How Human Social Culture Behavior Modeling Can Support a Comprehensive Approach to Operations

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ABSTRACT

In the current global security environment, the success of operations increasingly depends on leveraging all instruments of national and international power in a coherent fashion. Such a "comprehensive approach to operations" (CA) involves coordinated and coherent action by multiple operational entities that may include national/international government agencies, militaries, non-governmental organizations, corporations, and other actors. We review the history of the CA and related concepts, identify core technical challenges associated with effective implementation of a CA, discuss ways that computational modeling may be leveraged to address those challenges, review selected initiatives and tools that are helping to develop models and tools that may be useful in supporting the CA, and identify key science and technology gaps.

1.0 INTRODUCTION

Today, the US military rarely acts on its own. Rather, the challenges to national security are such that the services and other national defense elements are routinely required to coordinate or collaborate not only with other agencies of the US government, but with other governments and non-governmental actors. The military's operational role has expanded considerably. Where historically the military has focused on leading operations involving declared, kinetic-oriented conflict with a state-sponsored adversary, now it also routinely participates in operations with objectives focused on impacting non-combatant (green and grey) populations, and that may well involve facilitating the post-conflict recovery, reconstruction, and transition of a region. Mastering and utilizing the socio-cultural features of a given operational context has become an imperative.

With this reality, military operations are more likely to succeed if all instruments of national and international power (military, diplomatic, developmental, and economic) are employed in a coherent fashion. The multi-disciplinary concept of a "Comprehensive Approach to Operations" (CA) encourages coherent, coordinated, and constructive engagement amongst operational partners, such as national/international organizations, non-governmental organizations, businesses, international corporations and other local actors.

A number of key features characterize the CA to operations and have implications for its effective implementation. One, alluded to above, is the highly diverse array of actors who may be involved. The CA is a means to leverage the combined capabilities of these actors, which could include personnel from the military, public security, intelligence, diplomatic and development staff, host and local governments, allies, international organizations, non-governmental organizations (NGO), and private sector interests. Each type of actor brings its own resources, organizational structure, situation awareness, constituencies, priorities and politics. Yet, ideally, all will function as part of an effectively coherent whole for a given operation.

A related feature is the range of resources that are to be effectively applied in a given operation. The CA is a framework concept that enables the resources of the entirety of government, international organizations, NGOs, business, private actors, and local resources to be applied effectively in response to a crisis situation. Among the likely options are kinetic military action, disaster relief, humanitarian assistance, diplomacy, development, reconstruction, security sector reform, judicial reform, and social sector reform. These options vary enormously in a number of ways, not the least of which is their intended effects. All may be employed in stages as a situation evolves, or perhaps simultaneously. In any event, the ideal is for all to be coordinated, coherent, cooperative, and collaborative.

Historically, while elements of the CA to operations have been a part of effective counter-insurgency (COIN) operations, the concept is not restricted to or defined by COIN. Rather, the CA is defined in part by the fact that its elements should be applicable across the full spectrum of potential operations--domestic, expeditionary, or humanitarian.

A final feature worth noting is that, to be successful, implementation of a CA to operations must rest on a shared understanding of the situation, the strategy and objectives. Despite the diversity and even the possible conflict among goals of the actors, there must be some common picture of the context and de-conflicted understanding of goals and objectives. That said, it is important also to stress that the CA does not (necessarily) entail an integrated or centrally controlled response.

There has been recent international attention to the CA. NATO has moved to establish policy and recommended practices for its implementation [1]. In 2009, The Technical Cooperation Program convened a group to produce a baseline study of the CA in its five member nations. The study identified relevant doctrine and policy, culled lessons learned, and discussed the role of science and technology in supporting effective implementation of the CA. The group's recommendations will be highlighted later in this paper.

