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"Collective C2 in Multinational Civil-Military Operations"

"Comprehensive Thinking and Defense Analysis Transformation"

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Comprehensive Thinking and Defense Analysis Transformation

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ABSTRACT

Conducting multi-national Civil-Military Operations will require participating nations to think more comprehensively about security and take approaches that harmonize multiple elements of national, international and non-governmental instruments. While militaries will evolve new capabilities to address emergent challenges, they must also become more proficient operating with and alongside non-military actors -- seeking unity of effort when unity of command is problematic. A comprehensive approach to security that blends both hard and soft instruments of power will require loosely coupling disparate systems which may have vastly different missions, cultures and sponsorship.

The actors and systems involved in a multi-national Civil-Military Operation are more characteristic of living, complex and adaptive systems than classic linear systems that seek optimization and efficiency. Complexity theory points to a different approach – not focused on solving challenges – but on coping with and bounding problems and solutions to a limited set of more likely responses. Classic military operations analysis is adept at allocating functions and measuring the results of traditional battles or campaigns. This paper describes how military analysis, modeling and experimentation will need to evolve more descriptive and qualitative methods and tools to better address the complexities of multi-national Civil-Military Operations.

1.0 INTRODUCTION

Even before NATO found itself embroiled in both the Libya operation and the Afghanistan insurgency, there was growing realization that future challenges would be vastly different than the ones it had trained for over decades when the primary threat to NATO was Soviet troops advancing through the Fulda Gap. Insurgencies are different, and NATO operators, while ostensibly in Libya and Afghanistan to provide and promote security, also find themselves in a concerted battle for the hearts and minds of disparate ethnic groups, in addition to winning over their own sceptical and often impatient publics back home. Moreover, military commanders have to figure out how to better coordinate and integrate the varied elements one finds in a relief and reconstruction operation, elements not resident in a traditional military command chain.

This was not how defense transformation was supposed to evolve. The Information Revolution, which ushered in network-centric operations and precision weapons, was supposed to make warfare faster, cleaner, and cheaper. Precision targeting would eliminate collateral damage, and dominating the information sphere would eliminate – or at least drastically reduce – the fog of war. But while "network-centric operations" was being touted by theorists as the future direction of advanced militaries, several opponents reminded us that they also had a vote – and if NATO and the West in general had advantages in traditional warfare areas, smaller, agile and less-encumbered opponents could use off-the-shelf technology to create their own networks, conduct hit-and-run tactics and attack the West's strategic underbelly, time. As we deliberate on future warfare, we must not forget that clashes between peoples will always be more about individual and collective will than technological advancements.

NATO recognized this changed direction awhile ago. In the 2006 Riga Summit, in reference to operations in Kosovo and Afghanistan, it declared

> *"… today's challenges require a comprehensive approach by the international community involving a wide spectrum of civil and military instruments, while fully respecting mandates and autonomy of decisions of all actors, and provides precedents for this approach … to improve coherent application of NATO's own crisis management instruments as well as practical cooperation at all levels with partners, the UN and other relevant international organizations, Non-Governmental Organizations and local actors in the planning and conduct of ongoing and future operations wherever appropriate."*[1]

Today, NATO is challenged to redefine itself for the 21st century with a new Strategic Concept that may help instantiate a transformation to a more comprehensive approach for alliance security. From the 19 November 2010 Summit meeting in Lisbon

> *"The lessons learned from NATO operations, in particular in Afghanistan and the Western Balkans, make it clear that a comprehensive political, civilian and military approach is necessary for effective crisis management. The Alliance will engage actively with other international actors before, during and after crises to encourage collaborative analysis, planning and conduct of activities on the ground, in order to maximise coherence and effectiveness of the overall international effort."*[2]

The challenges to taking a "Comprehensive Approach" to security operations are many. Some are technological, as disparate entities develop architectures that may not communicate well together. For example even eight years after the 11 September 2001 terrorist attack on the U.S.; and after countless dollars were spent on new systems, organizations and processes,[3] a known entity with explosives laced to his underwear was allowed to board an aircraft bound for the United States on Christmas day 2009. Part of the problem might have been technological. How could the system have better sifted through massive data streams to connect-the-dots, share situational awareness and make more timely collective decisions? A perhaps larger part of the problem was cultural, and reflective of various complex adaptive systems that saw a benefit to not sharing all the keys to their kingdoms. Moving the U.S. CIA Director to the Pentagon and America's top officer in Afghanistan to the CIA may help, but it will take more to overcome a collective culture than just changing the leadership at the top.

This paper will examine how taking a more holistic approach to security combines elements of "hard power" (i.e., the military) with elements of "soft power" (i.e., diplomacy and international developmental aid) to create what some have called "smart power,"[4] others have called "whole-of-government"[5] and still others and NATO call the "Comprehensive Approach." Bringing disparate, stand-alone functional systems together to face a shared challenge will require an understanding of complexity and how complex systems absorb information and adapt to changes in their environments. This paper will also examine how Living Systems[6] theory and the purposeful evolution of sociological systems can inform disparate systems trying to harmonize their activities, and how human systems make decisions through a stimulus-response cycle.

