY

MDMP critics say that it is inflexible. The authors assert that automation of significant MDMP elements results in a process that not only supports adaptive planning, but simultaneously removes the heavy manpower investment and enables rapid analyses. When FM 6-0 states that "The fastest way to develop a plan has the commander directing development of one COA" (HQDA, 2015, p. 9-45), it implies that multiple COAs are the most time intensive aspect of the MDMP. The authors further assert that when speed of manpower and time intensive steps are increased via automation, that the entire process becomes more responsive to change, thereby increasing its' flexibility.

Rapid planning and execution has long been a warfighter goal. As part of our response to the 2013 Simulation and Mission Command Interoperability (SIMCI) project call, the authors envisioned a system of mission command (MC) systems that, without contractor technical support, exchange dynamic plan data vertically and horizontally in the Command Post Computing Environment depicted by the SIMCI Operational View (OV)-1 in Figure 2. Dynamic plan data enables plans to be played like a movie over the common map. Dynamic plans include control measures, maneuver graphics, and positions of units over time.

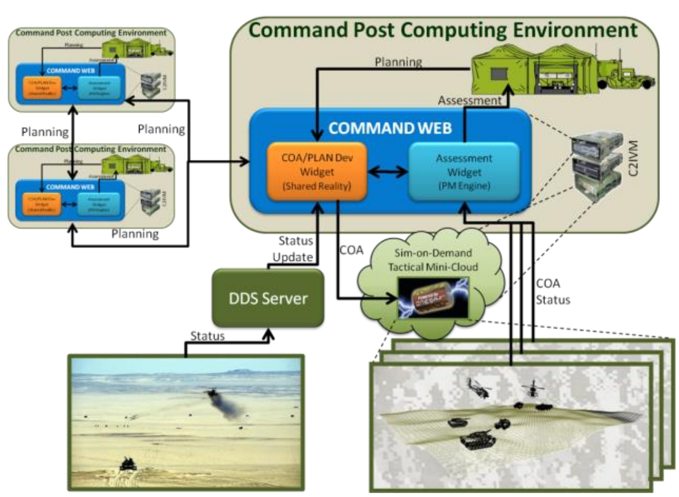

Figure 2 - FY14 SIMCI COAA and Running Estimate Task OV-1

When SIMCI accepted the proposed tasks, the authors repurposed three existing government off-the-shelf (GOTS) software products to realize a rapid planning and execution support proof-of-principle prototype.

Simplified plan entry, automated plan simulation and analytical measurement feedback are the three critical elements needed for planning and execution support automation. Simplified plan entry speeds plan development and unambiguously captures the plan for computation. Automated plan simulation is used to war game the COA and rapidly produces performance data. Performance analysis consumes war gamed combat status reports from the simulation and reports performance to the user in operational terms. The three tools we proposed to provide this capability were Shared Reality, One Semi-Automated Forces (OneSAF) and Performance Measurement (PM) Engine. Shared Reality is a training collaborative planning interface repurposed as a Mission Command user interface to simplify plan entry and display results evaluation. The OneSAF simulation was configured to consume the plan entered via Shared Reality, automatically simulate plans (no user-level interface) and produce analytical data. PM Engine™ is a human performance measurement and analysis tool repurposed to consume OneSAF analytical plan data, measure unit/platform-level performance and compare plan (COA) versus execution differences. When integrated as described, Shared Reality (Planning Widget), OneSAF and PM Engine (Assessment Widget) form MP-CAT.

The authors are unaware of any alternative tool that performs as MP-CAT without significant technical support staff. Previously, there have been attempts to provide simulation and/or replay capabilities in tactical environments such as the Combined Arms Planning and Execution System (CAPES) or Mission Planning and Rehearsal System (MPARS), but these have either been limited in scope or far too difficult for staffs to use as part of the MDMP process without technical support.