In the United States (US), there is no national definition of the CA, but there is widespread support for developing one. Concepts such as Comprehensive Approach, Whole of Government, Complex Operations, DIME (diplomatic, information, military, and economic) and Smart Power are widely used and discussed in policy, and in doctrinal, strategic, and operational documents. Much of the US policy and doctrine that now governs CA can be traced to the aftermath of the 1994 Operation Restore Democracy, in Haiti: "...senior policymakers observed that agencies had not sufficiently coordinated their planning efforts. More specifically, they found gaps in civil-military planning, disconnects in synchronization of agency efforts, and shortfalls in resources needed to support mission accomplishment." ([2], page 2)

On the diplomatic side of the US Government, National Security Presidential Directive 44 (NSPD-44) [3] is the key document, specifying the Department of State's leading role in interagency efforts for stability and reconstruction. On the defense side, Department of Defense (DoD) Directive 3000.05 [4] has a comparable significance, providing guidance on military support to stability, security, transition and reconstruction operations. The 2010 US Quadrennial Defense Review identified a set of Key Mission Areas (KMAs) in which DoD should build capabilities in order to be successful in the future global security environment. Several of these mission areas explicitly refer to the need to coordinate and operate with others across the US interagency and internationally. One of the key areas is building the security capacity of partner states. Much of US joint doctrine addresses establishing, operating, and evaluating combined and joint task forces. Joint Publication 3-08 [5] discusses interagency, intergovernmental, and non-governmental environments and provides fundamental principles and guidance to facilitate coordination between the DoD and other agencies and organizations. US Army Field Manual 100-7 [6] specifies how theatre campaign plans are to be developed, a process that accounts for the roles played by domestic and international actors likely to be involved in a CA to operations. Chief of Naval Operations (CNO) Guidance for 2010 stated that the Navy is to continue to evolve and establish international relationships.

2.0 IMPLEMENTATION CHALLENGES

Based on the preceding discussion, it may be self-evident that successful implementation of a comprehensive approach to operations may be challenging. The types of challenges that may be encountered range widely, with roots in organizational, cultural, and communication issues.

A starting point challenge is the simple lack of a common terminology and understanding within and between individual governments. It may literally be the case that potential CA partners do not speak the same language. Beyond that baseline challenge, it is likely that those partners do not use the same terms to characterize core operational elements, let alone what it means to take a "comprehensive" approach to the operations. There is a need at minimum for a CA taxonomy. Absent that, the lack of common understanding will lead to unclear direction across the set of actors, weakening communication and coordination.

The mix of military and non-military actors that may define the application of a CA to operations brings a set of issues. Many NGOs are circumspect, at best, about entering into any explicit coordinating relationship with the military. Typically, they stress non-kinetic means to their ends, and have constituencies and stakeholders that would react negatively to even indirect support of such means. There is also significant risk to consider. It is possible that opposing forces may target non-military elements, supposing them to be comparatively vulnerable, in an effort to disrupt whatever coordination may exist.

Another core challenge is the reality of highly stove-piped policy making, management, and implementing bureaucracies both within and across government actors. Demands associated with executing a CA to operations could dilute strong singular action that is at times necessary. Actors embedded in structures like this may well be unable to effectively respond to demands that comprehensive planning products place on them. In addition, information sharing may be compromised, a major problem as the management of information across government units and with other international participants is essential to effective implementation of a CA to operations. With respect to information management, for instance, the integration challenge alone is enormous. At present, it is unlikely that any nation or organization is capable of integrating their management practices and information to fully support field operations. This challenge will be strengthened where organizational and cultural features compel actors to resist sharing information in a timely fashion.

Developing metrics and measuring effects following implementation of a CA to operations is a major challenge area. The problem is not simply developing reliable ways to detect and track the impact that such operations have on populations and conditions on the ground. It is also a question of anticipating the interdependent effects of different powers that are utilized as part of a CA to operations. For instance, how does the effect of a diplomatic action impact a military strike (if at all)? How might a "say-do" gap open, what will its consequences be, and how can its effects be mitigated? These are the kinds of questions that concern the ways that constituent elements of a CA to operations interact.

There is also the "cat herding" challenge. Orchestrating a CA to operations is a highly complex logistical matter. It is difficult to align and control such operations given that the CA is defined in part by its inclusion of NGOs and other actors who are not controlled or directed by participating governments. Different goals can conflict at times within government departments and agencies –not insurmountable, but potentially a significant obstacle to progress. These can lead to different views on priorities, principles, and mandates. Different planning and execution time horizons between actors also contribute to the problem, especially when contrasting military and development agencies. A common planning process or tool, which could be used by various government departments and agencies, as well as NGOs, would help—especially with the foundational task of establishing a common vision of the desired end state. However, it must be noted that not all participating entities will have the resources or expertise to engage in the required level of planning and engagement to be fully integrated into an operation.

