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The State of the Art and the State of the Practice

Whither EBO?
Prospects for a Network Enabled Synergy

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Our world is a complex place, a myriad of ever-changing, interdependent variables whose course we can never entirely predict. The strength – and challenge – of an effects-based approach to operations is that it squarely addresses this complexity by concentrating on the most complex aspects of this world: man, his institutions, and his actions. Indeed, the entire effects-based approach can be characterized by four things: a focus on the human dimension of competition and conflict; the consideration of a full spectrum of actions whether in peace, crisis, or hostilities; a multi-faceted "whole of nation" concept of power; and the recognition of the complex interconnected nature of the actors and actions involved. The human dimension arises both from the fact that, no matter what form effects-based operations may take, they are ultimately about shaping human perceptions and behavior, and from the fact that the planning and execution of such operations depend heavily on human beings to make the complex estimates and decisions involved. Similarly, consideration of an entire spectrum of actions rather than of target destruction encompasses linkages of actions across a peace-crisis-hostilities spectrum. Because the focus is on what observers perceive rather than on what is done and because any action is therefore but one part of an observed whole, all operations are necessarily whole of nation or whole of coalition. Finally, any effects-based approach must proceed from recognition that all actions and the reactions they provoke are inextricably linked in a system of ever-changing and adapting human systems whose complexity fundamentally shapes both the nature problem and the task of assessing, planning, and executing any operation.

Complexity

The complexity that shapes the non-linear[1] nature of effects-based operations can be defined in terms of a continually changing array of interdependent variables in which the chain of causes and effects between an action and an outcome will seldom if ever be the same, in which outputs

[1] Perrow defines "complex" or non-linear in terms of "interactions in an unexpected sequence" as opposed to "linear" which he defines as "interactions in an expected sequence."
Charles Perrow. *Normal Accidents, Living with High-Risk Technologies*. Basic, New York, 1984. p. 78.

are not proportionate to inputs, and in which the whole is not equal to the sum of the parts.[2] (Figure 1) As a result, complex problems cannot be "solved" in the sense of a merely complicated problem and we must be content with bounding sets of most likely outcomes.

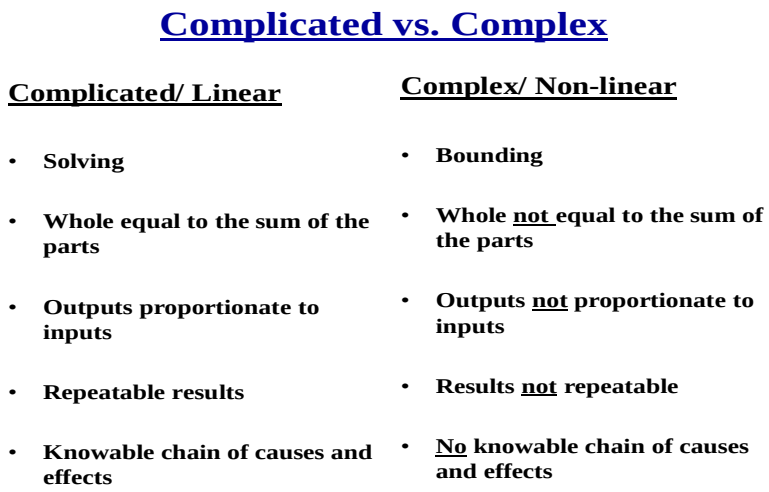

Figure 1

But, there is an additional challenge, for what we confront is not just a complex system but an array of complex adaptive systems that interact with each other and each change on their own in ways that are not entirely predictable. [3] The core challenge in any effects-based approach to

[2] In defining complexity as "conceptual equipment for policy-makers," James Rosenau points to four basic ideas embodied in complexity theory: 1. self-organization and emergence or the ability of the parts of a complex system to change and deal with change while preserving an internal dynamic; 2. adaptation and co-evolution or the ability to adapt to or co-evolve with the surrounding environment; 3. the power of small events to throw a system into disequilibrium and thus set off a reaction very disproportionate to the stimulus, e.g. the butterfly effect where the flapping of a butterfly's wings in China might provoke a hurricane in the Atlantic; and 4. sensitivity to initial conditions or the ability of only slight changes in the initial conditions can result in very large downstream changes.
James Rosenau, "Many Damn Things Simultaneously" in *Complexity, Global Politics and National Security*. David S. Alberts and Thomas J. Czerwinski eds. National Defense University: Washington, D.C., 1997. pp. 84-87.