The use of simulation to provide evaluation support for planning is nothing new, but has had its issues. The challenges using simulation have been that it is a) too complex and time consuming to set up and b) requires use and training of an entirely different set of tools and processes from those employed in operational environments. A key MP-CAT attribute is that it facilitates the MDMP only using steps that are integral to the planning process and is controlled on a unit's existing MCIS. MP-CAT step-by-step support to the MDMP is as follows:

1. Receipt of Mission – commanders use existing communication channels to receive plans, consisting of overlays populated with "intelligent graphics" that can be reviewed/expanded upon on receipt. The authors define "intelligent graphics" as operational maneuver graphics and control measures defined with Military Standard (Mil Std) 2525C symbology and associated with standards-based simulation commands.
2. Mission Analysis – Situation assessment is supported by the 3D map and received maneuver graphics. The staff identifies initial performance measures relevant to the commander's intent.
3. Course of Action (COA) Development – Courses of action are developed using intelligent graphics that depict alternative ways to accomplish the mission as shown in Figure 3. Units are associated with maneuver graphics and their locations are updated based on COA start state or current Mission Command data. This MDMP step also involves selecting and/or revising appropriate performance measures required for COA analysis and then submitting COA(s) for war gaming simulation and assessment.

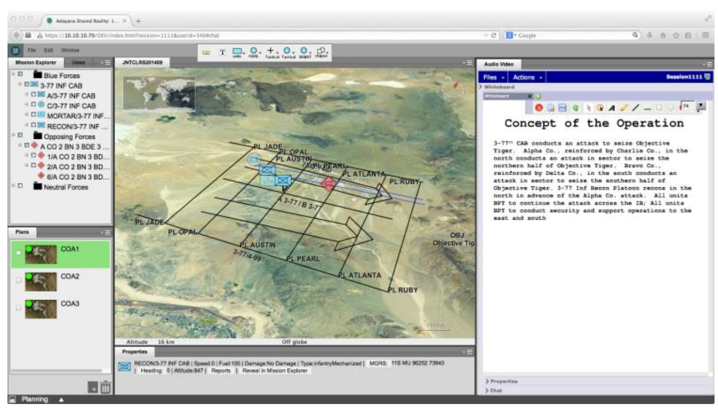

Figure 3 - COA Development

4. COA Analysis – After simulation, the data or graphical outputs from multiple courses of action are analyzed. Graphical analysis involves visual replay of battlefield operations while data analysis is conducted on high level performance measures such as "combat power" or time varied data such as unit's "available ammunition over time".
5. COA Comparison – multiple evaluated COAs are ranked against each other based on the measured performance. COA comparison does not imply mission success, but rather provides the high level and analytical information to assists the planner or decision maker to understand the expected tradeoffs for the various COAs. The planner uses the comparison results to modify and improve the COA and resubmits the course of action for automatic simulation and reassessment.

6. COA Approval – The staff reviews the COAs using the decision matrix shown in Figure 4 to select a specific COA for operational execution. Figure 4 shows COAs listed across the top and performance measures listed along the left. There are two performance measures groups shown, with "Fires and Effects" compared at the aggregate level and the group below expanded to compare its details of "Combat Power" and "Heavy Ammo".
7. Orders Production – Order production is facilitated by sharing dynamic plan data with other units using organic MCIS. Subordinate units begin mission analysis by replaying the higher level plan on their maps.

