Introduction to Architectures: HSCB Information – What It Is and How It Fits (or Doesn't Fit)

Dr. S.K. Numrich
Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311
USA

snumrich@ida.org

ABSTRACT

The military has voiced an increasing interest in introducing human, socio-cultural behavioural (HSCB) understanding into its education, training, intelligence and operational planning capabilities. The nature of the data required for developing a socio-cultural understanding presents challenges for the community, as does the relative immaturity of models and simulations in some of the disciplines that contribute to explaining socio-cultural phenomena. The objective of this paper is to deconstruct the problem of fitting HSCB data into simulations into several steps, starting with the vocabularies in which we begin to express the problem space and concluding with a brief review of two architectures – one designed for the analytic community and the other, already adopted by NATO, that enables distributed simulation. The author concludes that the greatest potential use for unifying architectures is their ability to provide researchers and practitioners an environment in which to explore, discover and advance the state of the art.

1.0 INTRODUCTION

> *In the end, we will never fully deliver security from the barrel of a gun; not in Afghanistan nor anywhere else. It will come as a combination of the so-called "3 Ds" – Defense, Diplomacy, and Development. I say it is even broader than that, and will require political, economic, cultural, linguistic, military, skills – in simplest terms, combining international, interagency, and private-public approaches.[1]*

With this statement, ADM Stavridis, Supreme Allied Commander Europe (SACEUR), clearly articulates that the road to peace as well as success in battle requires a holistic approach including an understanding of the socio-cultural environment – an understanding sufficient to create stability in cooperation with local population. If the goal is to use all the elements of national and international power aided by a clear understanding of the socio-cultural environment, then the tools used to assist military planners must also be capable of taking into consideration the economic and social structures, the culture and ethnic orientation of the population, and the myriad of influences within and from outside the local area.

Current planning tools have demonstrable capability in all aspects of kinetic operations in the traditional warfighting domains (undersea, sea, land and air). However, they were designed and built in an era following major state-against-state conflicts, a focus that is not consistent with the current state of the world nor with the broadened responsibilities of the military that include stability and peacekeeping in addition to counter insurgency and disaster relief. These tools, the models that support them and the training capabilities that enable the military to use them effectively, must be modified to include the relevant socio-cultural factors and their effects.

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This paper focuses on architectures, the structures that allow diverse models to run in a common environment, share data and produce integrated results. The interactions enabled by architectures rely on a common data structure and an understanding of how multiple factors combine to produce coherent effects. For this reason, the paper begins with an orientation to socio-cultural data and then moves on to examine several of the vocabularies that are being used to explain socio-cultural factors and how they impact the environment. Following these discussions, two architectures are considered – one designed to be used for analyses and the other most often used in distributed, interactive, real-time simulations. The paper does not examine the development of models, but rather assumes that models of certain types exist and are suitable for incorporation into the architectures to achieve analytic, planning or educational goals.

Architectures are useful only when their general structures can be readily adjusted to apply to diverse problems, in this case, problems of relevance to the military – relevance to a particular mission, relevance in the context of a particular area of the world and relevance to the level of operation. A final consideration is the level of expertise required of the operator who must use the tools. The resources available at a brigade headquarters differ significantly from the capabilities in the hands of the forward-based tactical decision-maker. These factors that focus and delimit a problem (mission, area of the world, level of operation, and operator skill) are referred to in this paper using the acronym MALO. .

The tools and architectures now used by the military reflect maturity in physics, engineering and computer science. They were conceived to support deterministic and stochastic processes capable of producing forecasts. Social science models are often descriptive and rather than projecting a forecast, they examine a number of potential futures. The application of mathematical and computational techniques to modelling in many social science disciplines social science modelling is relatively immature. In such an environment, what is the appropriate role of architectures? The paper concludes with a commentary on architectures and suggestions for their use in the research establishment as well as in military applications.

2.0 ORIENTATION TO SOCIO-CULTURAL DATA

Most data used in modelling and simulation is found in two forms: structured and unstructured. Structured data is information that has been reduced to numerical values found in tables or data sheets of various sorts. Unstructured data is found in unformatted text, most often in doctrinal manuals. Performance data used to specify the way entities function in kinetic simulations is most often formatted – lists of numerical specifications for such factors as speed, turn radius, a weapon's range and kill ratio. Military doctrine, tactics, techniques and procedures for using the entities are normally found in field manuals and are translated into when and how entities in a simulation function. Theory and experiment form the foundation and source of both formatted and unformatted data.

The situation is much the same with socio-cultural data. Depending upon the problem addressed and the computational methods employed the preponderance of data could be either structured or unstructured. Statistical assessments at national levels often use generally available national statistical tables. Unfortunately, for many cases of military interest – situations involving emerging nations, nations under stress or nations with limited infrastructure – statistical data may be incomplete, sparsely populated or developed using non-standard techniques. Many recent studies on the use of improvised explosive devices (IEDs) developed their data laboriously from numerous accounts of IED incidents. For such studies, the process of extracting data from text begins with the development of a code book, a set of definitions and criteria for turning the report of an IED incident into a set of numerical values that represent the time and place of the incident, the nature of the weapon, how it was detonated, the range of damage and lethality of the blast and any information on the group responsible for it. Coding data by hand leads to error and bias on the part of the human coder. Machine coding is not only possible, but is used widely in a number of social science fields; however, it also has difficulties and limitations. The need for this type of data coding is often difficult for those accustomed to physical and mathematical models to appreciate.

2.1 Characteristics of Socio-Cultural Data

The majority of the tools and models used today involve a one-on-one paradigm – weapon on weapon, force on force. Including a more comprehensive view of the human dynamics changes the problem from one-on-one to many-on-many, where the sides interacting include the local government, internal military forces, external military forces, leaders of internal factions, influences from external connections and the local population. Each faction involved has long-term motivations, short-term goals and perceptions of what a desired end state might be – driven by ethnic, religious or cultural perspectives.

The new factor critical for socio-cultural models, but largely absent from traditional military modelling, is perception. For centuries, the military has understood the necessity of understanding the mind and perceptions of the enemy. What is new is the need to understand the perceptions of the various factions of the population. The now superseded 2007 Irregular Warfare Joint Operating Concept, described irregular warfare (IW) as being "about people, not platforms."

> *IW depends not just on our military prowess, but also our understanding of such social dynamics as tribal politics, social networks, religious influences and cultural mores. People, not platforms and advanced technology, will be the key to IW success. The joint force will need to be patient, persistent, and culturally savvy people to build the local relationships and partnerships essential to executing IW.[2]*

In all things human, perception is reality. The situation as measured by all means and techniques and quantified by nationally and internationally accepted standards is only part of the story. The way the different factions of the population perceive and react to the situation is at the core of working effectively in the human environment. A simple example can provide a graphic, immediately accessible picture of the power of perception.

Consider the following situation. The national government promises to provide a guaranteed four-hour period each day at a given hour of reliable electrical power to every home in the nation. For many developing nations around the world, four hours of reliable electric power would be a boon; however, in major industrial nations having only four hours of reliable electric power a day would be a disaster. Further, let us consider that the promise is made with a guarantee that it would persist for the next four months. Again, for populations not accustomed to reliable electrical power, the promise of having daily power for the next four months would be a major improvement in their lives and they would consider the government successful at least at the level of providing energy infrastructure. Back in the industrial nation, the failure to remedy the situation of only four hours of reliable power for a four-month period would be totally unacceptable and worthy of a no-confidence vote against the government.

The situation is identical, but the perception and consequent reaction are based upon expectations conditioned by experience and societal norms. When taking into account the human dimension, it is not sufficient to know the situational data; it is also critical to understand how the different groups in the area perceive that situation.

2.2 Perceptual Data

Irregular warfare is defined by Joint Publication 1-02 as "a violent struggle among state and non-state actors for legitimacy and influence over the relevant population(s)." [3] Acquiring data on the current perceptions of various relevant factions in a population is the first part of the problem, but having a functional understanding of those perceptions requires going a step beyond. Knowing perceptions is perquisite to being able to influence them to achieve an end, and the ability to influence perceptions necessitates an understanding of those long-term factors that condition the formation of perceptions. As a result, understanding perceptions has an historical and cultural context that may not be apparent in the data itself.