A final challenge to note here is emergent behaviour. Even relatively simple systems exhibit behaviour that emerges more or less predictably from the interaction of their components. However, especially in more complex systems, behaviour may emerge that cannot readily be predicted or, indeed, accounted for by examining the system components. That is, the whole is greater than the sum of the parts. Such behaviour is highly likely in a system as complex as any operation that attempts to coordinate a set of actors as diverse as those involved in the CA to operations.

3.0 THE ROLE OF SCIENCE AND TECHNOLOGY

Given the considerable challenges discussed above, what science and technology initiatives may be appropriate and helpful? This was a core question of the Technical Cooperation Program's (TTCP) Ad Hoc Study Group (AHSG) on the Comprehensive Approach to Operations. AHSG participants solicited information from their respective nations on existing S&T programs or tools, as well as on S&T priorities. That information was then integrated by the group and a summary set of recommended areas of opportunity was produced (see the figure below).

Science & Technology Areas of Opportunity

- Multi-agency modeling, simulation, and experimentation to develop a CA operational concept (e.g. MNE 4, 5, 6)
- Tools, methods and techniques to support force synchronization
- Models and other tools for determining optimal multi-agency capabilities (e.g. PSOM)
- Development of organizational cultures and individual knowledge, skills and abilities (KSA) that support a CA to operations
- Analytical methods, models, and simulations that support analysis of emergent and directed behavior in CA networks
- Development of measures of effectiveness (MOE), and tools for assessing outcomes
- Methods to collect, integrate and visualize the non-traditional, socio-cultural information necessary for supporting a CA
- Decision support/COA analysis tools that leverage validated, social science-based models of socio-cultural behavior in regions of interest

In the US there is a robust and increasingly coherent set of S&T programs that, while not defined by a focus on the CA to operations, nonetheless are contributing to the evolution of the concept, exploration of its use, and development of tools to enable its effective application. Research and development programs span the full range of technical capability, including basic research, applied research, testing and evaluation, and transition to operational use.

Within the DoD, programs are sponsored and executed by the Armed Services, the Office of the Secretary of Defense (OSD), Joint Improvised Explosive Devices Defeat Organization (JIEDDO), Defense Advanced Research Projects Agency (DARPA) and Defense Threat Reduction Agency (DTRA) among others. The national laboratories (e.g., Sandia, Los Alamos, Livermore) conduct basic research that enables CA at least indirectly. DoD also coordinates and at times partners on research and development (R&D) with other departments, including the Department of Homeland Security, Department of State, and the national intelligence community. The DoD Command and Control Research Program sponsors and publishes a variety of material related to the C2 aspects of CA.

A recent report from the Defense Science Board Task Force on Understanding Human Dynamics [7] includes results of a DoD-wide call for data on relevant research efforts. While that call was not specifically focused on CA, the work reported back to the Task Force spans most of the S&T areas that enable a CA.

Categories of R&D (and technology evaluation) identified in the report include:

- Tools and techniques for collection and shared use of data, and for validation of socio-cultural models;
- Research, modeling and analysis of adversaries, insurgents, and terrorists;
- Influence operations and strategic communication;
- Geospatial framework and services to enable integration of spatial, temporal, and socio-cultural information;
- Simulation, training and mission rehearsal applications;
- Research and analysis to build understanding and capability regarding groups and populations;
- Modeling and research on operations, including tools for forecasting first- to third-order effects to support intelligence, course of action (COA) development, and decision making;
- Infrastructure and applications to enable visualization of model outputs, multiple forms of information, and uncertainty;
- Socio-culture-based indications and warnings and threat analysis.

In 2001, the Director, Defense Research and Engineering (DDR&E) established a Strategic Multi-Layer Assessment program that provides support to COCOMs and warfighters, and coordinates with the Joint Staff and US Strategic Command (USSTRATCOM) to support global mission analysis. The program also integrates human, social, cultural, and behavioral factors, producing focused multi-disciplined strategic and technical assessments, and provides training and education regarding the development and application of new analytic tools. National Security Council exercises serve the same purpose – determining how inter-agency contingencies can be better reviewed at various levels. At much lower levels, ongoing lessons learned may be utilized in shaping doctrine and training by examining recent experiences.