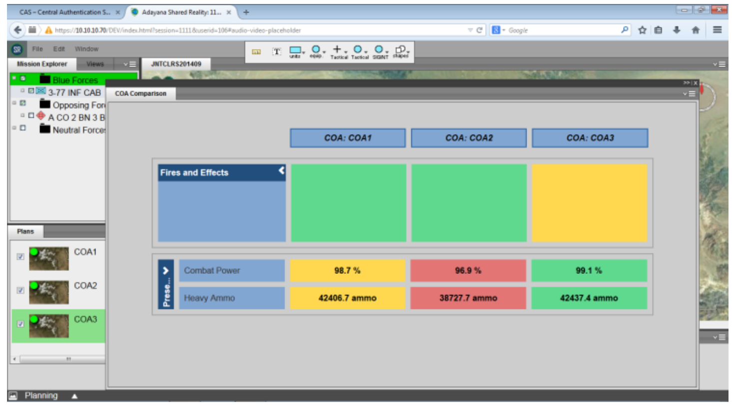

Figure 4 - Decision Matrix

8. Rehearsal – Mission rehearsal can be conducted by collaboratively replaying the plan with all participants simultaneously reviewing the recorded plan while confirming/questioning/addressing their expected battlefield conditions and plan execution.
9. Execution and Assessment – Assessment during execution is accomplished by automatic comparison of Situational Awareness (SA) data with the plan as the operation progresses. The differences between the executing operation and the plan are represented by the color of a single button that is green, amber, or red based on the state of the worst tracked metric. This significantly reduces the cognitive load on the warfighter by presenting actionable information through a common map and a single button. The detailed review depicted in Figure 5 shows the deviation values of the plan against the operation for all tracked metrics. It also allows users (staff, commanders, et al.) to set or adjust metric limits to reduce false warnings or adapt to operational conditions.

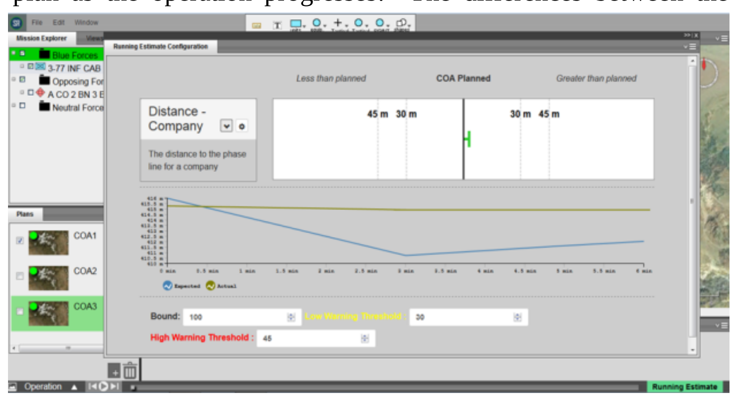

Figure 5 - Running Estimate Deviation Chart

Following the flow of the MDMP, MP-CAT increases the speed of the decision making process without increasing warfighter required training.

Increasing speed of the MDMP has been our assertion from the beginning, but what evidence do we offer that we have achieved any impact? While we do not have empirical measurements to compare a staff conducting the MDMP with and without MP-CAT, anyone witnessing an MP-CAT demonstration recognizes the simplicity and facility of how MP-CAT develops and quickly assesses selected COAs. Even without optimizations, MP-CAT simulates and assesses a battalion level, 20 minute, combat engagement within 2 minutes. A reasonably experienced battalion staff could expect to consume about an hour to setup, wargame and record the results of a single COA. And this is just one dimension of the speed increase. Others dimensions relate to COA development, plan distribution and assessment of current operations, the latter of which cannot be done today without significant delay. Elimination of the delay in current operations assessment is the single most significant "challenge" of the running estimate.

It is important to realize that MP-CAT intentionally does not roll up comparisons to indicate the "winning" or "best" COA. While automated decisions are the enemy of critical thinking, the reverse of too much data/information overloads decision makers. MP-CAT seeks to remove the impediment of time consuming data production during COA development, facilitate analysis, and preventing decision complacency while avoiding decision maker data overload.

REQUIREMENTS BEYOND THE PROTOTYPE

The authors encountered a number of barriers during development of the MP-CAT proof of principal prototype. Our goal was to provide an end to end demonstration of the concept, but not to develop the breadth of capabilities required for a fully operational capability. The most significant future requirements to achieve a full capability are:

Readily Available Battlefield State Information

Broadly useful COA and running estimate tools need a rich set of data from both simulation and live mission command systems. The data availability issue rests primarily with the MCIS. Each of the various mission command systems have their own data repository and access methods. Program Management (PM) MC must break down the walls between the WFF data silos to make battlefield details such as sustainment (e.g., fuel, ammunition), battle damage assessment (e.g., enemy and friendly damage), combat power (e.g., current capabilities of units), intelligence (e.g., enemy ops, obstacles, roadside improvised explosive devices (IEDs)), etc. available. The difficulty in accessing battlefield state information limits the performance metrics that can be developed and automatically employed in direct support of COAA and Running Estimate measurements.