Historical information provides a window on both the formation of perceptions and the behaviours driven by them. There is also a dynamic associated with perceptions. Conditions change, attitudes change, external influences change – and all of them drive perceptions and actions. Knowing how a faction reacted to similar circumstances in the past may not determine current actions, but as good Bayesians, we believe that the past provides indicators. Cultural, societal and religious norms are strong drivers of behaviour and they tend to be more persistent. Understanding what a cultural, ethnic or religious group values and how it deals with property and leadership, with crime and redress, provides a necessary foundation for working effectively with the population and their leadership.

With context firmly in hand, there are a number of means for probing the perceptions of the population. In a literate society, the media is a valuable resource for understanding the perceptions of the population, particular the vernacular media. Translation brings with it several sources of bias. The very fact that something is being translated implies that it is intended for consumption by a foreign audience and selection criteria include both what the media moguls feel would interest the foreign audience and what they wish the foreign audience to understand from a particular story. This is particularly true when there is considerable government control of the media and the government has a purpose in controlling its output. Translations themselves induce a bias through inexpert ability to capture a sentiment in a foreign language. Thus the vernacular is the most important source for acquiring perceptual data.

Interviews also provide insight into the attitudes and perceptions of local populations; however, information acquired from these sources must also be carefully interpreted. Subject matter experts, expatriates and focus groups often have their own agendas and biases. Unless they are currently living in the society in question, their assessments are second-hand: valuable, but not necessarily correct in all aspects.

Surveys and polls are extremely valuable, but also subject to error. Populations at stress are often less interested in giving answers to pollsters than they are in just surviving. In repressive environments, people are not likely to be forthcoming about their own reactions and will at times give answers that they feel the pollsters are seeking. There are a number of reliable, professional polling groups who understand how to build questions to elicit the right information from a local population, questions presented by members of their local culture and phrased in ways that make sense in that culture. At times simple polls administered by the military in their area of operation can be useful and informative. The Tactical Conflict Assessment Framework developed by the U.S. Agency for International Development (USAID) has been used effectively by the military in Helmand province in Afghanistan. The survey has only four questions, all of which are designed to elicit an extended response from the individual respondent.

Perceptions are not static and are influenced by whether the individual feels that his or her situation is improving or degenerating. This implies that both the situational data and perceptual data must be collected at regular intervals in crisis situations. Crisis situations normally exist in environments where the ability to collect data of any type is seriously hampered by a lack of security, by the state of the infrastructure, and by the ability to access representative parts of the population in spite of difficult conditions. Thus the need for continuous monitoring is greatest under circumstances least amenable to data collection of any sort.

2.3 Situational Data

The need to include all factions of the population functioning in the military environment places increased emphasis on data concerning all facets of the local population. Demographic information is critical, but only a clear understanding of the culture can determine whether the information needs to account for ethnic groups or economic groups, tribes or families and sub-tribes, national military or local militias or all of the above. Depending upon the nature of the country, the economic information may have to include the traditional economic information, non-traditional or barter systems and covert economies.

As difficult as it might be to acquire current and complete information about the groups functioning in the local environment, understanding the military, economic, financial and governance capabilities of these groups is often far more difficult. Few reliable sources of information are conveniently available. Considerable effort is needed to extract data from disparate sources, which, when used in combination, can yield valuable insight into capabilities of local groups.

2.4 Data Considerations Summarized

Including the human dimension in military tools and models increases demands already placed on data. In socio-cultural assessments, far more of the data must be extracted from unstructured text from diverse sources. Even the situational data is likely to have inconsistencies, lack current information, and be totally non-existent in areas of most critical concern. The human dimension involves human decision-makers who function on the basis of perceived reality; therefore, perceptual data takes on an importance not found in traditional force-on-force modelling.

In the end, all actions, kinetic and non-kinetic, change perceptions and influence a population. Similarly, what is said and not said at critical times can change perceptions. The ability to work effectively with factions in a population depends upon understanding the context in which their perceptions are formed and being able to work within that context to change perceptions that drive behaviour and thus change the operational environment to accomplish the military mission, whatever its nature.

3.0 DECONSTRUCTING THE PROBLEM

The problem at hand is how to introduce the complexity of the human dimension into military models and tools and do that knowledgeably and with the intention of growing individual solutions into a common approach that will service military needs in data acquisition, planning at various levels, education and training. There are many potential lines along which to break down the problem:

- Levels of operation: These are normally referred to as strategic, operational and tactical. Tools, models and simulations must be responsive to the needs at each level as well as to the type of expertise available.
    - Planning at the strategic level is normally characterized by a long time horizon with detail levels at national or just below. At the strategic level of operation resources normally include a high level of expertise in intelligence, the use of tools of various sorts and readily accessed reach-back to subject matter experts. Plans are normally written around the national or international goals for that theatre.

- At the operational level, planning begins at the national level and works down to provincial levels or the level at which the operations are dissected. In Afghanistan, this type of planning would include national, operational regions (Regional Command (RC)–East or RC-South, for example) and within a national force is likely to extend down to the highest forward level command. Plans are subject to change with changing conditions at the local level.
- Plans at the tactical level are developed and executed with more rapidity than at higher levels of command. While remaining consistent with the commander's intent at the strategic and operational levels, these plans are developed without the expertise available to strategic and operational commands and are in direct response to local conditions.

- Analytic vs. Operational: While there are certainly analytic tools in use in the operational world, the distinction to be drawn here is one of vocabulary and technical orientation rather than where the tools are used. The analytic community is characterized by a focus on metrics and measures and has developed a language and tools responsive to this orientation. Analysis can be done at any level of operation, but tends to be characterized by the use of models with a significant level of mathematical rigor and rapid execution times to enable the user to run many model experiments and assemble statistical bases from which to draw assessments. The operators require suites of tools that can be used in the classroom for education and in training exercises to build the skill base and sensitivity of the military force. When in regional headquarters or deployed, the operators need tools to aid in the acquisition and use of information, tools to aid in planning that include the effects of the human dimension and tools to test and evaluate courses of action, again including the effects of the human dimension, but the human dimension as they know it in their area of operation. Metrics are essential, but the focus is on the operation rather than analysis and the time horizon of many operational planners is seventy-two to ninety-six hours (close to immediate in the mind of the mathematical analyst).

- Characteristics of Execution: These are computational distinctions and they will surface in the discussion of architectures. Among the computational characteristics is real-time execution vice much faster than real time execution. Analytic applications run to acquire statistics must run faster than real time. Training applications are often done in real time to permit user interaction. Most analytic applications are run on a single computer or off a single server; whereas, test and training application are often run on different processors, sometimes separated geographically.

- Research vs. Operational: This distinction is extremely important as we attempt to field tools and capabilities that can handle HSCB data to allow planning and analysis of courses of action while taking human dynamics into account. While the military has been anxious to add HSCB capability to their arsenal, the dialog between the military and the social science research community has not been smooth. Both sides understand there is much that social science can contribute to military missions; however, matching actual capabilities to expectations has been difficult and exacerbated by lack of common vocabulary.

All of these approaches to examining the problem space have limitations and virtues; however, a more universal decomposition can and should be applied regardless of the approach selected. Figure 1 outlines this common method for deconstructing the problem in to vocabularies, models and tools, architectures and, finally, applications and interpretations. The rest of this paper will parse the problem along the lines suggested by Fig. 1, but will not talk about individual tools and models.