Lastly, this paper will explore operations analysts' needs to develop better tools and techniques to aid commanders facing comprehensive approach challenges. Classic assessments between kinetic armed forces will need to be augmented with human, social and cultural models incorporating a better understanding of social networking and human relations. The complex challenges we face will require equally complex solutions that fully consider the ultimate complex actor, the human.[7]

2.0 COMPLEXITY AND LIVING SYSTEMS.

Any enterprise that features human decision makers is a complex and adaptive living system, and living systems will not – and should not be expected to – act like mechanical systems. Repeatability and predictability are absent, but that does not mean that challenges to living systems cannot be bounded, that is, reduced to a core of most likely explanations and answers that are to some degree useful for planning and responding. We can explain this process in terms of Complexity Theory and Living Systems Theory. The first helps describe the nature of the challenge and the limits of what we can know or measure; while the second provides us a framework of how living systems deal with complexity, adapting their behavior to better their fitness for success.

2.1 Complexity.

Complex systems are characterized by the on-going interaction of many continually changing interdependent variables. We can never fully know all of the variables nor how they will interact; as a result, we cannot precisely predict the system's behavior. Furthermore, these changing constellations of variables are interconnected in time, space and function, are shaped by what has gone before, and influence what follows. They can affect other systems in their geographic area – or in other areas that may appear far removed. Small actions in one system can produce disproportionately large effects in others, and vice versa. Finally, as this interconnectedness implies, elements of complex systems cannot be separated from the system as a whole without changing the character both of the element itself and of the system.

This complex "mess" can perhaps best be illustrated by the distinction between the English words "complicated" and "complex." To use an example, a jet aircraft is complicated. A pilot may not understand every part of the cause and effect chain between advancing the throttle and the aircraft moving, but they know that advancing the throttle produces a predictable outcome. They also know from experience that output is proportional to input: the more power is added, the more thrust is produced. The predictability and proportionality of input and output derive from the fact that the aircraft has a fixed design integrating a series of known constants and linear cause and effect chains. It is complicated but not complex.

A piloted aircraft pitted against another piloted aircraft introduces "complexity." We cannot know precisely what will happen in such an engagement because we cannot know all of the interdependent variables involved or how they interact. What are the skills, psychological states, and experience levels of the pilots? What are the mission assignments and success metrics? General flight characteristics might be known, but what about the materiel condition of the specific aircraft and its systems? Is one pilot perhaps a new parent and therefore flying more conservatively? Is one flying with abandon after receiving a "Dear John" letter?

And the piloted aircraft are not only complex but adaptive. They are continually absorbing new inputs and adapting their actions during the engagement. In brief, systems that involve people act more like living systems than mechanical systems. We can never know all the permutations of complex systems nor be able to predict outcomes, but that does not mean the situation cannot be bounded.

An aircraft is a simple, tactical example. When looking at the operational or strategic level, many more variables are introduced, and at varying scales – greatly adding to the complexity, and introducing "emergence."[8] In a humanitarian assistance operation, there are many human entities trying to harmonize tasks on a common theme that may or may not have interacted in the past. This kind of operation will be more successful if the organizations involved are agile and dynamically adaptive. The most agile enterprises will act like living systems.

2.2 Living Systems.

Efforts to try to treat or control people like mechanical systems will ultimately fail. This is because human beings, human organizations and the security environment writ large are living, co-evolving complex adaptive systems. And all living systems are the current survivors of a Darwinian selection, products of a continuing, interlocking co-evolutionary process, that has taken two distinct forms: the biological evolution of cells, organs, animals and man; and the sociological evolution of groups, organizations, communities, societies, states, and the international security environment as a whole (Figure 1). The latter – the evolution of human organizations – is *purposeful* in that it is the aggregated fruit of human assessments, opinions and decisions, for better or worse. In essence, these living human systems learn and adapt as they deal with their

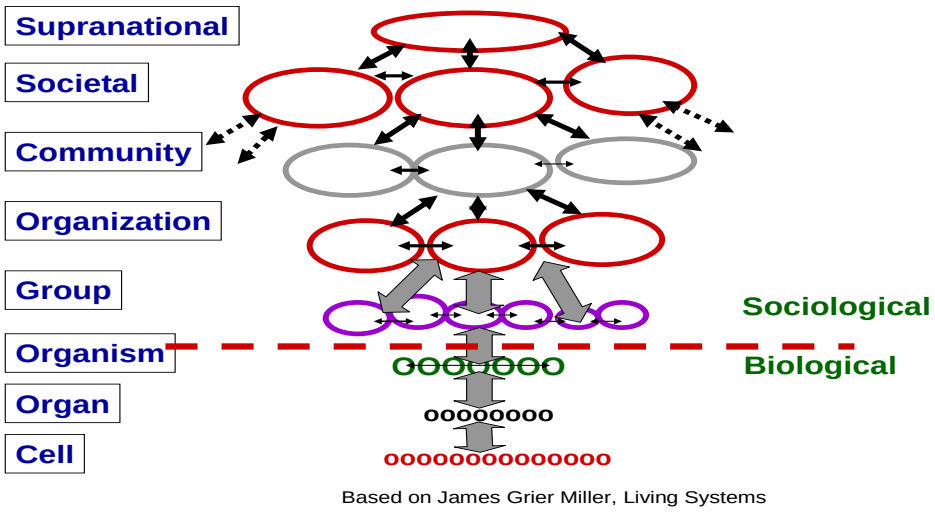

Figure 1

changing human and physical environment. Paradoxically, this implies that the "stability" of any human system actually derives from a dynamic ability to learn, adapt and change. In fact, because the environment is always changing, stasis or the failure to evolve would signal a system's eventual demise. Because evolution implies "survival of the fittest," we should be able to understand why certain systems, organizations and societies succeeded or failed and identify the processes and capabilities that were critical to their survival, e.g., learning and adaptation. James Miller, in his book "*Living Systems*," identified 20 such "essential processes" common to all complex adaptive living systems.[9] These processes are reflected in the nature and actions of all human organizations and provide a starting point for any analysis of the systems or their actions.