Common Force Structure Data

Simulation initialization is challenging due to the lack of available libraries describing operationally relevant force configurations. This data needs to consistently support both simulations and mission command systems.

Combat Operations Performance Measures

Flexible, simple, and intuitive performance measurements are challenging to describe and develop. While Army Doctrine Reference Publication (ADRP) 5-0 (HQDA, 2012) includes an entire Assessment chapter (5) in which measures of performance (MOPs) figure prominently, we concluded in our research that there are no generally available MOPs archived for reuse. This is an MDMP limitation, because it needs MOPs for analog COA comparison and assessment in current operations.

Subjective Inputs

The authors agree with ADRP 5.0 (HQDA, 2012) that fully effective assessment requires the combination of both objective (quantitative) and subjective (qualitative) data. Collecting subjective inputs requires a human subject matter expert (SME). For example, an operations officer can look at a COA operation end state and quickly assess how well friendly and enemy positions for future operations compare to other COAs. This is an example of a challenging measurement to automate. Limited by time and funding, only objective performance was measured.

CAPABILITY INTEGRATION ONTO MISSION COMMAND SYSTEMS

In the previous section, we identified barriers to completing Course of Action Analysis (COAA) and Running Estimate tools. In this section we identify technologies that ease the incorporation of MP-CAT-like tools with Mission Command systems and the computing environment being built by U.S. Army PEO C3T.

Ozone Widget Framework (OWF)

MP-CAT made use of the emerging OWF by updating Shared Reality and Performance Measurement Engine to be compliant with OWF applications. The OWF is an extensible web framework that houses various command and control lightweight web applications called "widgets". OWF presents different war fighting function (WFF) (Maneuver, Fires, Intel, Sustainment, etc) tools to the user by pulling in information from established MCIS, such as CPOF, AFATDS, etc. OWF naturally integrates WFFs with use of a common map, but through its extensibility it also enables added capability, such as MP-CAT, Logistics Reporting Tool, or simulation-based training.

Common Map

After 20 years, via the OWF the Army has succeeded in producing digital-terrain (3D map) functionality on par with the 1990's overlays on paper maps. Multiple MCIS can integrate their data output onto a common terrain viewer widget. The common map widget does not necessarily force the tools data to be interoperable, just displays it via a Common Map API. Interoperability between widgets is needed if the MC applications are to work together synergistically and reduce redundant software. However, a common map is a major breakthrough and can enable significant advancement in MDMP support.

Common Data

The ability to combine WFF overlays onto a common digital terrain is not unlike like Geospatial Information System (GIS) layers. The ability to view this data on a common map widget is spurring work to actually integrate stove-piped Mission Command Systems information into a unified data environment, primarily to enable interoperability among MCIS. This begins to address issues identified by the MP-CAT effort where unified data for simulation-based analyses is key to effective mission command system support.

Pooling Virtualized Resources

PM MCs Battle Command Common Software (BCCS) server is host to the Command and Control Integrated Virtual Machine (C2IVM) environment and to potentially many other C2 virtual machines (VM)s. The hardware resources required are significant, but easily overloaded. VMs must be prioritized for final system configuration. Moving any software into this architecture will use precious pooled resources and its resource impact must be minimized. Methods to dynamically allocate virtual machine resources must be considered in order to automatically create new simulation instances and then remove them.

WAY AHEAD FOR MISSION PLANNING HUMAN MACHINE INTERFACES

With very limited exceptions, the MDMP is an analog, human process. Efficient human machine interfaces (HMIs) are critical to make the computerized MDMP simpler than the analog process. With MP-CAT, the authors augmented mission planning by making it easy to authoritatively simulate each COA, and to analyze supporting data behind assessments, rather than stating which COA is best. Avoiding the "best COA statement" continues decision maker control of the decision process, and provides higher fidelity plan evaluation uncolored by personal bias. Providing in-stride planning evaluation tools keeps the mission planner as the expert and prevents critical thinking complacency caused by relying on computer recommended plans.