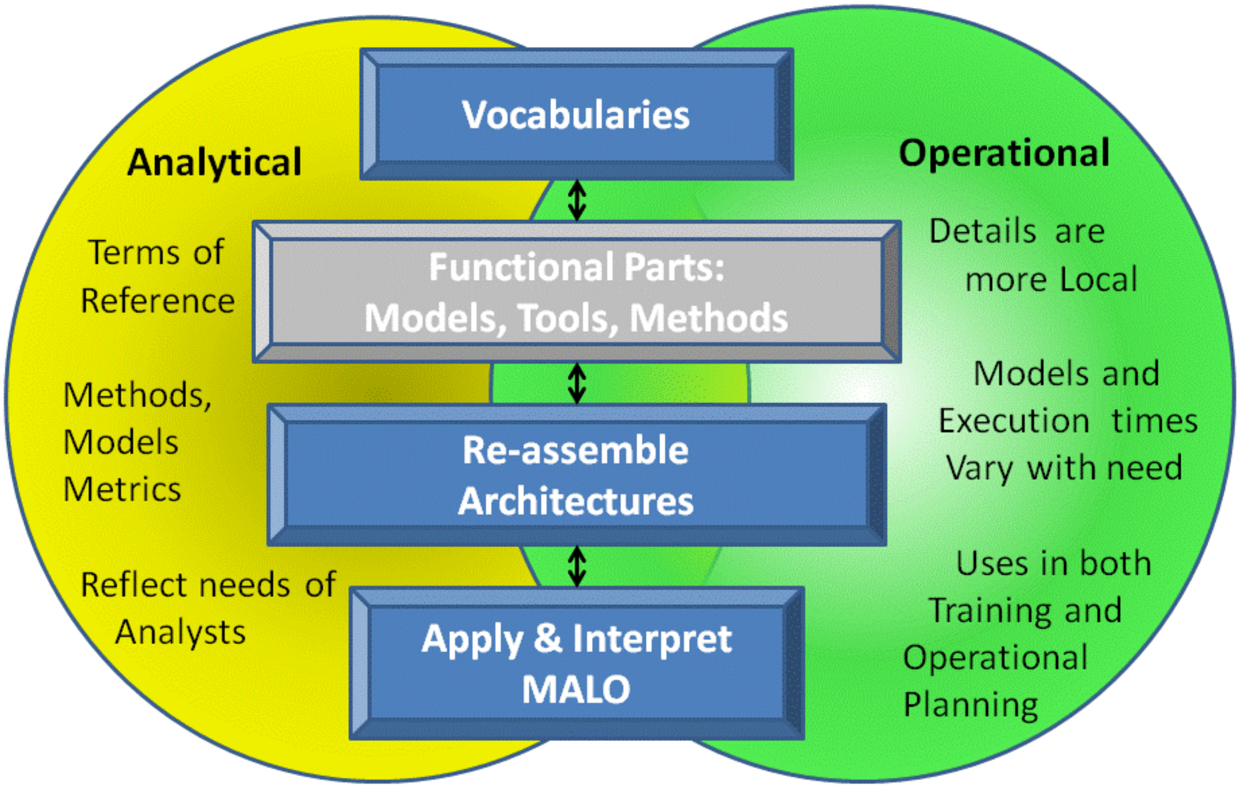

Figure 1: Deconstructing the Problem.

The first step in working with a problem is to agree on a vocabulary that allows the details of the problem to be discussed by all interested parties. More formal approaches extend these vocabularies into taxonomies, ontologies or metadata structures for enabling computer implementation in the form of data structures. However, the first step is to allow humans to engage in meaningful dialog. Among the initial objectives of the dialog is to clarify user needs and requirements. Using these needs, the research and applications community can begin to employ their scientific understanding of the problem to specify potential solution paths, including data collection and tools, all consistent with methodologies commonly accepted in their fields. The result of this process is often to break the problem down into pieces that can be solved. Once this is done, there is a need to synthesize or re-assemble the pieces in scientifically consistent ways to bring understanding and clarity to the original problem. The role of architecture is to enable the re-assembly of the pieces. They type of architecture selected will depend upon the nature of the problem, the type of the pieces to be assembled and the type of interaction required by the end user.

When the problem types persist, and one expects that problems involving HSCB data and socio-cultural models will remain of interest for a significant time, clusters of tools and models emerge around a particular architecture. Once such models have been interfaced, they can be reassembled and used to address different, but related problems. The development of High Level Architecture (HLA)-compliant models that can be used upon demand in new federations is such a cluster. For HSCB applications, there will be other clusters around different types of architectures, some of which are now beginning to emerge.

Having architectures with clusters of models available allows the user or his agent to apply the models to solve new problems and interpret the results. However, the utility of the models thus assembled will depend upon the factors summed up using the acronym MALO which appears in Fig. 1 and was defined earlier in this paper.

4.0 VOCABULARIES

Whether using models to explore problems or conducting military operations, the need to have a corporately understood and adopted vocabulary is vitally important. In coalition operations, the various nations and their military representatives must be able to resolve issues among themselves and plan coordinated actions using a mutually understood vocabulary. Similar understanding must extend up and down the military chain of command. The importance of developing and maintaining this type of understanding was underscored by General Krulak when he coined the phrase, the *strategic corporal*.[4] When military activities are focused on the population and take place on the streets and in local neighbourhoods, the soldier or marine on patrol can make decisions and act in ways that have international, strategic repercussions—hence, the *strategic corporal*.

In numerous gatherings where social scientists and military operators were present, the two groups tended to talk past each other. There was no common vocabulary and even when the same words were used, the meanings tended to be different. In fact, across the social sciences, there is no common vocabulary. The U.S. Defense Science Board puts the problem plainly and succinctly.

> *Technologies to support an understanding of human dynamics lie at the intersection of a broad set of disciplines: the social sciences (anthropology, sociology, political science, history, and economics), the biological sciences (neurobiology), and the mathematical sciences (computer science, graph theory, statistics, and mathematics). These typically independent disciplines have distinct histories, terminologies, methodologies (observational versus experimental) and evaluation approaches (quantitative versus qualitative), which sometimes lead to inconsistent practices, outcomes, and/or recommendations.* [5]

A vocabulary used by one community will be imbued with the perspectives and methods of that community. This will be true in the vocabularies explored in the rest of this section. Three vocabularies coming out of the analytic community and one recently emerged from the military educational system will be examined briefly in terms of how they support the applications they serve. These are by no means the only vocabularies being used in the HSCB community, a community that declares itself not yet ready to establish a definitive vocabulary or taxonomy of its own.

4.1 Vocabularies from the Analytic Perspective

In two of the three vocabularies, the intended application drove the development of the vocabulary. In the first case, the application was a form of mathematical analysis and in the second, the vocabulary in which the problem was decomposed was aimed at establishing a set of metrics designed to measure progress toward stability. The third vocabulary was developed to provide a more general application space for a broadly based set of analytical applications. In all cases, the vocabularies take into account both situational and perceptual data.

4.1.1 Catastrophe Theory and Manifold-Based Policy Impact Assessments

The analytical posture that produced the first vocabulary is based on the premise that the use of manifold analysis in catastrophe theory, with data based on societal factors, could lend insight into the effect of policy decisions in Iran and Afghanistan. The starting point for the analysis was the 79 recommendations of the Iraq

Study Group, a set of recommendations in need of an analytic method to assess their relative impact and importance. A framework that allowed each of the 79 recommendations to be assessed in terms of its impact on key properties of the overall political and societal environment was needed. The author of the method, Alexander Woodcock[6], developed a framework of four key variables or properties of the political environment and assessed the impact of each recommendation on each of these four key variables. The four key variables formed the analytical vocabulary of this approach and are defined as follows:

- In-Power Segment (IPS) or Government Strength. One of the key objectives of the military and diplomatic activities in Iraq was to increase the strength of the duly elected government and its regard among the population and the regional entities with which it must do business. The factors that involve government strength were measured in increases or decreases of this variable.
- Out-of-Power Segment (OPS) or Opposition Strength. Another objective of the military and diplomatic activities in Iraq was to reduce the influence of the various groups that opposed the duly elected government. Recommendations directed toward these goals were measured under this key variable.
- Balance of Coercive Force (BCF). Control of violence and the provision of security is a key component of establishing long-term stability for the duly elected government in Iraq. The factors that tipped the balance of security in favour of the government were weighed as positive contributors to this key variable.
- External Influences (EXT). The variable measures the extent to which external influences control sectors of the Iraqi economy and hence welfare. A viable exit strategy has to include a reduction of external influences on the Iraqi economy.

The author and prior collaborators had found catastrophe theory to be a proven framework for analysis where a small number of key variables could be defined. Thus the method-driven vocabulary consisted of the four terms above and the manner in which recommendations fit into the framework. The vocabulary is sparse, the analysis at a very strategic level and considerable work is required to fold each of the 79 recommendations into the analytic space defined by the four variables.