2.2.1 Emergence and the need for higher-scale analysis

When we look at vertical integration of living systems, it is important to understand that higher-level systems exhibit emergent qualities that are more and often vastly different from the mere aggregation of what occurs at the lower levels. For example, information technology provides today's leadership with increased visibility into operations at the lower levels. This provokes the question, is the increased connectivity more helpful or harmful to a dynamic situation? Does it aid situational awareness or invite micromanagement? Or, looked at another way, does increased tactical-level visibility seduce senior leaders away from their emergent roles, which is to manage operational and strategic level effects?

The military describes its planning and thought processes in three related, but distinct levels of war: strategic, operational, and tactical. In analogous terms, consider building a home. At the strategic level is the developer or architect, with a vision and access to resources to execute that vision. The general contractor would be at the operational level, responsible for bringing in the right players to execute the strategic blueprint and synchronize efforts. The tactical level consists of the carpenters, plumbers, and electricians who actually build the home.

Today, with social networking propagating first-hand accounts of incidents around the world within minutes, a tactical action can have strategic effect. As a result, some may be inclined to think that the three levels of warfare no longer apply, or that the dividing lines have blurred beyond distinction. However, while tactical actions can, and inevitably will, have effects at multiple levels, operational and strategic functions retain their importance. The roles of the architect and general contractor remain essential.

What important and emergent functions of the higher command are ignored when it focuses overly on the tactical level? The military has made an art and science of the operational level. This is why many governments defer to their militaries when disasters (manmade or natural) occur. That being said, most military tools are built to address tactical-level problems. We design better hammers, saws, wiring and pipes – and even promote our best carpenters to become general contractors (and even architects) – often without the requisite training and resources required to succeed at the higher-level roles. In warfare, the more serious concern however, is the *opportunity cost* of information technology luring the higher command to micromanage the tactical battle.

The proliferation of more precise and timely tactical-level situational awareness tools, all excellent in their own right, could cause operational-level commanders not only to second-guess subordinates (and thereby suppress initiative), but to be drawn into the tactical battle themselves, causing them to perhaps lose site of the big picture. This raises several questions. Are operational-level commanders provided tools appropriate to the operational-level mission? What are the operational and strategic effects sought? Do we have the means to address and measure these effects? These questions are particularly apt in civil-military operations, where disparate interagency, non-governmental and military entities find themselves together on a common "battlefield" with limited tools, limited metrics, and with plethora cultural barriers that prevent easy collaboration. This begs more questions. When dealing with disparate elements and differing scales, how do we determine what is essential for success? How do we get to ground truth?

2.2.2 Seeking Ground Truth

Some leaders venture to the front to ascertain what's really going on with soldiers who have "boots on the ground." Other leaders step back to better take in the "big picture" so they don't miss the forest for the trees. Which leader comes closer to the truth?

It is instructive to look at military insignia as a metaphor. Gold and silver are precious metals found in the ground. Junior officers wear gold and silver bars which relates to their focus – close to the ground. When they are promoted to "field grade," their bars are exchanged for oak leaves – found in tall trees – representing a more elevated view of the tactical picture. While still focused on the tactical battle, perhaps they're now able to see over low walls. Colonels wear eagles, which fly well above the tree line, gaining perhaps a campaign-level perspective where several battles can be monitored simultaneously and – if need be – constrained resources can be appropriately allocated. Finally, general and flag officers wear stars, representing the broadest perspective of all – perhaps even global.

For those who find themselves with their "boots on the ground" and calling for fires (or in the case of a humanitarian mission; more tents, water, or medicine), nothing is more important than completing the assigned mission while, if possible, surviving to either serve again or return home to those being defended. But when resources are constrained, an operational level commander may have to make hard decisions that prioritize one effort over another, euphemistically called managing risk. In addition, an operational level commander may choose to halt or accelerate an effort on witnessing operational or strategic effects that may or may not be obvious at lower levels of the operation. The operational-level of war is not merely the aggregation of tactical-level actions, and this makes an operational-level perspective different, often dramatically so, from the perspective needed at the tactical level. Let's clarify this further with an analogy.

Soccer (or association football) is fluid and dynamic, and success comes to those who better adapt on the fly, executing self synchronized movement towards a common goal. It requires stamina and endurance, in addition to multiple ball handling and team skills. In other words, success requires tacticians who can adapt, modify, and execute at the point of action.

But what skill sets are required at the next higher level? To be a successful coach, additional knowledge, skills and abilities are needed. While players are immersed in the rhythm of the game, coaches are concerned with harnessing resources to win over time.