Human Machine Interface (HMI) Design Considerations

To provide effective HMIs for mission planning, we arrived at a set of attributes that we believe would be associated with the most effective Mission Planning and Execution Monitoring HMI:

In general, to reduce computer-aided planning training, the planning HMI should be as closely consistent with the existing OWF common map widget focus as possible. Maneuver graphics comprise the lion's share of operation/plan description and visual information. Any course of action or plan should primarily describe operations with maneuver graphics. Maneuver graphics must be "intelligent" to convey the military action to the simulation. This isolates the planner from the need to know anything about the specific simulation(s) in use. Furthermore, the HMI should:

- Enable plan entry through creation and/or receipt of Mil Std 2525B/C/D maneuver graphics. Passing maneuver graphic based plans between units enables receiving units to augment general higher-level mission. Added details might be elements such as movement formations, target speed, expected times to be at objectives, etc.
- Display known friendly or enemy units, obstacles, friendly or enemy locations, consistent with existing MCIS.
- Support 2D and 3D operation visualization for effective situational awareness of the COA and/or terrain.
- Support workstations with large display areas and mobile devices for data entry with limited display areas.
- Contain a customizable library of standard operation performance metrics.

- Make COA assessment transparent to the planner, using the same map, requiring no technical support and not require the planner to leave the COA/plan development environment to execute the MDMP.
- Any COA related detail should be viewable as a graph, on a map and as raw data. The COA and/or plan should be (re)playable on the digital map.
- Compare COAs at abstract levels with detailed measurements on demand. The planner should be able to view COA comparison at multiple levels of detail to confirm combat event causality associated with COA rankings.
- Allow planners to never leave the map/planning environment to consider COA assessments.
- Support mission rehearsal since it requires the same features used for COAA. The interface should be as provided for COAA, but with distributed participation control features.
- Share graphical overlays of expected friendly, enemy, and terrain obstacles with other mission command systems, not just among planners. Once the operation begins, the plan and operation should be contrasted and deviations from the plan should trigger alerts to inform/warn. This implies that the HMI not only must display alerts and plan deviations, but also must support trigger and measurement specification. Alerts can be specified in roll up or individual fashion, depending on their operation importance.

During prototype development, the authors engaged Army mission command stakeholders at PEO C3T and Ft. Leavenworth's Mission Command Battle Lab for HMI feedback and how the prototype would support mission planning and running estimate tracking in realistic operational settings. Without exception, the authors received feedback reinforcing the listed attributes.

Many of these attributes were implemented by MP-CAT. As such, use of most of these capabilities reinforced the effectiveness of these attributes to allow for quick entry, evaluation and assessment of COAs and to receive efficient feedback on executing plans.

Performance Metric Development

During development of the mission planning and execution software, the authors discovered that there was little available information about operational performance measures. As such, work is needed to classify, develop, and validate a library of metrics for planning and operational use. That library should measure the following:

- Warfighter functions (Maneuver, Fires, Sustainment, Intel, etc.) state.
- Operations/Missions (Offensive, Defensive, Blockade, Peacekeeping, Deception, etc.) interim and end states.
- Objective and subjective evaluations

Building a library of operational performance measures is no small task. To support commanders and staff metrics measuring COAs and operations execution for any military context, the library must contain measurements important to <u>any</u> part of <u>any</u> operation for <u>any</u> warfighting function. We found that creating metrics was non-trivial. Starting the planning process without this library of metrics requires that they be developed as part of the planning process, when planners have the least time. This is one major reason why the MDMP is difficult to execute in a time constrained environment.

As described earlier, metrics would not be complete without subjective measures for qualitative assessments, so an effect metrics library must also contain them**.** To make such measurements useful, tools must exist to capture subjective measurements from SMEs and a system used to combine that input with objective measurements. The authors believe that the simultaneous development of subjective and objective metrics for each measurement would provide a means to have immediately usable metrics (subjective but labor intensive) and a data pool to validate objective metrics under development (comparison of subjective analysis to objective algorithms). The authors have insight that rapid metric development tools can be developed and used to accelerate the process of updating or creating new metrics. Tools like this are also vital to include evaluation of such things as the commander's intent, which is essential to evaluate mission success. Many important metrics may be available as objective measurements, but there will always be essential aspects that will require subjective evaluation.