4.1.2 A Vocabulary for Measuring Progress

While the first example of an analytic vocabulary was based on a computational method, this second vocabulary is associated with metrics, but no particular form of computational analysis. Measuring Progress in Conflict Environments (MPICE) is an effort by the U.S. Department of Defense (DoD), U.S. Department of State (Science Advisor) and USAID to determine how effective development activities undertaken in conflict environments were in achieving goals of peace and stability. According to the authors, the purpose for developing MPICE was:

> *To establish a system of metrics that will assist in formulating policy and implementing strategic plans to transform conflict and bring stability to war-torn societies. These metrics provide both a baseline assessment tool for policymakers to diagnose potential obstacles to stabilization prior to an intervention and an instrument for practitioners to track progress from the point of intervention through stabilization and ultimately to a self-sustaining peace. This metrics system is designed to identify potential sources of continuing violent conflict and instability and to gauge the capacity of indigenous institutions to overcome them. The intention is to enable policymakers to establish realistic goals, bring adequate resources and authorities to bear, focus their efforts strategically, and enhance prospects for attaining an enduring peace. [7]*

The MPICE framework measures progress in terms of a state's moving through three stages of stability. In the first stage, Stage 0, the country is judged to have enforced stability – a situation in which "active and robust action" on the part of external forces, potentially in partnership with a large international presence, is the only means of imposing order. The second stage, Stage 1, is termed assisted stability and in this stage, violence has been reduced to the extent that a local force can maintain order, but still with the presence of outside military forces and civil assistance. External intervention in Stage 1 is at a sufficiently low level that it can be sustained over an extended period of time. The final stage, Stage 2, is termed self-sustained peace and represents a situation in which the state can cope effectively with residual violence, without the assistance, military or civil, of external powers.

Five factors are used to assess the situation of a state in crisis: political moderation and stable democracy, security, rule of law, economic stability and social well-being. With respect to each of these factors, the objective is to move from a lower to a higher stage in stability; therefore, each factor has two objectives; one intended to move the state from Stage 0 to Stage 1 and the second to move the stage from Stage 1 to Stage 2. Progress is measured against two primary indicators: diminishing the drivers of conflict and strengthening institutional performance. Tables 1 and 2 display the framework for two of the five major factors.[7]

Table 1: Goals for Political Moderation and Stable Democracy.

Diminish the drivers of conflict	Competition for exclusive power diminished
	Political grievances diminished
	External destabilization diminished
Strengthen institutional performance	Peace settlement strengthened
	Delivery of essential government services strengthened
	Government legitimacy, responsiveness, and accountability strengthened
	Political parties strengthened
	Minority participation strengthened
	Citizen participation and civil society strengthened
	Free and responsible media strengthened

Table 2: Goals for Safe and Secure Environment.

Diminish drivers of conflict	Political violence diminished
	Threat from ex-combatants diminished
	Popular support for violent factions diminished
	Use of national security forces for political repression diminished
	Criminalization of national security forces diminished
	External destabilization diminished
Strengthen institutional performance	Compliance with security agreements strengthened
	Performance of national security forces strengthened
	Subordination and accountability to legitimate government authority strengthened
	Public confidence in national security forces strengthened
	Consent for role of international security forces strengthened

Each of the subordinate factors is further decomposed into a set of measurables to complete the framework. This framework and the metrics that support it are all designed for performance at the state level. When all the subordinate factors are completely specified, there are in excess of eight hundred metrics against which to asses state performance. An MPICE evaluation might look something like Figure 2.

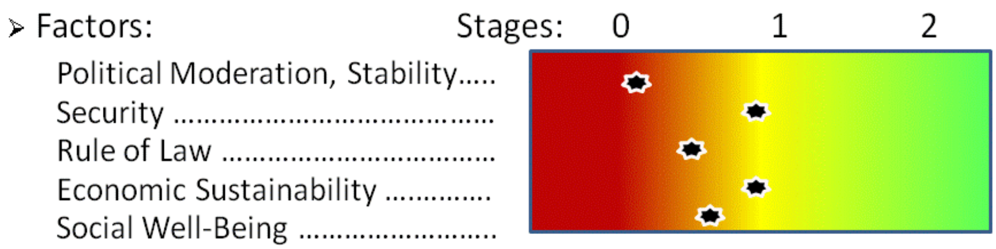

Figure 2: Notional MPICE Evaluation.

MPICE developed the framework with its attendant vocabulary and the metrics, but did not develop a computational system for aggregating individual metrics into the overall evaluation for each factor. MPICE rather explains its methodology in terms of the data sources used to evaluate the metrics. Content analysis uses contemporary media to provide data on incidents relevant to the metrics, as well as the opinions of the populace. Expert opinion is gathered from a select group of subject matter experts. Statistical analysis is used on the situational data; however, in unstable environments, collection of such data is difficult and hampered by a lack of functional infrastructure. The final source used is survey or polling data to acquire the responses of the population. This combination of situational and perceptual data is consistent with the foregoing overview of data needed to support socio-cultural analyses.

While MPICE was clearly developed to be used at the state level, it has been used at the neighbourhood level in Haiti as a test case, with the results that MPICE is a viable means of measuring progress at a local level with some adaptation. MPICE has been presented to NATO as a potential international best practice for assessing the effectiveness of military and civil aid policies applied to civil distress in areas where conflict is present.

4.1.3 Vocabulary to Support Analysis

Conflict Modeling, Planning and Outcomes Exploration (COMPOEX) was developed by the Defense Advanced Research Projects Agency (DARPA) in response to the need to plan complex military operations in environments that must be represented by large-scale systems of systems that include non-physical systems (e.g. political and military systems). All of these systems are considered to be adaptive and to exhibit emergent or unexpected behavior. The COMPOEX framework was designed to provide an adaptive and robust approach to planning based on a comprehensive study of both the structure and dynamics of the systems in the environment. [8]

The vocabulary built for COMPOEX begins with the military's deconstruction of influences in terms of political, military, economic, social, information and infrastructure (PMESII). These factors are characterized as either attributes in the virtual or simulated world, or as political or social actors. The resultant decomposition is as follows:

Table 3: Actor-Oriented Data Sets – Partially Perceptual.

Political	Regional Influences
	National Government
	Government Institutions
	Local Government
	Military Organization
	Criminal Network
	Non-governmental Organizations (NGOs)
Social	Population Segment Attitude

Table 4: Factors Describing the Virtual World – Situational.

Economic	National Macro-economy
	Meso-Economy
Infrastructure	Electrical Power
	Telecommunications
	Water Service
	Sanitation Service
	Healthcare Services
	Education Services
	Manufacturing
	Agriculture
	Construction
	Food Production and Distribution
	Transportation Networks
Information	Media Sources
	Media Channels
Military	Security by Rule of Law
	Military Deployment
	Military Engagement
	Insurgent Targeting

Like MPICE, this framework further decomposes, but in the case of COMPOEX, the decomposition is in the context of computational models capable of representing either the actors or the virtual world. For the actors, they relate along four lines of interaction: political, social, economic and armed military. The models represent a broad range of capabilities and the terms found in the next level of decomposition involve the data required and the data supplied by each model. Because the models can be used at different granularities, these data may be replicated at different scales to accommodate modeling at a local, provincial or national level. According to Waltz, a typical COMPOEX system of systems model once assembled could have over 10,000 values associated with as many as 156 snapshots in a model run comprising two to three years of evolution.

While the analytic purposes that drive MPICE and COMPOEX are different and produce differences in the vocabulary used to represent their frameworks, both systems divide their data into situational (statistical in MPICE and virtual world in COMPOEX) and perceptual. This underscores the statements made earlier that in representing socio-cultural factors, both types of data are critically important.

4.3 The Operational Perspective

The vocabularies and frameworks examined thus far emerged from analysts who design capabilities to support decision makers, but who themselves are not the decision makers. They result from the analytical mind exploring situations in which military forces are involved and not from the military whose task is to accomplish the operations. This next and last framework emerged from a concerted effort to understand the needs of the U. S. Marines by working with them directly and marrying robust social science theory to their operational needs.