And what about team owners or league officials? While an appreciation of the game itself is certainly desirable, different expertise needed at the enterprise level might include marketers, accountants, physicians, travel agents … people with business acumen, financiers. At this level, the actual play of the game is less important than the emergent tasks: television contracts, sponsorship, jerseys to market and considerations of which cities to open up or close down based on potential support base or tax incentives.

Of course, one big difference between the sports example and the military is that the military *does* care who "wins the games" as well as the state-of-play on the field. But that does not change the fact that at the operational and strategic levels wider effects need to be assessed, requiring different tools and expertise. Nonetheless, our personnel plans select expert tacticians with "strong legs and lungs" for higher command, giving minimal attention to the skill-sets needed to succeed at the operational and strategic levels.

Operational and strategic commanders do need a sense of the fight at the point of action, but even more, they need a sense of the battle at a higher level; monitoring operational and strategic effects and providing value-added input – whether it's proactive or by negation. Moreover, strategic and operational level commanders must avoid the temptation to micromanage tactical-level actions just because information technology has provided them precise and timely visibility to that level. Otherwise the tactical fight can deteriorate to 5-year-olds playing soccer – all swarming after the ball – with no one focusing on the other required functions or bigger effects.

This caution applies in both directions. With the ability to network and move massive amounts of data, there's an increased tendency to push more tactical data up to senior leadership for either background or decision making. Not only may this overload the higher-level commander, but it could also act as a disincentive to tactical commanders who may become inclined to seek permission for action rather than take appropriate initiative. This loss would become evident only at the worst time, when communications are degraded or negated.

When mutual trust exists, higher-level commanders empower lower-level commanders to execute without detailed central control, and that allows lower-level commanders to learn to operate autonomously in degraded conditions. And it is also imperative that we build and nurture information security in the

technology and systems that provide information both up and down chains of command – especially in a more dispersed force. Building and maintaining trust in people and in our systems is crucial to success.

On a human level, militaries build trust by promoting a common culture. U.S. Marines, for example, shepherd people from disparate backgrounds through an intense bonding experience to make them lifetime members of "The Corps." Knowing that all Marines share a common legacy and have been through a similar crucible fosters an enduring atmosphere of mutual trust within that fighting force.

Humans tend to trust other humans who are willing put their lives on the line, if needed, to protect a friend or advance some common cause. This is perhaps why warriors who go to battle together form bonds not easily replicated elsewhere in society. Building on the human ability to deal with complexity and trust will be crucial to success in future warfare, especially when it comes to command, control and decision making. Therefore, trying to engineer the human out of the loop would be a mistake.

3.0 DECISION-MAKERS AND DECISION-MAKING

Operations Analysis helps decision makers make better decisions, be they operational commanders involved in a campaign or acquisition officials determining the size and capabilities of a future force. But how can operations analysis evolve to also assist decision makers involved in complex, comprehensive approach, civil-military-type operations? The idea of cumulative purposeful change embodied in sociological evolution puts man squarely in the center of any attempt to deal with the comprehensive approach challenge. This is to say that we must understand not only the mechanical interaction of systems, but also the way in which the human decisions that engender change are made and how they evolve over time. Three constructs are relevant: the "rational actor," the decision making process itself, and the process of learning and adaptation.

3.1 The "Rational Actor"

If we were to assume a world of "irrational" actors, there would be little hope of bounding any problem sufficiently to cope with it or of even maintaining sufficient rational behavior on our own part to even try.[10] But, what is a rational actor? The dictionary defines rationality as "the latent power to make logical inferences and draw conclusions that enable one to understand the world about him and relate such knowledge to the attainment of ends."[11] But this does not mean that to be rational is "to think like me." The message of complexity and living systems theory is that rationality, like the behavior of any complex adaptive system, cannot be separated from the whole without losing its meaning. By extension, this warning translates into two caveats.

- First, rationality as a complex behavior can be understood only within a specific context that has social, cultural, religious, economic, political, diplomatic and other dimensions, that has a "where you sit" structural and organizational setting, and that has an individual or group character based on education, experience and training.
- Second, given the continually evolving nature of complex adaptive systems, any context reflects but a snapshot in time, the product of a particular constellation of variables and a physical and psychological environment within which the individual or group of decision-makers operates for a particular time. As this implies, rationale should be expected to vary as the constellation of variables change.

The assumption of a "rational actor," even so contextualized, might seem a shaky reed upon which to base any analysis, but in fact much of daily life is built around such an assumption.[12] Most social science theory is based on the fundamental rationality of human beings -- from Wall Street bankers to cannibals -- even though the rationality of one might appear totally irrational to the other. This same reliance on a

rational actor construct is apparent in the work of historians and political scientists who see the rationale for a given action deriving from a particular constellation of variables. As history testifies, variables change over time as the natural and human environment evolves, as decision-makers shape and are shaped by that environment, as thinking is shaped by the changes, and as organizations and individual decision-makers learn and adapt. History also provides a data base that retains the entire complex holistic context of past problems (and solutions). It enables us to take snapshots of particular constellations of variables and trace how they developed or how particular actions resulted in one or another set of outcomes. And, it enables us to identify which variables proved to be important at a given time and "tag" them to discern trends that might prove significant in similar situations. By assessing the retrospective whole of a problem, history provides a library of analogies and metaphors for communicating complex ideas and understandings about similar situations, a complexity shorthand used by humans to form mental models that aid decision making. For example, in the United States, the numbers 911 convey an understanding that could take up books.