Synchronizing Operations/Tasks

The planning method employed in MP-CAT by the authors stops short of producing a written 5 paragraph field order with Annexes. While the authors don't suggest that MP-CAT output fully replaces a 5 paragraph field order, we recognize synchronization best practices cited in the MDMP Handbook (CALL, 2015) "An effective war game results in defining the roles of all enablers and … synchronizes their role in the fight. Key products to be developed in the war game include the synchronization matrix, decision support template, and decision support matrix" (p. 54). This view recognizes the value of decision support matrix in the MDMP COA Analysis step (see Figure 1). We represent the war game through dynamic maneuver graphics and found this to be effective to describe synchronized operations. The synchronization (sync) matrix augments a plan described by dynamic maneuver graphics for key task/events whose synchronization is critical to the execution of that plan. Its purpose is to identify the when, where and who of key actions/tasks that must be synchronized for the planned operation to achieve its required effect. The need for synchronization is not restricted to combat actions, but also includes logistical, personnel, intelligence or other warfighting functions. The synchronization matrix can be best presented in tabular form, and consists of a list of the times, the tasks, the units involved and task locations.

Increasing Plan Distribution Speed

Planning speed is measured against the enemy's decision cycle. If the friendly decision cycle is faster than the enemy's, lives are saved by seizing the advantage before the enemy can. We envision a faster/better method of distributing and monitoring plan execution. During the MDMP orders production phase, at the expense of time and manpower, the approved COA becomes the written plan. This occurs at every echelon an order is received, until the order is finally issued at the company level. Consequently, significant manpower and time is consumed converting orders from graphical to textual back to graphical in any single multi-echelon operation.

In addition, the written order is likely physically delivered as they are often too large (many megabytes) to distribute over established high bandwidth networks, let alone restricted bandwidth, ad hoc radio networks. Speed of delivery (not to mention security) is increased if an order is distributed over existing data networks, vice by vehicle.

If Troop Leading Procedures (TLP) are used, the written order is foregone and the plan is distributed as a collection of maneuver "graphics and other control measures" (HQDA, 2015, p. 10-8). This removes the time costly burden of converting plans to and from graphics and text. Distributing the TLP collection of graphic overlays, can be done with MC messages and occupies significantly fewer bytes over limited bandwidth data networks, but does not convey near the information as a written order with overlays. However, this gap can be narrowed as the population becomes more familiar with maneuver graphics and increases their use of the significant amount of information that can be embedded in Mil Std 2525C symbology.

We recommend improving TLPs by sending *dynamic* overlays (simulation data) containing routes, movement timing, etc. that can be replayed, elaborated upon and subsequently sent to subordinate units who can do the same. Like TLPs, this increases speed of delivery by sending the overlays over the network as data, and by not converting to and from written orders to graphics at each planning echelon. Importantly, uncertainty is decreased as the *dynamic* plan conveys significantly more information than mission planning *static* overlays. We advocate getting inside the enemy's decision cycle, and doing that when accompanied by more certain execution saves lives by winning the battle.

Automation Results Without a Special Interface

The MDMP needs results without forcing the user to interact with a unique interface. The following are mandates for protecting the commander and staff from added tool training:

- **A Simulation is Necessary**. Simply put – no simulation means no data, COA measures or COA comparison.
- **Lives Depend on Authoritative behaviors**. Decision makers must be able trust the outcome. Simulations without authoritative behaviors are to be avoided.
- **No Added Complexity.** The interface should be the operational MCIS interface.
- **Intelligent Graphics.** Digital Mil Std 2525C-based maneuver graphics "video" play the plan on the map.
- **Added Planning Benefits.** Benefits, such as route planning, sensor and weapon range display can be had.

Changing the Human Machine Interface Boundary Through Increased Automation

We have so far described the work done with MP-CAT for SIMCI. We have also extrapolated that work into characteristics of the HMI that a simulation-enhanced Mission Command system might support. But we have not discussed the farthest implications of a simulation as a decision making system.