Another effort, the Coalition Warfare Program, provides funding to projects that conduct collaborative research, development, testing, and evaluation with foreign government partners. The program (administered by the Director of Planning and Analysis, for the Under Secretary of Defense of Acquisition, Technology and Logistics) exists to assist Combatant Commanders, Services, and DoD Agencies in integrating coalition enabling solutions into existing and planned programs. It focuses on short-term interoperability solutions, along with the early identification of coalition solutions to long-term interoperability issues, such as architectures and major systems acquisitions.

In addition to R&D, joint experimentation, wargaming, and other exercises are critical elements of overall US capability-building regarding the CA to operations.

Supporting the DoD-related institutions and programs are a wide-ranging set of research-oriented institutions, both public and private sector. These include think tanks and foundations (e.g., The Markle Foundation), academia, and industry. Federally Funded Research and Development Centers (FFRDC), including MITRE, RAND, and the Institute for Defense Analyses, provide technical support to DoD and other government sponsors. MITRE emphasizes engineering of complex systems across DoD and other US government communities; RAND specializes in strategic and policy-level studies; the Institute for Defense Analysis (IDA) focuses on technology systems assessment and strategic planning.

Finally, there is a significant S&T role played by training and education programs that are sponsored by or in other ways support the DoD. For example, the National Defense University conducts quarterly symposia to create a cadre of professionals familiar with interagency processes and initiatives. These programs may be mechanisms for experimenting with or prototyping new technology and tools. And, of course, there is great interest in developing tools and technology specifically for the purpose of delivering better training (e.g., leveraging gaming technology). Another program, the Interagency Counterinsurgency Initiative conducts outreach through conferences, workshops, consultation, and collaboration. Included in this is the Consortium for Complex Operations, which networks training, education, research, and lessons learned programs underway across the US government.

This survey of DoD-related programs and initiatives should not be considered comprehensive. Rather, it is intended to illustrate the fact that there is a good deal of research, development, and training work going on across the DoD and interagency that is aimed at supporting and better enabling a CA to operations.

4.0 LEVERAGING COMPUTATIONAL MODELING

In this section, we describe a few of the US programs that are supporting work on computational modeling that will benefit effective execution of a CA to operations. We then provide a list of some particular tools and, based on the earlier discussion of challenges, characterize how each tool can support implementation of a CA to operations. That discussion also indicates some of the areas where further work—research, development, and testing—would be helpful.

4.1 PROGRAMS

A number of US programs support research, development, testing, and transition of models and model-based tools that support effective implementation of a CA to operations. The OSD Human Social Culture Behavior (HSCB) Modeling Program is a vertically integrated effort to research, develop, and transition technologies, tools, and systems to Programs of Record (POR) and users in need. Administered by the Assistant Secretary Defense Research and Engineering, the HSCB program is funded via three Program Elements, one focused on conducting applied research, one on maturing and demonstrating the tools and software outputs of that research, and another on testing and transition of tools and systems to formal acquisition programs and users. Rooted firmly in social science theory and methodology, the program's overarching goal is to provide DoD and the US government with the ability to understand and effectively operate in human social culture terrains inherent to non-conventional missions. The program exists to support development of capabilities/tools for use in intelligence analysis, operations analysis and decision-making, training, and joint experimentation activities.

The US Joint Forces Command (USJFCOM) sponsors the Joint Concept Development and Experimentation (JCD&E) program, which includes a multinational experimentation series. That series provides opportunities to explore new concepts and capabilities for multinational and interagency operations (http://www.jfcom.mil/about/about1.htm). Modeling and simulation are critical elements of multinational experimentation, helping to generate recommendations to leadership, and to deliver validated innovations to practitioners.