3.2 Action-Reaction Cycles and Decision-making

Living systems theory gives us a model of a human complex and adaptive system in a state of continual and purposeful evolution fed by a stream of human decisions. And the "rational actor" offers a construct for understanding the decision-maker. But there is another piece to the conceptual puzzle: the decision-making process itself. This process is rooted in the stimulus and response process basic to all sentient living systems. Yet, purposeful decision-making is far more than a purely reflexive response. This process has come to be embodied in John Boyd's Observe, Orient, Decide and Act or OODA loop. In Boyd's construct, the decision-maker *observes* a situation that might require action, *orients* his thinking to consider potential actions and their implications for him, then *decides* on a course of action, and *acts* in some way.[13] This cycle is repeated time and again in an on-going spiral as one actor, and then the other, continues the interaction. (Figure 2)

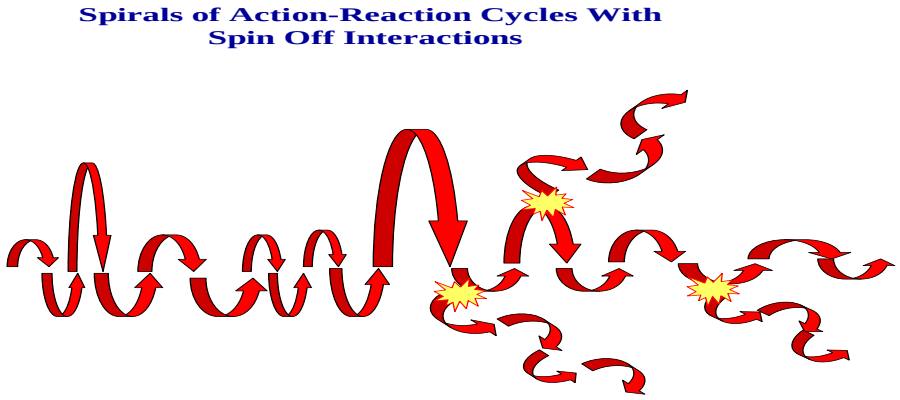

Figure 2

Although presented as a way to think about fighter aircraft engagements, Boyd's OODA construct is now broadly applied to all sorts of interactions and is widely accepted across government and industry. This OODA loop is consistent with the behavior of both complex adaptive systems and the living systems framework. This is especially true because the OODA loop actually depicts an on-going spiral of cycles in which each interaction is shaped by those that preceded it and shapes all the interactions that follow. But as the preceding discussion of complex adaptive systems underlines, there are two things missing from the OODA construct:

- The context within which the actors decide, without which neither the rationale nor the interaction can really be understood, and
- The multi-dimensional nature of any interaction that affects all parts of the living system.[14]

The idea of an *action-reaction cycle* and OODA loop must be expanded to include the larger organizational, social and system-of-systems context. As used here, "context" is both internal and external.

- Internally, context defines system identity and helps organize and define both the limits of consensus and freedom of action within an organization – short of seeking a new consensus or changing the organizational culture. It is the complex fabric for all understandings, processes, information and knowledge.
- Externally, context is the environment of interacting and co-evolving systems in which the organization and its action-reaction cycle are operating. It encompasses the on-going spiral of interactions with those systems. No complex adaptive system can function shorn of this social, economic, cultural, political, and diplomatic environment.

The utility of the action-reaction cycle in this context is that it offers the possibility of examining each step in detail, breaking each down into separate tasks and groups of essential processes that the organization must accomplish to survive and succeed.

3.3 Learning and Adaptation

The living systems theory highlights the need for all actors to adapt to a continually changing constellation of variables and, in turn, the need for a continuous process of learning, from tactical elements at the point of action to national and international leaders – In fact, anywhere human decisions are required. Indeed, it is the ability to learn and adapt that is central both to the process of sociological evolution and to the way that humans cope with more immediate dangers. We can break this process down into five levels of adaptation:

1. Adaptive Action
2. Learning
3. Learning to learn
4. Defining/ redefining success, and
5. Co-adaptation.[15]

Adaptive action is the immediate tactical action and reaction as one actor, our fighter aircraft, for example, observed changes in energy states and positioning, and adapts during a fight. Learning implies a process of evaluating this interaction for lessons to be learned and disseminating those lessons, for example, debriefing the flight to intelligence officers who then synthesized the information to pass to follow-on aircrew. Learning to learn takes the next step, to address how we adapt the ongoing process of learning to better capture and disseminate the lessons learned; as in creating "Topgun" (Navy Fighter Weapons School) to provide an intense training course that simulates combat and helps accelerate experience. Defining or redefining "success" involves a higher level adaptation, in which the original objectives, risk-versus-gains calculus, capabilities applied and approaches to achieving those objectives are reassessed and adapted to changing circumstances. For instance, at the end of the Cold War with the outer air battle threat

to the aircraft carriers reduced, the U.S. Navy fighter community evolved their fighters to precision bombers to become more relevant to the new security situation. Finally, Co-adaptation is the process of translating lessons learned from a set of external interactions into organizational and institutional changes to better deal with change. An example of this might be adversaries of the West building an anti-access capability to challenge a perceived power projection advantage, while Western forces adapt by building an emergent fleet of stealthy, unmanned systems. Together, these overlapping levels of adaptation outline a process that occurs through multiple layers and many individual actors in a living system.