Operational Culture for the Warfighter [9] is written from the perspective of anthropologists working with Marines who bring to the table use cases from around the world that span a broad spectrum of operations, including combat operations, counterinsurgency, stability and reconstruction, humanitarian assistance and disaster relief, and training and operating with foreign forces. The authors use three different descriptive models from anthropology in combination to create a framework designed to help the Marine understand, work with, and potentially influence peoples from different cultures. The three models are ecological, social structure, and symbolic, and are defined by the authors in the following way:

- *Ecological Model: focuses on the relationship between cultures and the physical environment*
- *Social Structure Model: examines the way the social structure of a group affects the roles, status and power of various members*
- *Symbolic Model: studies the beliefs, symbols and rituals of a cultural group [9]*

Each of the three models looks at a socio-cultural group from a different perspective. The ecological model is strongly economic, dealing with how the group works with elements of the environment and the ownership and production of commodities of value, even hi-tech commodities. It looks at conflict as a logical outcome of competition for scarce resources. The manner in which a culture deals with commodities of value has a direct impact on how the people will respond to reconstruction, development and relief operations handled by the military.

The social structure model's perspective is one of power and influence – how a society organizes its structures and relationships. From the perspective of this model, war and violence are a result of power struggles in which losing groups continually challenge the existing system to acquire better access to goods or to shift their positions in the power structure. The social structure model provides valuable insight into insurgencies and civil strife.

The developers of the symbolic model are oriented more toward ideology and take the position that culture is the product of thought and the construction of belief systems and values. Physical environments and social structures do not illuminate how a society functions; rather, these relationships emerge from the ideals and beliefs that guide the choices of the individual and group. The symbolic model helps explain the psycho-emotional reasons behind actions and conflicts in the society. Therefore, the symbolic model is particularly important in understanding conflicts involving ideological and religious motivations.

The models are important for providing a robust scientific foundation for understanding violence, its causes and potential means for resolution; however, they are too abstract to apply directly to the development of military plans and actions. The authors take these three models and expand them into five specific cultural dimensions that can be observed in areas where the marines operate and incorporated into assessments of the local situation for purposes of planning. The following table that lays out the expansion of the models into dimensions is taken directly from Salmoni's work but combines several different tables and texts.

Table 5: Framework for Operational Culture for the Warfighter [9].

Dimension	Explanation	Specific Components
Ecological Model		
Dimension 1: **The Physical Environment**	The way a cultural group determines the use of physical resources. Who has access, and how the culture views these resources in terms of access and ownership.	Water, land, food, materials for shelter, climate and seasons (the way they stress and frame the use of the environment), fuel and power
Dimension 2: **The Economic**	The way people in a culture obtain, produce and distribute physical and symbolic goods (food , clothing, cars or cowrie shells)	Formal and informal systems Systems of exchange networks Relationship systems
Social Structure Model		
Dimension 3: **The Social Structure**	How people organize their political, economic and social relationships, and the way this organization influences the distribution of positions, roles, status and power within cultural groups.	How the culture handles: Age, gender, class, kinship, ethnicity, religious membership
Dimension 4: **The Political Structure**	The political structure of a cultural group and the unique forms of leadership within such structures (bands, councils, hereditary chiefdoms, electoral systems, etc.). The distinction between formal, ideal political structures and actual power structures.	Political organization, cultural forms of leadership, challenges to political structures
Symbolic Model		
Dimension 5: **Beliefs and Symbols**	The cultural beliefs that influence a person's world view; and the rituals, symbols and practices associated with a particular belief system. These include also the role of local belief systems and religions in controlling and affecting behavior.	History, memory, folklore Icons, rituals Symbols and communication Norms, Mores, taboos Religious beliefs

In the above framework, the symbolic model points directly to perceptual information; however, in each of the other dimensions, the way the structures are developed forms and is formed by the world view of the people. Therefore, in working all of these dimensions, there are situations to be observed and reactions to the situations framed by the world view of the population. Corruption and nepotism can be observed and measured (Transparency International produces indices on corruption annually [10]), but working effectively with a population requires knowledge of how that society views what we call corruption.

This last vocabulary is far more oriented to understanding the culture, a fact that is understandable both from the perspective of the authors who are anthropologists and from the perspective of the Marines who have to navigate the unknown and often dangerous waters of peace-keeping in a foreign culture.

4.4 Closing Remarks on Vocabularies and Frameworks for Understanding

Why spend so much effort looking at different vocabularies and frameworks? Vocabularies are essential for framing problems and for developing the data structures for architectures. The fact that there are currently many distinct vocabularies that do not readily map into one another is an indication of the immaturity of the field of computational social science. The problem stated by the Defense Science Board [7] is real. We have cultural divisions across the disciplines that encompass the perspectives from which we study human dynamics, and those divisions must be bridged before we can create a holistic approach, a single vocabulary or framework for incorporating social sciences into military processes.

We build frameworks based on our perspectives on the problem. Woodcock built his on a strategic view designed to create a means of evaluating high level decisions in Iraq. There are indications that the framework could be transported to another area of interest, but the perspective will remain strategic, and formed by one who looks at the world through mathematical constructs. The MPICE framework was created to develop metrics by which decision makers could assess progress in stability in reconstruction operations. The focus is clearly on quelling dissidents and building the institutional capability of the national government. COMPOEX developed a framework for planning military actions in complex environments and used the military construct PMESII as the starting point for the framework. Operational culture married a robust anthropological perspective with a large number of case studies of military operations to create a framework directly related to what the military operator needs to know to conduct his missions. The perspective in each case drove the development of the vocabulary and framework. The common element in all of the approaches is the recognition that both situational and perceptual information are required to understand the environment. The discussion of architectures will build on this fact.

5.0 ROLE OF ARCHITECTURES

What is an architecture? According to the US DoD, an architecture is the structure of components in a program or system, their interrelationships, and the principles and guidelines governing their design and evolution over time. (DoD 5000.59-P (reference (g))). [11] If modern military operations span a broad spectrum of activities and involve complex situations, and if we tend to think about those complex situations along different disciplines (economics, politics, military capabilities, etc.), then it would seem natural that we build and use models using the methods appropriate to those disciplines. We break problems down into smaller bits that we can solve, but in the end, the understanding must happen at the broader system-of - systems context in which all the individual pieces play their roles alongside, and often interacting with, the other pieces. Architectures enable the reassembly of separately constructed parts, but architectures depend upon data structures and metadata which themselves emerge from the vocabularies used to deconstruct the problems at the outset.

Fundamental to any architecture is enabling the interaction of individual components or models through exchange of data – common meaning and format – otherwise termed lexical and syntactic interoperability.

This is a minimal standard and does not guarantee a meaningful, integrated output. One of the earlier, widely used architectures for distributed simulations, the Distributed Interactive Simulation (DIS) protocol, IEEE 1278, did not specifically include any technical means for establishing consistent meaning; however, those using this protocol to create simulations engaged in a careful review of "enumerations," the specific list of variables to be transferred using the DIS protocol data unit (PDU). Similarly, when using the HLA, the meaningful exchange of data is established using the Federation Object Model (FOM), which, like the enumerations, is created in the process of standing up a particular simulation event. In both cases, the architecture specifications enable lexical and syntactic consistency, but human processes are needed to create meaningful interoperability or semantic consistency.

The reason for bringing meaning and semantic consistency to the fore in this discussion is the need for common vocabularies to create semantic understanding across the disparate disciplines involved in socio-cultural modelling and simulation. If model builders from different disciplines talk past each other when examining the problem and use different methodologies to create their models, there is a significant possibility that combining them through the exchange of formatted data will not create a meaningful system or synthetic world. Semantic consistency implies that across the entire group of models being brought together for the simulation, there are no conflicting assumptions buried in the models. The process of ferreting out inconsistencies in assumptions involves building a common vocabulary for discourse and, finally, for creating the data structures for the architectures.

Both architectures to be discussed provide for lexical and syntactic consistency, but rely on human processes to establish semantic consistency. COMPOEX is designed for execution of models that run much faster than real time and does not provide for distribution across multiple, separate computers. The HLA is designed to enable the individual models to run on independent platforms, allowing latency to be the limiting factor in geographic distribution. HSCB data and models using and responsive to HSCB data can be integrated into both architectures. These are not the only architectures being used for military simulation; however, they have been used more widely than some other systems and they serve distinct communities of interest.