The Air Force Research Lab (AFRL) supports research that addresses the fundamental long-term challenge of predicting adversary behavior, with the objective of providing a detailed understanding of probable intent and future strategy in order to identify potential courses of action that both adversaries and other entities' commanders must consider while taking action. One major product of the AFRL research is the National Operational Environment Model (NOEM), a holistic modeling environment that supports baseline forecasts, analysis of pressure points for resolving instabilities, and what-if analysis. For more information on AFRL, go to http://www.wpafb.af.mil/AFRL/.

4.2 TOOLS

A number of methodologies and tools are in use and emerging that enable a CA. At the strategic level, a number of analytical tools enable modeling to anticipate and understand instability, and may be used to inform programmatic, operational, and tactical level plans. The US State Department Office of the Coordinator for Reconstruction and Stabilization has developed the Interagency Conflict Assessment Framework (ICAF). The ICAF is designed to help agencies develop a common picture of the drivers of violent conflict in a given country, and to facilitate establishing a baseline against which to evaluate the impacts of US involvement. A similar tool is the Global Forecasting Model of Political Instability, a product of the Political Instability Task Force, a government-sponsored grouping of researchers and scholars from a number of US universities (http://globalpolicy.gmu.edu/political-instability-task-force-home/).

Closer to the operational level, there are several modeling tools either in development or already in use. An example is Senturion, a simulation capability that analyzes the political dynamics within local, domestic, and international contexts and predicts how the policy positions of competing interests will evolve over time. Developed by Sentia Group, Senturion relies on agent-based modeling to structure a simulation of the behavior of the individuals and groups that influence political outcomes. For an analysis of Senturion's application to a series of case studies, see reference [8].

DARPA began development of the Integrated Crisis Early Warning System (ICEWS). The system will provide commanders with a capability to proactively manage and respond to security risks in their area of operations--spanning the entire spectrum of the crisis early warning and mitigation cycle. The system integrates social science models, theories, and data across multiple levels of analysis to systematically identify antecedents to a variety of destabilizing events. Starting in 2011, the OSD HSCB Modeling Program continued ICEWS and supported extension of its capabilities

Social network analysis, game theory, systems dynamics, and red-teaming are methods and techniques with promise for improving our understanding of network behavior. Needed are analytical methods, models, and simulations that support analysis of emergent and directed behaviour in CA networks, and which increase understanding of trust-building and cohesion factors. The Office of Naval Research (ONR) sponsors the program on Command Decision Making and Adaptive Architectures for Command and Control (A2C2). Using a combination of mathematical and computational models and empirical experiments with Navy officers, the A2C2 program has investigated the effectiveness of the alternative innovative organizational structures that are being enabled by the explosion in network connectivity. See the ONR Website for more information (http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Command-Decision-Making.aspx).

Modeling-related R&D can also help advance capabilities for force synchronization and development of a common and coherent operational approach. The Conflict Modeling, Planning and Outcome Experimentation Program (COMPOEX) is a first-generation systems architecture for executing various computational models including systems dynamics and agent-based models [9]. Sponsored by DARPA, COMPOEX was designed to provide a suite of tools to help military commanders and their civilian counterparts to plan, analyze and conduct complex campaigns, simulating political, military, economic, social, information, and infrastructure factors.

Visualization is an important mechanism for enabling better coordination in conditions like those characteristic of a CA to operations, where the actors are not only diverse but often distributed. Effective coordination will rest in part on a common operating picture, and planning will be facilitated by having the ability to display geospatial layers of social, cultural, and behavioral factors that define the human terrain. To help meet this need, the OSD HSCB Modeling program is supporting development of visualization tools and infrastructures that display hybrid data sources such as geospatial layers, between individual and group relationships, and related socio-cultural data in ways that are easy for the user to assimilate and that address how evidence is created using provided data and how uncertainty propagates throughout the system. Another initiative, the MAP HT Joint Capability Technology Demonstration, addresses the limited Joint, Service, and Interagency capability to collect, visualize, and understand the socio-cultural information necessary to assist Commanders in understanding the "human terrain" in which they operate (http://www.mapht.org/).

Models are also being used to support effective training to build cultural awareness and understanding. Modeling and simulation technologies are leveraged for serious games and other virtual interactive tools in the context of military training. One R&D area for the HSCB Modeling program is demonstration of distributed training technologies to speed the development of socio-cultural skills of coalitions in current military operations.