3.3.1 SOF in Afghanistan, 2001-2002

At the operational level, building in adaptation, and understanding context is even more challenging. When Navy SEAL[16] Captain Bob Harward was assigned to lead the international Special Forces effort in the early days of the Afghanistan operation, he had a challenge and an opportunity. Not only was he to pull together the Special Forces activities from 7 nations, he was also asked if he could do so without the normal level of combat support.[17] Having just departed from command of Naval Special Warfare Group ONE in Coronado, CA, Captain Harward suggested that he could get around this deficiency if he could tap into his former command center for reach back support. Being able to reach back or reach out for support from subject matter experts is critical for success in a networked-centric distributed force. The challenge is how to build the requisite trust in both the physical and social systems, and then effectively mesh operational tempos. In this case, having just left the command, Captain Harward intimately knew the SEALS who would be responding to his queries as they had just trained and operated together. The command center at Coronado also understood the limitations of Special Forces, who often operate far from other mutual support and would tailor their responses to provide the forces on the ground exactly what they needed, in a manner they could absorb, in a timescale that made sense.

4.0 OPERATIONS ANALYSIS TRANSFORMATION

4.1 Classic Operations Analysis … quantitative vs. qualitative assessment

Classic operations analysis tends to the normative and quantitative, seeking to identify optimal solutions between clashing systems. In Industrial Age warfare[18], with the two World Wars being the classic examples, quantitative analysis could be quite useful. Success was defined by the ability to mass-produce (and also mass-destruct), and an economic engine that could out-produce its competitor had a distinct advantage. And this was measurable. Most analytic tools also tend to focus on the tactical level of war, aggregating data from numerous battles and fronts, often inattentive to the harder to measure effects sought at the operational and strategic levels of war.

Information Age economies and warfare are different. Mass production gave way to specialized production and, now, individual consumers and producers have the ability both to drive content and mass effects. Viral videos, Wikis, social networking sites, blogs, and GPS-synchronized mashups[19] of data and models, all connected through the World Wide Web and dispersed through mobile phones, point to the increased empowerment of small groups, and even of individuals. Large, bureaucratic (and often very successful) systems could find themselves disadvantaged against more agile and smaller groups who can inexpensively buy into the Information Age and create mass effects – for good or evil ends. Industrial Age tools often replaced human labor with machinery that could produce widgets faster and with better precision. Information Age tools do not replace humans, but better connect them.

A comprehensive, civil-military approach that requires all the instruments of national power (diplomatic, informational, economic and military), in addition to international and non-governmental instruments to better harmonize actions will require new analytic approaches and tools. Metrics will

be dynamic and non-linear, and must embed rather than suppress the human element. It will require tools that not only measure force-on-force and kinetic effects, but also the effects of, for example C4ISR[20], human behavior, irregular warfare, and stability, security, transition and reconstruction operations (SSTR).

If a model is a simpler but representative example of a real world activity, modelling complex human behavior will be a challenge. According to Yale Professor Paul Bracken, in an article about "net assessment,[21]"even more important than the quantification of data is the quality of the thinking:

> *"Perhaps oversimplifying, there seem to be two kinds of people in the world: those who build mathematical models, and those who focus on the world. The two groups usually don't talk to each other. Each plays to a different audience. The modeler gains status by impressing other modelers and giving talks at professional societies. Those who focus on the world usually don't go to such meetings. They play to an audience of what's actually taking place on the battlefield, whether it is located in a foreign land or in a corporate board room.*
>
> *In place of modeling complex and thinking simple, net assessment tries to model simple and think complex. The spirit is one of using relatively simple models, numbers, and trends, and to think long and hard about what they mean."*[22]

As long as models are used to augment deep thinking, not supplant it; they may help offset any perceptual bias on the part of the decision-maker. Certain models may be useful in helping humans make sense of complex environments.

Complex and adaptive systems require descriptive rather than normative modeling focusing on the "plausible behaviour of individuals"[23] and systems. And since the interactions between entities are as important as, if not more important than the individual entities themselves, some form of system dynamic modeling would be helpful in trying to understand a complex operation. To better capture the human element, agent-based models can be built with either simple or complex rule sets. They can interact with other agents and even be made to learn. In this way, one could approximate what certain agents, properly contextualized, might do over time; assuming one had enough subject matter experts and data to make the modeled agents interesting and representative. In 2007, NATO's International Security Assistance Force experimented with a stochastic, agent-based model – Synthetic Environment for Analysis and Simulation (SEAS) model – which "forecast" friendly, neutral and enemy reactions and was fed through a large reach-back mechanism with frequent data updates on the demographics of different layers of the population. Another interesting model, the UK's Peace Support Operations Model (PSOM), performs population-centric campaign-level analysis with human-in-the-loop, semi-agent-based representation that measures the population's perception of security, consent to leadership (positive or negative reaction to various other factions), the state's ability to function, and the threat. PSOM includes a "Hi-Level Game" political move as well, as they did not want to treat this important and often neglected level abstractly. While PSOM is primarily an operational level model, the UK has also developed a "high-tactical level" model with more granularity called STOAT (Stability Operations Analytical Tool).[24]