5.1 COMPOEX: An Analytic Perspective

COMPOEX was developed to permit the analyst to explore many potential futures and to gain an understanding of the how different circumstances impact the outcomes of specific actions. The use of the architecture by DARPA was to enable rapid course of action analyses for military planning. As indicated in Section 4.1.3 of this paper, the vocabulary that provides the framework for COMPOEX is based on the PMESII concept of the environment, a choice that reflects the orientation of the military analyst. Tables 3 and 4 show how the human actors and virtual world are laid out in terms of the PMESII actions.

COMPOEX was also designed to enable multiple levels of resolution, something that is not shown specifically in Tables 3 and 4. In irregular warfare, the goals are set at the strategic level, but events at the local level impact national-level thinking. The nation is a system of systems where local activities combine in some way to produce the national environment – politically, economically, socially and militarily. COMPOEX acknowledges this by enabling analyses at three levels: local, district or provincial, and national. Where there are models that produce local information that can be aggregated to produce results at the provincial or national level, the local models 'report to' the aggregation algorithm and the results of the aggregation are passed up to the higher level. Interaction among the models is enabled at the data level where models report their results and stand ready to execute when data used for input changes. COMPOEX synchronizes at distinct time steps, at which point the models report and seek new data. Models also have time synchronization that is specific to their algorithms. If, for example, an economic model is designed to use data accrued over a three-month period, it waits until that time is marked by the COMPOEX time synchronization to seek data and execute. If the time step for COMPOEX execution is one week, then a model that executes every three months would wait on the order of 12 time steps before execution and would report back either in the next cycle or at a time delay representative of the real-world process.

Figure 3 provides an architectural view of the information presented in Tables 3 and 4. It also adds the concept of multi-resolution execution. The figure is adapted from one shown by Hartley [12] in his validation analysis of COMPOEX. The colors in the background separate different PMESII domains; however, the illustration groups the Political, Social and Economic domains together at the left, leaving the remaining three separate and in order as Infrastructure, Information and Military. Notice particularly the interaction of the three local economic models as they produce results that go both to the interaction plane as well as to the aggregation algorithm. The aggregation algorithm reports through the interaction plane up to the provincial area power struggles. When aggregate models use local data, they can access that through the interaction plane as do PS1 and E1 in the illustration. In Figure 3, the political and social actions are on the left and the virtual world computations begin with economics and continue to the right.

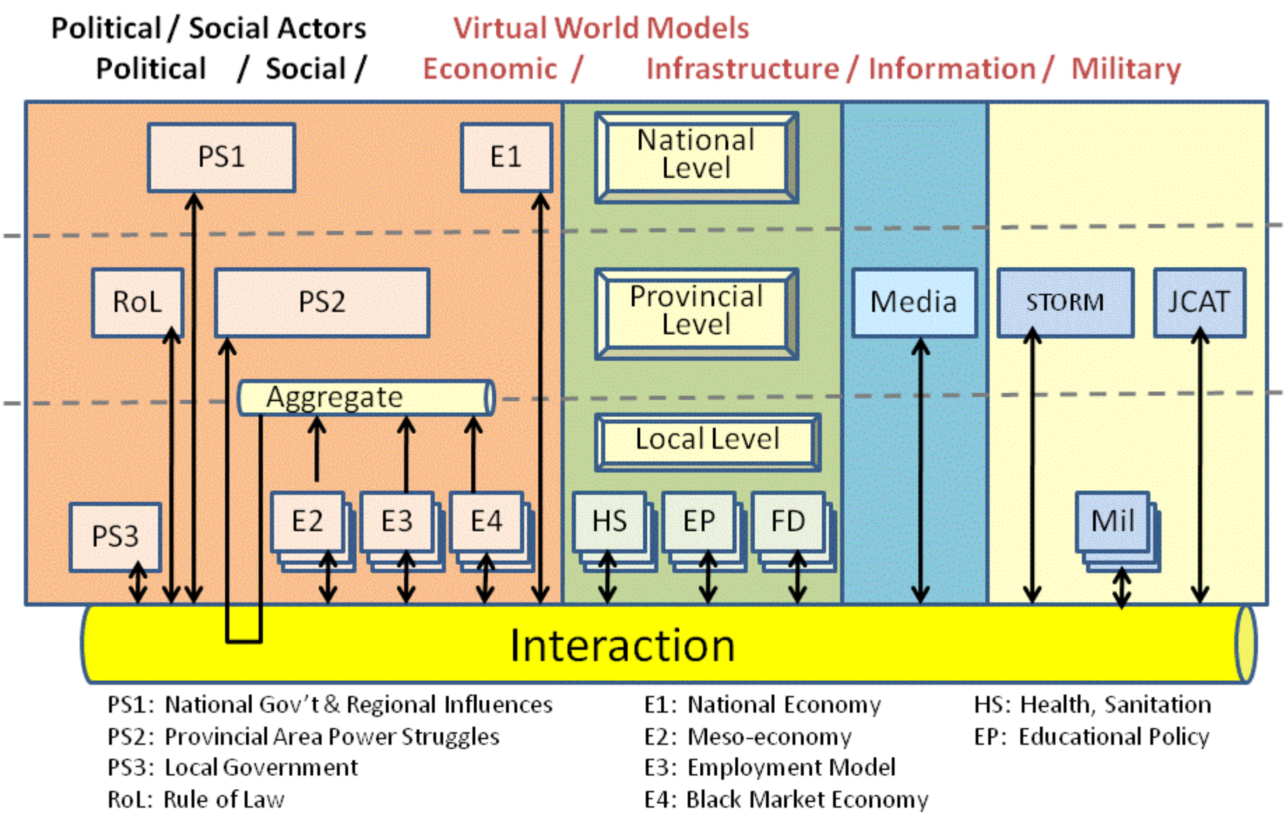

Figure 3: COMPOEX Model Framework.

In Figure 4, the concept of the COMPOEX architecture is turned on its side as if Figure 3 were rotated 90° clockwise, thereby placing the factors that compose the virtual world on the bottom and the interaction of the socio-political world on the top. Figure 4 emphasizes the different types of models that were used in the DARPA program and is adapted from Figure 2-6 in the paper by Waltz [8]. The network of nodes and lines in the upper portion of the figure represents interaction among the social and political actors engaged in a struggle for power and influence. The computational framework for these interactions is an agent-based model developed by Taylor, et. al. [13]. The models that provide the virtual world computations come from various disciplines and methodologies, and include systems dynamics, Bayesian nets, Petri Nets, Markov models and discrete time models. The agents interacting at the socio-political level react to the situational factors in the virtual world as they are presented through the conversion layer into the type of data that can be assimilated by the decision structure programmed into the agents.