[3] Professor Murray Gell-Mann describes the complex adaptive system as one that "receives a stream of data about itself and its surroundings. In that stream it identifies particular irregularities and compresses them into a concise schema, one of many possible ones related by mutation and substitution. In the presence of further data from the stream, the schema can supply descriptions of certain aspects of the real world, predictions of events that are about to happen in the real world, and prescriptions for behavior of the complex adaptive system in the real world. In all these cases, there are real world consequences: the description can turn out to be more accurate or less accurate, the predictions can turn out to be more or less reliable, and the prescriptions for behavior can turn out to lead to favorable or unfavorable outcomes. All of these consequences then feed back to exert 'selection pressures' on the competition among the various schemata, so that there is a strong tendency for more successful schemata to survive and for less successful ones to disappear or at least be demoted in some sense…A complex adaptive system (CAS) may be an integral part of another CAS, or it may be a loose aggregation of complex adaptive systems forming a composite CAS. Thus, a CAS has a tendency to give rise to others."

operations lies in creating and implementing a coherent set of actions to achieve a desired end-state in a system of complex adaptive systems in which few variables are subject to our control; yet, the complex system of systems described could, hence, give rise to a nearly infinite number of outcomes. Living systems theory offers an alternative. It points out: that, in the real world, complex systems are the product of a biological/sociological evolution that continues to weed out systems that cannot function; that we can identify a multi-tiered system of complex living systems; and that, because the systems are the product of evolution, we can identify a finite comprehensible set of processes that are essential to their survival.[4]

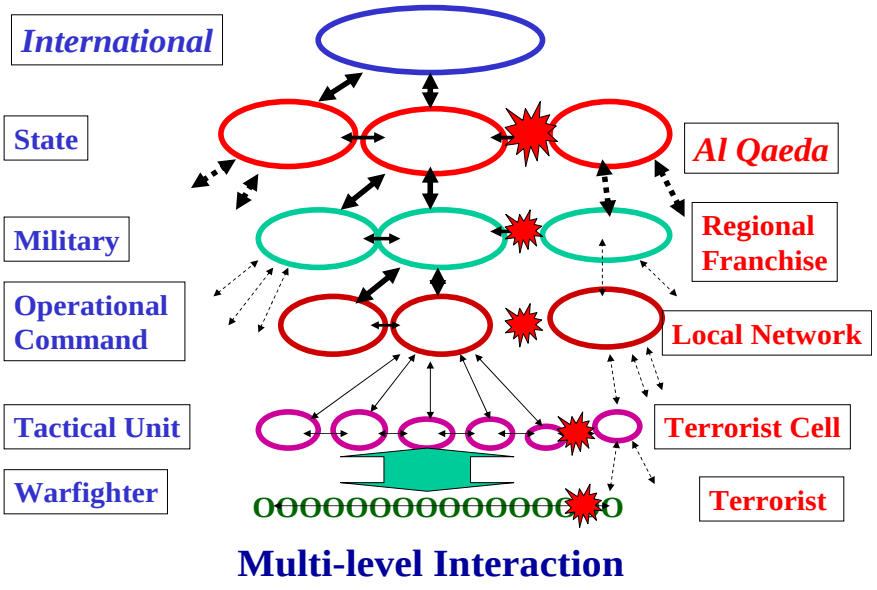

Figure 2

In the five top levels of this system of living systems (Figure 2), we can recognize familiar military organizations from the warfighter, to the tactical unit, to the operational command, to a Defense Department or General Staff, to a national leadership, and to the international arena. [5] Because the model is generic to all complex adaptive systems, we can also break out similar levels of complexity for other government departments and other states, and we can do the same with non-state actors, international and non-governmental organizations and

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Murray Gell-Mann, "The Simple and the Complex," Alberts and Czerwinski. pp. 8-10

[4] James Grier Miller identifies a total of 23 such evolution-driven "essential processes" to be found in complex adaptive systems at all levels.
James Grier Miller. *Living Systems*. University of Colorado, Denver, 1995. pp. xvi-xvii.