This is not an exhaustive list and there is assuredly a lot of modeling work ongoing in many nations, but to usefully simulate complex, comprehensive approach operations will require some sort of mashup hybrid of agent-based, system dynamic, computational and human-in-the-loop modeling. Considering time and space, system-dynamic modelling is perhaps better at capturing the time element, and agent-based modelling is better at capturing the space dimensions. Validation of models that address DIME/PMESII[25] elements is difficult, as metrics like legitimacy and influence are more rooted in the social than the physical sciences. Various academic and professional disciplines may need to be brought

together and thought of holistically – again. Ultimately, validation will rest not so much with the models, but in the trust developed between the decision-maker and the decision-support analysts.

5.0 CONCLUSION.

When General Charles Krulak was Commandant of the U.S. Marine Corps in the late 1990's he forecasted the complexity of modern warfare and the Comprehensive Approach with his notion of a "3-Block War," in which soldiers would find themselves simultaneously conducting humanitarian operations, peacekeeping and traditional warfighting in urban settings. He posited a "strategic corporal," empowered with information, but also trained and educated to seamlessly work among and above the traditional levels of warfare. Much of this has come true, but it's more complex still than even a visionary like Krulak could have imagined. For example, the mere use of terms like "3-Block War" or "irregular warfare" may alienate diplomatic actors and can create difficulties when trying to integrate with international relief organizations. Indeed, signals are appearing that militaries, after fighting insurgencies for so many years, would prefer to go back to managing just the security element, turning over other "non-military" roles to an interagency, intergovernmental body which would do all the "soft power" things that are not what most militaries trained and equipped themselves to do. It is increasingly clear, however, that building up other arms of government capacity to be able to better handle the "Comprehensive Approach," while laudable and necessary, will never be sufficient to relieve the military of such missions.

Non-military organizations will also continue to adapt and learn in this new environment, but their success will always come more from the interactions between elements than from the elements themselves. And success in this environment will be more about networking people than deploying technology: social networking and the harmonization between agile elements may turn out to be the best approach to conducting 21st century complex operations. Having a better understanding of how complex adaptive living systems respond and learn will enlighten us not only about our potential adversaries, but about ourselves as well.

Analysts will need to develop new models and better tools to measure the operational and strategic effects needed to prevail in complex, comprehensive operations, to address the emergent requirements of disparate systems, to augment kinetic, tactical-level tools, and to assist, not replace human decision makers. And the ultimate validation of this system will be the trust between the commander and the analyst, as there will never be enough time to fully understand all the assumptions that go into a model, a recommendation, or an action.

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[1] NATO Riga Summit Declaration, 29 November 2006. <http://www.nato.int/docu/pr/2006/p06-150e.htm> accessed 17 February 2010.

[2] NATO's New Strategic Concept, 19 November 2010, < http://www.nato.int/strategic-concept/index.html> Accessed 02 May 2011

[3] Including the establishment of an entirely new Federal Department overseeing Homeland Security and the creation of an overarching Director of National Intelligence to sift and collate a sea of data from countless sources.

[4] "Smart power is neither hard nor soft—it is the skillful combination of both. Smart power means developing an integrated strategy, resource base, and tool kit to achieve American objectives, drawing on both hard and soft power. It is an approach that underscores the necessity of a strong military, but also invests heavily in alliances, partnerships, and institutions at all levels to expand American influence and establish the legitimacy of American action. Providing for the global good is central to this effort because it helps America reconcile its overwhelming power with the rest of the world's interests and values." From "CSIS Commission on Smart Power: A smarter, more secure America" dated 6 November 2007. << http://csis.org/publication/smarter-more-secure-america>> accessed 18 February 2010.

[5] Whole-of-government implies coordinating all the elements of national power. In the U.S. this is often referred to as DIME (Diplomatic, Information, Military and Economic). While bringing together these elements is often a necessary and difficult challenge, it is not always sufficient. Other governmental bodies and non-governmental organizations will also play a role in many security situations and they must also be considered.

[6] Based on James Grier Miller, Living Systems, Denver, University of Colorado, 1995.

[7] Much discussion these days on unmanned systems is often along these lines. Man is fallible, machines are not – therefore we should try to replace man with machines whenever possible. In reality, no systems are unmanned; they are just remotely controlled in some fashion, either directly or indirectly. There needs to be a better understanding of how unmanned systems will operate alongside and in conjunction with manned systems if we are to truly transform military operations.

[8] While there is much literature and difference of opinions as to what constitutes emergence, I will use it similarly to how it was defined by Professor Goldstein of Adelphi University: "the arising of novel and coherent structures, patterns and properties during the process of self-organization in complex systems." From Corning, Peter A. (2002), "The Re-Emergence of "Emergence": A Venerable Concept in Search of a Theory", Complexity 7(6): 18–30, http://www.complexsystems.org/publications/pdf/emergence3.pdf accessed 12 March 2010.