We said earlier that keeping "the mission planner as the expert … prevents complacency of relying on computer recommended plans." Automated decisions open up an entire "basis for decision making" field of questions. One question is the selection of the decision-making algorithm. The authors are familiar with attrition-based, discrete event modeling, which may indicate the impact of a decision based on average unit combat power. But other research indicates that this may be narrow-minded, as Effects Based Operations (EBO) (Gilmour, 2005) key off of what is important in operations effects. And there are many others, favor the "weakest link" algorithm, where decisions hinge upon the worst value of key measurements. And as we consider how to make decisions based on measurement algorithms, we must also consider the impacts of those decisions on follow-on operations. Finally, if we select indicators automatically, that selection process must not be hidden, or we risk user trust issues.

But, how far do we go to support the commander and staff? There are very many factors to consider when attempting decision-making automation. In the ground-breaking combination of technologies combined in MP-CAT, the authors intentionally stayed away from automated decision-making. Automated decision making is very difficult and expensive to do in a validated manner. Decision support, while requiring full exposure of data upon which assessments are made, is much simpler, and infinitely more acceptable than defending representations of human decision-making. Decision support leaves the decision ultimately to the experienced warfighter, which is where it belongs, until automated decision making is an established, and well understood methodology.

RECOMMENDATIONS

Recognizing the speed realized in automatic comparison of empirically measured COAs within the planning process and successful prototype demonstration, we might conclude that our work is done. But we would be remiss if we did not look beyond the obvious warfighter benefits. Additional research is needed in the following areas:

DoD Authoritative Force Structure Data

The Army Organization Server (AOS) is now the authoritative Army source for a rich supply of U.S. Army force structure data suitable for both Mission Command and simulation systems. Current force structure data is partially, and insufficiently represented, based on the old MTOE technology. Adherence to the new Global Force Management Data Initiative (GFM DI) DoD directive by Mission Command and simulation systems should eventually resolve the "Common Force Structure Data" issue identified earlier.

Truly Common 3D Terrain Support

We previously describe the common map breakthrough as integrating data from multiple, separate MCIS and simulation systems onto one map. Today's US Army simulations internally use Army Geospatial Center qualified (SE Core) terrain enhanced with operationally relevant services. To realize mission rehearsal and operations visualization with tools for fields of view, lines of fire, route concealment, etc., MCIS also need an enhanced level of 3D terrain services support. A future MDMP support enhancement would be for all MCIS supporting and collaborating systems to collectively use one AGC certified terrain representation and take advantage of the same terrain tools used by simulations for on-the-fly terrain analyses. This would also significantly save on system resources currently consumed with redundant services.

Maneuver Graphics

We recommend that a broad set of Mil Std 2525C symbology be converted to intelligent graphics so that they support all WFFs and can be used to more fully convey the plan(s) both to MC users, to simulation and, in the future, to provide tasking to autonomous vehicles.

Broader MDMP Applicability

If the MDMP'S heavy cost of manpower and time is removed, then the MDMP is no longer inflexible or time intensive. What if our first premise to "fix" the MDMP with automation made it agile enough for general employment in more time restrictive environments? If the MDMP is shortened/agile, then its applicability may also become broader, because more comprehensive analysis can now be done in shorter time. For example, it is difficult to use the analog MDMP at the Brigade and almost impossible at the Battalion level. Perhaps the automated MDMP is now practical at the company level. In another example, the analog MDMP is a one shot effort at Brigade and lower echelons. Since the enemy often acts unexpectedly, the automated MDMP might be employed to develop and analyze branches and sequels if/when the initial plan becomes overcome by events.

CONCLUSION

The authors believe the MDMP can be more effective simply by increasing COA analysis speed, reaping better execution in the running estimate, and faster plan distribution using dynamic maneuver graphics. Automating MDMP decision support for flexible planning and re-planning, reduces total process time. Planning and deciding faster than the enemy save lives by seizing the initiative with rapidly produced, better evaluated and more fully conveyed plans. The MP-CAT prototype shows significant promise in improving the human-oriented MDMP by reducing the manpower and time costs, thereby opening up the rest of the process to more focused critical thinking. The technology represented by MP-CAT should be further explored for a more comprehensive solution.

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