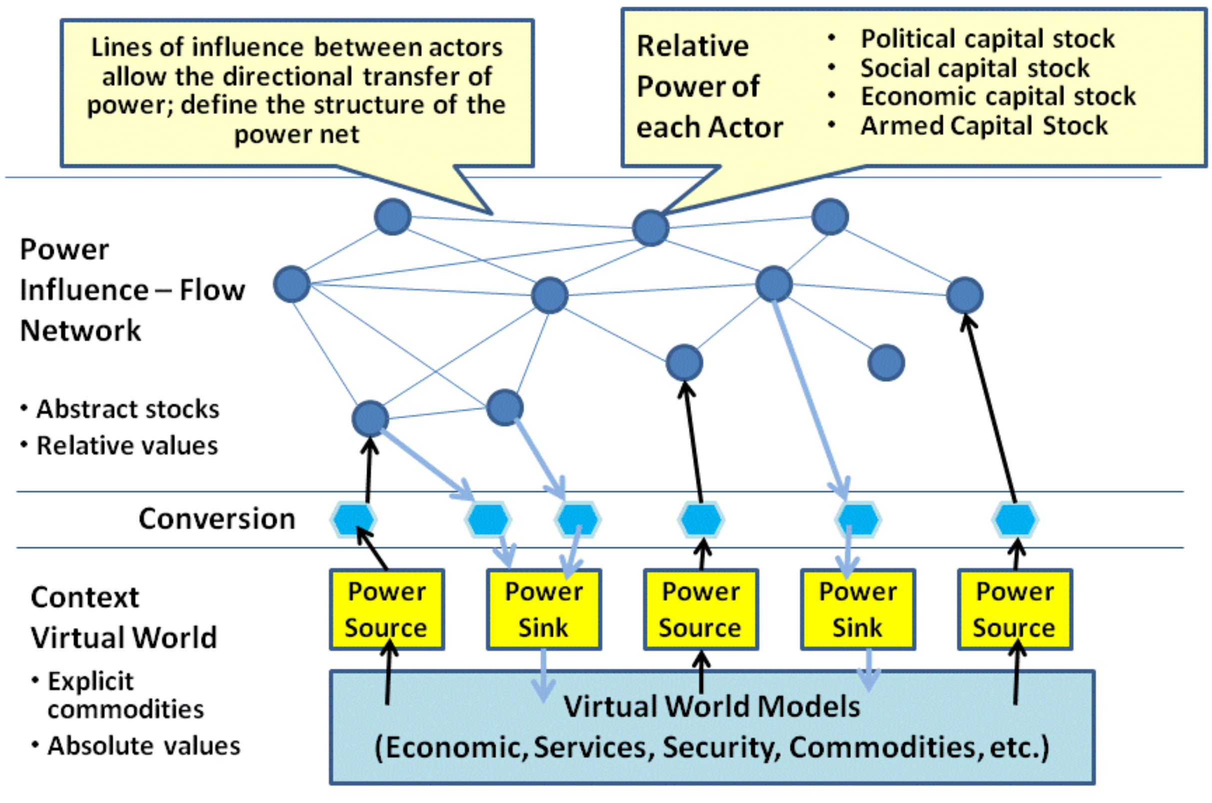

Figure 4: COMPOEX Multi-Resolution Execution Environment.

The terminology of stocks, sources and sinks is reflective of the systems dynamics approach used in bringing together diverse elements that comprise an interconnected system. The entire framework is grounded upon the theory of political power struggle. This theory is one of the three different anthropological models, the social structure model, used in developing the vocabulary for operational culture (Section 4.3). Agent-based models implement decision structures as part of the artificial intelligence that allows the agents to interact meaningfully with each other and with the environment. Implementing one model to motivate an agent's decisions is difficult, but has been done [13]. Using several models simultaneously would require a very complicated decision structure, one in which an agent could at one point be making decisions as a political entity seeking power, and at another point the same agent's decision process could be dominated by a cultural or ideological tenet. In addition, the cultural orientation of specific populations would require that the rules in the decision structure be adapted to each new culture present in the environment. While this use of the COMPOEX architecture relies on the social structure model, the architecture itself is not limited by that model and could implement a different theoretical model by employing different heuristics governing the decision-making in the agent-based modes and by using an appropriate set of models in the associated virtual world.

COMPOEX was designed to create an environment in which models could be assembled to address a particular problem. Ideally, the architecture would be populated by a large number of models of different sorts and the analyst could compose his simulation based on the models that best fit his current application. While this, of course, is possible, it is not quite as simple as it sounds, because every new combination of models creates a new system that has to be tested for validity and sensitivity to the particular variables under scrutiny. It should be noted that this is true of all simulation environments, not just COMPOEX.

5.2 Adding HSCB Capability to an HLA Federation

NATO has adopted the HLA for distributed simulation. In HLA-enabled simulations, there is a common synthetic world or battlespace in which entities of different types interact with one another and with the elements of the synthetic battlespace. The complications introduced by adding the human dynamic is one of what entities to add and at what levels should the interaction take place. While the HLA is most often used in real-time simulation exercises to permit humans to interact with the synthetic environment in a natural fashion, HLA can also operate with different time management schemas that would allow faster than real-time execution. For this examination of the HLA, real-time execution will be assumed.

Traditionally, the battlespace is populated with Blue and Red forces – friendly and adversary entities. Irregular warfare requires that there be a focus on all the groups functioning in an operational area; thus the first data that would come into play would be demographics and an understanding of the decision-making by the relevant factions and the individuals belonging to them. This statement assumes that individuals and the groups to which they belong are not identical in terms of their behaviours. The next consideration is the decision structure, the artificial intelligence that creates the interaction between the human actor, his environment and the other actors in the environment. HLA has often been used with semi-automated forces in which the entities can work without human intervention or can be taken over by a human as an operator directly controlling elements of the entity's behaviour. Initial decisions in building HSCB federations would have to address how much intelligence would be built into which entities, and whether to permit human operators to take over certain entities.

The agents would have to be sensitive to the socio-cultural environment. Again, this is not exactly new for semi-automated forces. They are built to read terrain data and many respond to environmental data of various sorts, including dynamic changes in that data. The data exchange mechanisms of publish and subscribe allow this type of dynamism. The idea of separating the problem into environmental data and intelligent agents that react to that data is reminiscent of work done nearly a decade ago to develop environmental servers [14]. The models that produced the situational data in the weather environment were hidden behind a server. Weather data could be supplied either by compute-intensive weather models running on massive computers elsewhere or live feeds from operational system, providing data streams either prior to or during execution. The server would simply make the data from any source available to the simulated entities, which would then consume the data and behave accordingly. While the decision structure for human entities or agents executing in the environment would necessarily be more complex than that of a ship, tank or aircraft, the concept of the server would remain the same.

The advantage of the server is that all entities get the same information, but the models providing that information could be replaced as better models are found. The server allows the environment to be dynamic without changing the way in which the entities access information. The application of servers to human behaviour is not new and has been used by Silverman to allow human players in games to experience such factors as fatigue and stress, his behaviour modification functions. [15] However, these behaviour modifiers are distinctly different from situational factors in a socio-cultural environment. The notion of this type of application in an HLA federation is explored in greater detail by Numrich. [16] Figure 5, taken from Ref. [16] shows a notional concept of the HLA architecture separating the situational and perceptual data into server and agents.

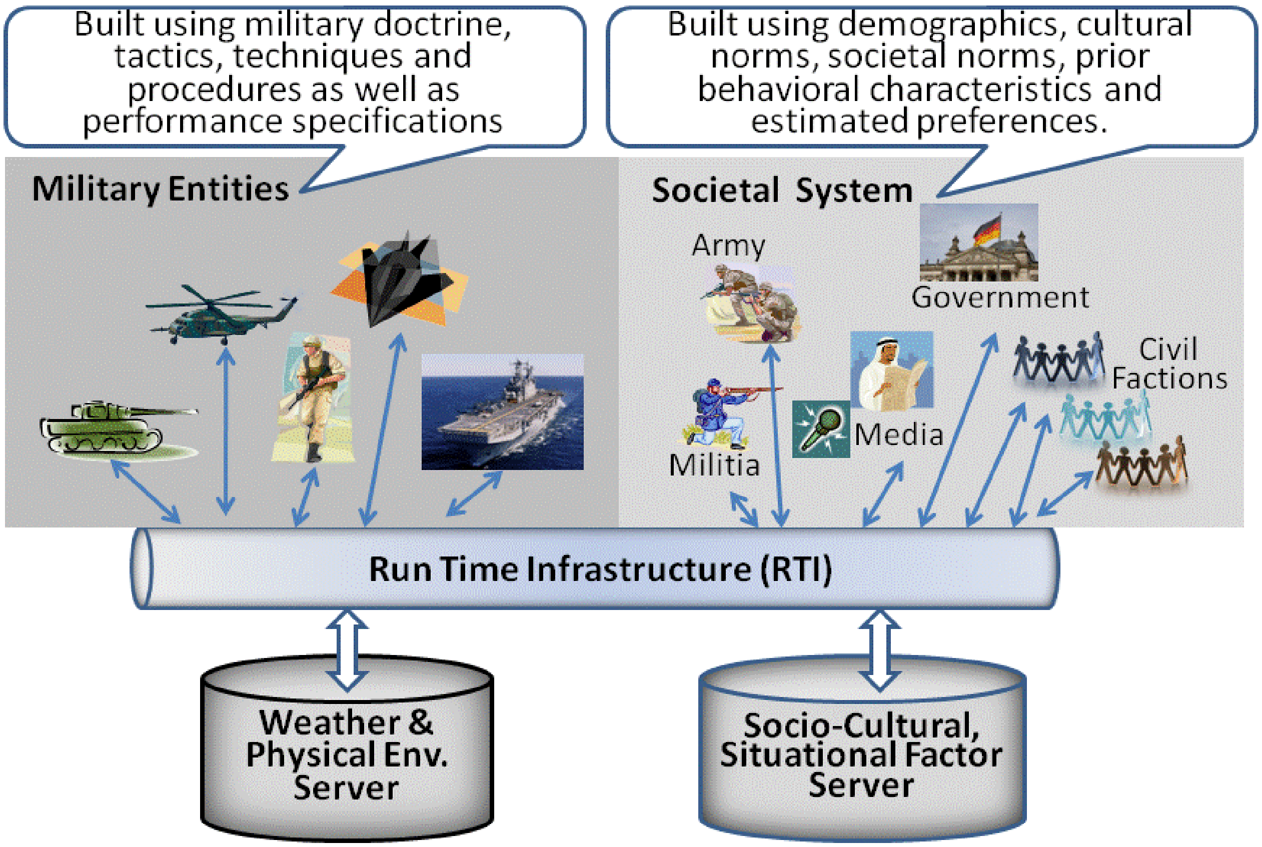

Figure 5: Socio-Cultural Server and Societal Agents in an HLA Federation.