[5] The author has focused on the six highest levels of Miller's living systems, from human beings to the international security environment, that is, the arena within which states and non-states from international organizations to economies to terrorists interact.
Miller. pp. xvi-xviii.

even terrorist organizations. As the diagram indicates, interactions between systems will take place simultaneously on many different levels with each interaction tending to proceed at a pace dictated by its local circumstances.

These interactions will not just be with a foe. If we take a cross section of Figure 2 at the level of the operational commander, for example, we would likely see interactions with allies, neutrals, representatives of different departments and agencies of the commander's government, with non-governmental organizations (NGOs) and international organizations such as NATO or the United Nations and with their agencies. (Figure 3) Each of these other actors would occupy a position in different complexity hierarchy and reporting chain yet each would face local challenges and time lines that more closely resemble those of their local peers than those of their respective reporting chains. This is to say that, given the latitude to do so by the organization or command structure in which they find themselves, the local actors, as individual complex adaptive systems in their own right, will tend to adapt, self-organize and create an emergent local network to cope with their particular circumstances.

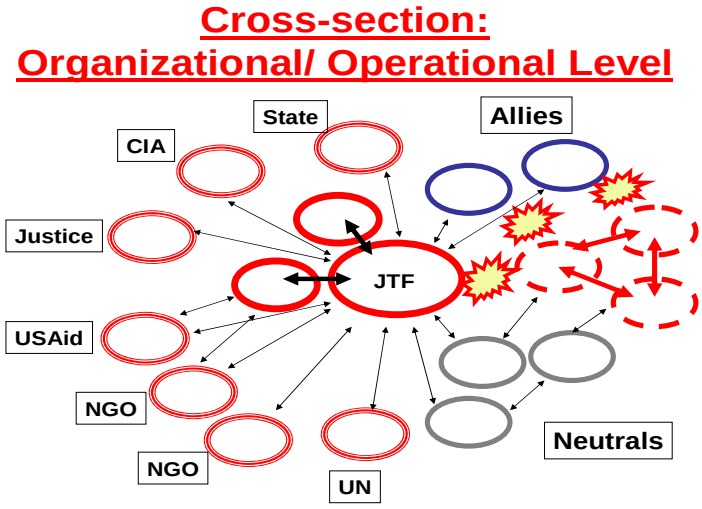

Figure 3

Within all of these interactions, we can also identify a set of five "essential processes" that embody the living system processes common to actors. Each actor, thus, would need: (1) to create some level of awareness of what was going on; (2) to make enough sense of this picture to act or react; (3) to decide on a course of action to deal with the challenges presented; (4) to carry out those actions; and (5) in doing all of this, each would be subject to an idiosyncratic array of social influences that would shape both their sense-making and decisions.[6] We can further break

[6] Each of these generic "action-reaction cycle" essential processes subsume some number of the living system processes outlined by Miller. For example, social influences include Living Systems processes such

these processes into series of generic problems that each would face in undertaking the process and the requirements for information and knowledge that these implied.[7]

The Complexity Paradox

At the core of any approach to dealing with the complex problems of effects-based approaches to operations lies the need for a human role. The description of the systems of complex adaptive living systems that constitute our world seems daunting and doubly so in the context of conducting human-centered, cross-spectrum, whole of coalition operations. However, there is a paradox here: complexity simplifies the problem. If we accept the innate complexity of what we are trying to accomplish, then we accept too that there cannot be perfect awareness, that we will never have all the answers and that we will never entirely understand our adversaries – or for that matter the friends and neutrals with whom we work. We accept too that cannot "solve" the problem and can never plot all possible consequences of our actions. And, we accept the need for the human – that product of biological evolution and genitor of sociological evolution – as key. Complexity in short sets a relative standard for decision-making: that it is sufficient to do all of these things better than our would-be opponents.

The essential processes and their breakdown into decision-making tasks point to three rules of thumb for the required human involvement.

1. *The greater the uncertainties, ambiguities and unknowables, the greater the requirement for human intervention.*

In interactions between complex adaptive systems, there will always be uncertainties, unknowns, and unknowables the extent of which will vary with the numbers and intricacy of the interdependent variables at work. As the uncertainties are to be found at every level and arena of interaction, so too the need for human intervention will exist at all levels. This human role two functions: to act where the information and knowledge needed are not available whether by virtue of the uncertainties and ambiguities involved or because they are simply unknowable; and to act where what is needed cannot be known in time. In a word, the human is called upon to fill in the blanks. The greater the extent of the uncertainties, unknowns and unknowables involved, the greater the scope and scale of this human complex decision-making role is likely to be.