Measuring the impacts and effectiveness of complex operations is a major area of need and ongoing work. The US Army Corps of Engineers has developed the Measuring Progress in Conflict Environments (MPICE) methodology for measuring outcomes in the transition from open conflict to stability and reconstruction operations. MPICE includes a comprehensive, generic metrics framework, procedures to tailor the metrics to the environment and mission, and a computer-based tool to archive, analyze, and visualize the collected data. Another effort to look at effects, sponsored by the HSCB Modeling program, will develop and validate software that models the outcomes of collaboration between US military forces and NGOs.

One area where there is a significant need for further work is capability planning and force optimization. Determining the optimal set of multi-agency capabilities for a given operation is a significant challenge, and modeling can help inform decisions about those capabilities. In the United Kingdom (UK), a number of models have been developed that can inform capability planning. These include the Peace Support Operations Model (PSOM) and its Stabilization Operations Analysis Tool (STOAT). In addition, the UK has developed DIAMOND (Diplomatic and Military Operations in a Non-Warfighting Domain), which is a model intended to help assess the effectiveness of variations in force mixes.

4.3 CHALLENGES

While there is expanding activity to build a deep, rigorous DoD-wide portfolio of computational modeling-based applied research, a number of primarily technical challenges persist (see list below).

Persistent Modeling Challenges

- A more complete basic research foundation grounded in inter-disciplinary social science
- Multi-scale and hybrid models
- Transparency in models and tools
- Interfaces enabling use of models across military domains, environments, and echelon levels
- Policies, procedures, information systems, and requisite training to sustain HSCB modeling usage
- Validation and verification of socio-cultural behavior models
- Processes, procedures and training to ensure appropriate use of models in support of "robust" decision making
- Methods for valid collection of quality socio-cultural data and systems in which those data can be readily accessed for use in modeling

Applied research, advanced technology development, and pre-transition prototyping all should rest on a solid, broad foundation of effective basic research. Yet, that foundation remains relatively thin. More attention is needed for validating theory and building basic understandings of socio-cultural dynamics.

Multi-scale and hybrid models are needed to instantiate, explore, and predict highly complex social processes. Multi-scale models work across multiple levels of granularity (e.g., from local to national to regional) to represent how actions at one level propagate through and impact other levels. Hybrid modeling integrates different modeling modalities (agent-based, system dynamics, etc.), and theory from multiple disciplines. Determining how to validly integrate theory from multiple disciplines, different modeling modalities, and varying levels of data granularity is a major challenge.

As socio-cultural behavior models transition to operational programs, an ever-broader range of prospective users will be using them and the tools built to leverage them. Most of these new users will not be modelers. Prospective users need to understand enough about what's "under the hood" so that they can grasp what the model is doing and translate how unexpected variations that occur in their real-world scenarios might be served by a given model or tool. It will also be important, and both operationally and technically challenging, to develop interfaces (data, user, execution) that will enable models to be used across military domains, environments, and echelon levels. We can also build confidence in the use of model-based tools by supporting their deployment with appropriate policies, procedures, information systems and—of course—training.

Methods for verification and validation (V&V) of hard science models are reasonably well established. The same cannot be said for the inherently complex models of socio-cultural behavior. Because of the V&V problem, it is especially important to consider and educate leaders on how to select, use, and interpret socio-cultural models. Selecting an optimal strategy is problematic when there are multiple plausible futures. The use of computational modeling and simulation can help reveal uncertainties and estimate probabilities associated with various COAs.

The "data problem" is not necessarily that there is little of it, but that (a) often it has not been collected in valid ways (b) collection is often hard in difficult to reach, technology-limited areas, and (c) socio-cultural data is often too "messy" to be readily accessed, shared, and integrated across computational models. Further investment is needed in addressing each of these interrelated problems.

5.0 CONCLUSIONS

This paper is a modest attempt to highlight some of the current significant work that is helping to better define, understand, and execute a CA to operations. Given the complexity of the topic, the paper would be incomplete under any circumstances. In addition, we have kept our attention almost exclusively on US-based ideas, programs, and tools. There is a good deal of thoughtful, innovative work being done that is led by other nations. Fortunately, much of that work is being done in partnership with representatives of the US military and government.

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