[9] The 20 essential processes or critical subsystems of a Living System are: the *boundary* which maintains the identity and culture of the system or organization, and protects it from the outside environment; the *reproducer* which ensures the system's continuation, the *ingestor* which brings matter-energy across the boundary for system sustenance, e.g. revenue and budget; the *distributor* which allocates the matter-energy throughout the system; the *converter* which adapts the matter-energy to the needs of the parts; the *producer* which generates the matter-energy; the *storager* which maintains and operating stock of matter-energy; and the *supporter* which takes care of housekeeping functions; the *extruder* which eliminates system waste products; the *motor* which moves the system with relation to its environment; the *input transducer* which senses outside information and brings it into the system; *internal transducer* which senses internal system information and readies it for transmission within the system; *channel and net* which is the architecture that transfers signals between systems; *timer* which helps the decider with any time related actions; *decoder* which takes information from the input transducer and gives it a private code for the internal system; *associator* which helps the system learn by forming enduring associations among items of information in the system; *memory* which stores information in the system and retrieves it; *decider* which gives guidance, coordination, and control of the system; *encoder* which turns private code to external code for communicating outside the system; *output transducer* which transmits information from the system to the outside environment. Miller, p. xix.

[10] Admiral David Jeremiah, USN noted at the beginning of operations off Libya in 1986 that, if he accepted Libyan leader Muammar Qadahafi as irrational, there would be no way to predict his actions or the course of the crisis and thus no way to plan, but if he accepted his rationality and tried to understand it was, he would have some idea of what might happen and could plan accordingly. Edward A. Smith, *Effects-Based Operations*, CCRP, Washington, 2002. pp. 450. I would add that the same calculus applies in today's operations in Libya. If we do not understand Qadahafi's decisions, it is because we fail to fully understand the context that bounds his actions.

[11] *Webster's Third New International Dictionary*, Unabridged, Britannica, Chicago, 1986. Vol. 2, p. 1885.

[12] For example, we show up at a bus stop with an assumption of the basic rationality of the driver and thus that the bus will show up at approximately the time scheduled and that the driver knows how and where to drive. The schedule and driver's rationality exists within a multi-dimensional context. The driver will seek to show up on time because he or she has a family to support and needs to hold onto the job or seeks to advance by good performance and the bus company will insist that the bus be on schedule to avoid a loss of customers. This is to say both are acting rationally but doing so within somewhat different contexts.

[13] Colonel John A Boyd, USAF. "A Discourse on Winning and Losing." Air University Lecture. August 1987.

[14] Boyd certainly did not ignore the question of context but appears to have seen it primarily as part of the *orient* step whereas the discussion of complexity and the nature of the human dimension of a comprehensive approach would indicate a more pervasive role touching every aspect of the OODA cycle.

[15] See Anne-Marie Grisogono and Edward Smith, "Warfighters to Coalitions: A Case Study in Multi-level Adaptation," Paper presented at the 11th ICCRTS, Cambridge, United Kingdom, 2006, and Anne-Marie Grisogono, Edward Smith and Mark Clemente, "Cajole and Coordinate? C2 in Whole of --Government, --Nation, and -Coalition Action," Paper for the 13th ICCRTS, Seattle, Washington, 2007.

[16] SEALs (Sea, Air, Land) are Navy Special Operations Forces

[17] **"Combat support** refers to units that provide fire support and operational assistance to combat elements. Combat support units provide specialized support functions to combat units in the areas of chemical warfare, combat

engineering, intelligence, security, and communications." From << http://en.wikipedia.org/wiki/Combat_support>> accessed 22 February 2010.

[18] The distinction between Agrarian, Industrial and Information Age warfare is elegantly described in Alvin and Heidi Toffler's "War and Anti-War: Survival at the Dawn of the 21st Century," Little, Brown and Company, 1993.

[19] "a mashup is a web page or application that combines data or functionality from two or more external sources to create a new service." From << http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)>> accessed 19 February 2010.

[20] C4ISR is an unfortunate mashup of capabilities and stands for Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance – each of which probably deserves separate attention, but are often collectively ignored since C4ISR is not as appealing or tangible to senior operators and procurement officials as planes, ships, tanks and weapons.

[21] "The objective of a net assessment, as perfected by Marshall's office (Andy Marshall, Office of Net Assessment's founder and still current director), was to provide an even-handed look at both sides of complex military competitions, examining the long-term trends and present factors that govern the capabilities of the United States and its potential enemies." From << http://www.sourcewatch.org/index.php?title=Office_of_Net_Assessment>> accessed 19 February 2010.

[22] Bracken, Paul "Net Assessment: A Practical Guide," << http://www.carlisle.army.mil/usawc/parameters/06spring/bracken.pdf>> accessed 19 February 2010.

[23] Macal, Charles M. and North, Michael J. "Agent-Based Modeling and Simulation" from Proceedings of the 2009 Winter Simulation Conference.

[24] From "NATO Specialist Meeting on "Analytical Tools for Irregular Warfare" 23-27 March 2009, Bundeswehr Transformation Center, Ottobrunn German (RTO SAS Panel 71) where author was a presenter and participant.

[25] Diplomatic, Information, Military, Economic / Political, Military, Economic, Social, Infrastructure, and Information