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as maintaining the "boundary" distinguishing one system and another, e.g. "Americans don't do torture." evident in the post 9/11 security environment. Miller. p. xix.

[7] Smith, *Complexity, Networking, and Effects-Based Operations*. CCRP, Washington, D.C., 2006. Chapter Six.

2. *The greater the complexity of the problem, the greater the human role will be.*

Complexity theory tells us that, given a myriad of ever changing interdependent variables, there is no perfect "solution." What we must do rather is to "bound" the problem and solution so as to determine which assessments might be closest to being correct and which prospective solutions have the greatest probability of working. Historically, this has required human intervention – in essence, using one complex adaptive system to deal with another. This bounding is never perfect and carries no guarantee that the bounded assessments and solutions will be correct. Instead, it is based on the likelihood that the better bounded the problem is, the greater will be the probability of a correct decision. The relative nature of this bounding applies as well to the adversary. The better the foe bounds the problem the more likely he is to be right. Thus, it is not necessary to be right all of the time to win. Neither side will be. Rather, it is simply necessary to be right more often, more consistently, and in the right things than the opponent.

3. The less the time available for decision-making, the greater the role of the human in making that decision.

As the above rules of thumb intimate, the speed at which a decision or assessment needs to be made is a function of the urgency of the requirement and not the speed at which the ingredients for a correct decision can be made available. To the degree that ambiguities and uncertainties cannot be resolved within the decision time available or that the complexity of a problem cannot be bounded in time, the human decision-maker has no choice but to exercise best judgment to fill in the blanks and deal with the situation.

History tells us that none of this is new. Decision-makers have been confronting and dealing with complex challenges for centuries. The world has always been and will always be a multi-tiered system of complex adaptive systems. The essential processes and rules of thumb have always been reflected in how political, military, and even business leaders have organized and operated. Indeed, good human decision-makers have been coping successfully with the complexity throughout history. What we have been describing above is not a solution but the nature of the complex problem we confront and what it has meant for the leaders of the past. The fact that this is not new means that the real questions to be considered are not whether or not to conduct effects-based operations and whether humans can deal with complexity. We already do so with varying degrees of success and, in a world of asymmetric competitors and psychological attrition warfare, we have little choice but to continue to try to do so. The real question is instead:

how can we conduct effects-based operations *better*. However, the word "better" implies two separate questions: how might we improve the ways in which we have historically pursued effects-based operations; and how we might do things differently. The answers to these questions can perhaps best be approached by making a clear distinction between *classic effects-based operations* and the emerging potential for a new form of *network enabled effects-based operations*.

Classic Effects-Based Operations

The term *"classic effects-based operations"* encapsulates the approach that good leaders throughout history have taken to deal with the complex problems outlined above. This approach recognizes the innate complexity of competition and conflict and relies heavily on the intuition, education, experience, and occasionally, the sheer genius of human decision-makers to deal with it. It accepts that there will be no perfect answer and that no plan or process will be of any value unless it is timely whether that timeliness is in the context of an operational planning timeline enumerated in days or hours, or in the all too literal “drop dead” timeline of seconds faced by a strategic corporal on a road block. However, dependence on the “man in the loop” has its limitations. The quality of human decision-making is imperfect, varies greatly from one person to the next, can be slow, and is usually not very accurate. But, we need to careful to distinguish between two types of decisions here. For example, a fire control problem in a military operation presents two decision-making challenges. One is essentially a problem of ballistics and the other is the problem of whether or not it makes sense to fire. The former involves a linear application of physical laws and is readily subject to machine solutions that are far faster and more accurate than those of any man in the loop. The latter centers on the complex and never entirely predictable web of consequences that evoked and may flow from that action. This kind of assessment is not readily machineable and, thus, demands human intervention. It is in this latter function that the quandaries of effects-based operations arise.