The HLA architecture should support the development of an agent-server system using the concept of situational and perceptual data. However, designers would have to exercise restraint in choosing what to simulate in this fashion, at what level of aggregation the simulation should be composed, and which theories of behaviour should animate the agents. To create a federation that exhibits the consistency essential for validity, these considerations need to be addressed and documented at the outset.

5.3 Deciding About Architectures

Both architectures discussed above are capable of handling HSCB data and applications. They differ in their approaches because they come at the problem from different perspectives. These are not the only architectures currently being used to handle socio-cultural information. At least two other architectures are in use and under continued development, specifically to include HSCB data and models.

The Dynamic Information Architecture System (DIAS), originally designed to represent geospatially oriented natural systems, was linked with another object-based framework, Framework for Addressing Cooperative Extended Transactions (FACET), to implement societal behaviours of individuals and groups interacting within the complex natural environment provided by DIAS.[17] Both of these models were developed at Argonne National Laboratory and have been used for more than a decade to enable human entities to interact in a rich, dynamic natural environment.

A newer architectural concept is under development using the Web 2.0 services to wrap data sources, data processing, analytical modelling, and report generation into a flexible workspace. This system, SORASCS (Service Oriented Architecture for Socio-Cultural Systems), is based on the notion that a large number of data sources and tools could be used together if there were relatively simple process for assembling them for use. This service-oriented architectural approach will accommodate both thin and thick client applications and will provide some common services and tools that can be added easily and seamlessly. [18]

There are multiple architectures for many reasons, but at least in part because they serve different types of users and applications. They all support syntactic and lexical consistency, but before there can be a semantic consistency within an architecture, there has be some level of agreement on vocabularies, the meaning of the terms used to describe the models and data that are integrated into the architectures. In an assembly of social scientists, there would be few if any who are willing to admit that the social science disciplines are ready to agree on a single vocabulary. Given this lack of agreement at the level of vocabulary, why then the press for an architecture?

The issue has been pushed by members of the military who are facing complex situations on a daily basis and who need tools to help them interpret the observable events in their environments and turn that understanding into effective action. The Air Force Office of Scientific Research and the Human Effectiveness Laboratory at the Air Force Research Laboratory chartered a study by the U.S. National Academy of Sciences on "Behavioral Modeling and Simulation: From Individuals to Societies" published in 2008. [19] After an extensive review of the state of the art, the study board recommended an integrated, cross-disciplinary research program to include focused study on how to federate models and modelling components across levels of aggregation and detail. The report highlighted the need for semantic interoperability and the need for architectural test beds for experimenting with different concepts of federation.

There are several architectures, both familiar and usable, that can be used for socio-cultural simulation by the different user communities in the military; however, none of these architectures offers semantic consistency and all require considerable skill and knowledge on the part of the user or the group building the federated system. The best use of architectures today is to serve as a sandbox for experimentation – a means for working with and learning from the models we currently have and for developing design criteria for the next generation of models and architectures. We lack laboratories in which we can try experiments and test models and theories when we begin combining cross-disciplinary capabilities. Architectures can provide those synthetic laboratory environments for learning.

6.0 CONCLUSIONS

Socio-cultural modelling and simulation requires that we bring together capabilities from a broad range of scientific disciplines, but we lack the connective tissue to make them work seamlessly together. The disciplines from which the capabilities arise have different vocabularies; they interpret events differently; their concepts of measurement, data, and models differ; and all of these differ from what the military user expresses as his needs. To frame the problems well, we must begin to engage in the type of cross-talk from which a common vocabulary arises. Salmoni engaged in such a dialog in the development of operational culture. Language is the first problem and it has a direct impact on the data structures for architectures.

The national Academy study also indicated that there is a problem of realistic expectations on both the social science and military side of the discussions. The military, long accustomed to kinetic models that result from deterministic equations, expect generalizable, predictive models, but are confronted by social scientists who present descriptive models and explanations. Social sciences contribute valuable understanding to the context of irregular warfare, but it is neither predictive nor generalizable. Applicability is limited by:

- The nature of the mission (M),
- The area of operation (geographic regions and their societal components) (A),
- The levels of command (strategic, operational, and tactical) (L), and by
- The knowledge and skill level of the end user or operator (O).

These very real considerations, MALO, not only limit generalizability of models and simulation, but provide what may also be a useful framework for deconstructing problems. Picucci discusses these concepts at length. [20] Socio-cultural information is needed for many military missions and the mission can narrow the scope of the vocabulary, data and models required to help the military user gain essential insight whether at home training for deployment on a particular mission or in the midst of a mission and planning for the next set of actions. A counterinsurgency mission does not require the same information and understanding as does a disaster relief mission. Responding to a tidal wave in Indonesia, a hurricane in Haiti or an infrastructure failure in a developed nation all require different approaches based upon the geography, the demographics, the motivations and capabilities of the population and a determination of current needs in each case. The approach that worked yesterday in Iraq may not work today in Afghanistan. In fact, the actions that produced beneficial results last week in Kandahar may not work there this week because conditions have changed and the reactions of the population and the insurgency toward NATO forces have changed. The area of operation makes a difference, geographically and culturally, and the environment is dynamic, adaptive, and reactive to a multiplicity of factors exogenous to military activities.

The National Academy study and the use of multi-resolution modelling as a driving concept behind COMPOEX, represent the recognition on the part of the scientific community that resolution and granularity are essential issues for data and for models. The technical community looking at human behaviour looks at individual, group and society. The military divides the problem along strategic, operational and tactical levels of operation. Both concepts, while distinctly different, point to the need for multi-resolution modelling. Research has not as yet yielded a general method to aggregate from individual to group, because an individual does not always exhibit the same behaviours when in the presence of others. The extent to which local information can and should influence strategic and operational decisions is a hotly debated issue in many military circles under the guise of distributed versus central command and control. Both communities, military and research, understand the importance of aggregation, and both the scientific and military levels of aggregation will have to be represented in models that include socio-cultural factors.

The research communities in their rush to get capability to the military have not fully understood the limitations of resources available at different types of military installations. Research grade tools that require continual contact with the developer are not practical for deployed forces at any level. The military will always experience limitations in the availability of communication channels (readily accessible bandwidth) and qualified human resources. Architectures and the capabilities they bring together have to be designed with the end user in mind, and may never be deployable beyond a command headquarters where there is a skill base to use the application. When data acquisition is a problem, that problem cannot be handed over with tools to the operational user who has neither time nor resources to begin a quest for data. The end user in the field, on the other hand, has valuable data, but no simple means of entering it into a system where he or other users can then retrieve it.

Taking these MALO limitations into account can help both the social scientist and the military user to communicate more effectively about the nature of the problem and the potential for providing suitable tools designed to improve understanding about the socio-cultural environment of concern to the military.

Architectures running faster than real-time applications to enable analytic study and real-time architectures that allow the user to interact with the synthetic environment exist and can be used with HSCB data and models; however, the architecture that provides a sandbox for studying socio-cultural modelling as it applies to military needs is likely to be the most valuable architecture for the next decade as the research and military communities gain expertise in handling problems with socio-cultural implications.

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