Applying our complexity-based “reasonable” standard, the challenge in an effects-based operation is to come up with a solution that is good enough to work and timely enough to deal with the situation at hand. This good enough/ timely enough standard will hardly be surprising to military decision-makers but is important to any discussion of human roles because it the sets the real world standard for the decision-making required. It implies that the human task is to decipher complex problems sufficiently well to identify the one or more approximate "80 percent" solutions. The quality of effects-based decision-making we seek, thus, is measured in

terms of the likelihood of a given decision-maker obtaining a better and more accurate 80 percent solution than an opponent in the time available. This level of human decision-making is clearly attainable and history offers numerous examples of decision-makers who have done so. What is more, the ability to make such decisions is not restricted to the occasional genius. Cognitive scientists tell us that dealing with such complex problems is the kind of task for which humans have been "hard wired" by hundreds of millennia of evolution to the point that the more complex the problem is, the better the human is likely to perform relative to the machine. Indeed, the central contention of naturalistic decision-making is that the human is better able to deal with the complexities and uncertainties of military operations than the machine and that this is especially so when operating against a short time line.[8] Logically, the success of this human role hinges on who the decision-makers are and on how the organizational structures within which they must operate either restrict or enable them to function.

Choosing the Right Decision-Makers.

Given the idiosyncratic variability of human decision-making, for a classic effects-based approach to be successful, the right person needs to be in the right position at the right time. President Abraham Lincoln grappled with this kind of selection problem for the first three years of the U.S. Civil War as he searched for a Union general with the complex, "big picture" vision needed to win the war and the ability to select talented military subordinates to implement it. Yet, historically the breadth of talent that a commander – even a President – could tap was limited by the vagaries of social networking and by the need to winnow out those who in practice lacked the ability to deal with the uncertainty and complexity of real world operations.[9] The challenge for classic approaches was therefore to create a system for identifying, nurturing, and winnowing potential decision-makers to ensure that the right person was in the right spot to make the timely decisions needed. Today the challenge is no different even if the particulars may be. We need to identify decision-makers at all levels to handle the complex problems of a post 9/11 environment characterized by asymmetric conflict and contests of psychological attrition for which traditional physical attrition-based models do not readily apply.

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[8] Jim Stor. "The Commander as Expert," *The Big Issue: Command and Combat in the Information Age*. David Potts ed. Washington, D.C., CCRP, 2002. pp. 97 ff.

[9] Such battlefield winnowing is risky and expensive in lives, and history is rife with disasters stemming from choosing the wrong man. The American experience in North Africa in 1942-943 underlined in painful detail that America's peacetime selection processes was not a good indicator of how well a commander would function amid the complexities and short time-lines of real world battlefield much less to spot the innovative genius of a Patton. See Rick Atkinson. *An Army at Dawn, The War in North Africa 1942-1943*. New York, Henry Holt Co., 2002.

Organization.

Both military history and complexity theory indicate that any attempt to exert minute "control" over the all of the interactions between complex adaptive systems comes at the expense of forces' ability to learn and adapt to a changing local situation. In fact, "command and control" has always betrayed a yin-yang tension between a need for direction, integration, and hierarchy on the one hand and autonomy and operational flexibility on the other. The tension reflected two enduring problems: the limited span of control that a single individual might feasibly exercise; and the breadth of the awareness and knowledge he could perceive and internalize.[10] Historically, a tendency toward hierarchy was balanced by the limits of situational awareness. Because a general could only reliably see the battle in front of him, he had to grant some measure of autonomy to subordinates beyond his view -- a situation that was equally true of diplomats in distant posts. The pragmatic result was a balance between a hierarchical organization and a pragmatic mode of operations that permitted autonomous action where needed. However, it also produced a situation in which a "whole of nation" approach could not reasonably be exercised in the field.[11]

With the rise of better communications over the past century and a half,[12] the balance between integration and operational flexibility has been continually tested.[13] Rapid global communications also present two new challenges: minor military actions that heretofore escaped

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[10] As the *lévée en masse* drastically increased the size of Napoleonic era armies, it became increasingly necessary to move to a more hierarchical organization. After all, as von Clausewitz pointed out, while it might not be possible to control 500,000 men individually, it is possible to control three army corps and for the corps commanders each to control several divisions, and so on. Martin Van Crevald. *Command in War*. Cambridge, Harvard, 1985. p. 261; Carl v Clausewitz. *On War*. Howard and Paret editors. Princeton, Princeton, 1976. p. 294; Keegan. *A History of War*. New York, Knopf, 1994. pp. 348-353.

[11] Napoleon as both commander in chief and head of government theoretically combined all elements of a whole of nation response, but actually could not exert such control due to delays in communicating with Paris . See Charles-Maurice de Talleyrand. *Lettres de Talleyrand à Napoléon*. Paris, Bonnot, 1967 and Josephe Fouché. *Mémoires de Josephe Fouché*. Paris, Bonnot, 1967

[12] This balance began to change by the time of the U.S. Civil War with the introduction of a ubiquitous telegraph system and an Army Telegraph Office adjacent to the White House that was frequently visited by President Lincoln – a predecessor to the current "Situation Room." With the telegraph, Lincoln as national commander-in-chief could and did intervene in military decisions to exert a "whole of nation" influence on Union efforts. One example of this commander-in-chief's intent was Lincoln's closed conference with his major military commanders in the closing days of the Civil War in which he laid out his ideas for how the war was to be concluded and his plans for its aftermath – an intent later reflected in the generous terms the generals accorded surrendering Confederate armies.
Shelby Foote. *The Civil War: A Narrative*. Time-Life, Alexandria, 1999. Vol 14. pp. 33-35

[13] Alberts, Garstka, et al. point to six such command and control philosophies in *Understanding Information Age Warfare*.
Alberts, Garstka, et al. *Information Age Warfare*. pp. 170 ff.

attention now can signal critical shifts in national intent,[14] and the untoward actions of the strategic corporal can derail large scale strategic initiatives. This instantaneity creates a temptation to exert tactical level control even as adversaries become more adaptive – a problem compounded in "whole of nation" operations involving many elements of national power.

Network Enabled Effects-Based Operations

Against this backdrop of classic, human-centered approaches to dealing with the complexities of the operational environment in general and of effects-based operations in particular have appeared the technologies and thinking of the Information Age. Whereas the classic approach was largely limited to choosing the right decision-makers and organizational structures with the hope that both would function as expected in real world situations, the Information Age capabilities suggest we can do something more.

"First Generation" Network Centric Operations

In the first flush of network centric operations, efforts to exploit Information Age tools tended to focus on taking man out of the loop so as to decrease human error and increase speed of command, areas in which the pay-off for investment in new information technologies was most evident and quantifiable. Networked communications also seemed to offer a way to centralize decision-making at higher levels of command where it was expected the manpower and information resources existed to "solve" the complex battlefield problems and control the "signals" and potential missteps. To these ends, these efforts often attempted to linearize the complex operations with proliferating processes each trying to key variables or to reduce the complexities to sets of pre-planned targets so as to fit them within the confines of the network capabilities and architectures available.

However, "first generation" network centric operations quickly ran afoul of the complexities of effects-based operations. Taking man out of the loop to create "sensor to shooter" architectures, for example, worked to increase the speed of command but only when applied to the relatively narrow part of the operational spectrum where pesky complex variables could be eliminated. Centralizing direction at higher levels was and remains a necessary element in achieving unity of effect, but it also reduces the ability of "edge" actors to adapt and survive in

[14]A succession of Middle East crises between 1967 and 1973 are good examples of this signaling and counter-signaling between the U.S. and the Soviet Union using naval forces.
Smith. *Effects-Based Operations*. pp. 193-204

fast paced local interactions. New information tools also tempted us to believe we could apply increasing computer power to obtaining definitive answers to multi-faceted, continually changing complex problems and to do so quickly enough to avoid slowing decision-making to the point that solutions were no longer timely. Finally, first generation thinking also brought a tendency to look at effects-based operations as something not scalable, least of all to a tactical level. The limitations of this first generation, "man out of the loop" approach are even more evident when viewed from the perspective of the special character of effects-based operations: their human dimension; the vast operational spectrum they span in peace, crisis, and hostilities; their inclusion of whole of nation and whole of coalition operations involving all the elements of national power; and above all, their inherent complexity. Each characteristic reinforces the need to deal with very large numbers of continually changing interdependent variables, and each presents an ever-changing and not entirely predictable set of non-linear problems that extend well beyond the straightforward focus of first generation networking on communications architectures.

Something More

All of the above is not to say that network centric operations are not applicable to effects-based operations. That would throw the baby out with the bath water. Quite the contrary, it is to say that Information Age capabilities and thinking can and must contribute considerably more than linking sensors and shooters and more than communications architectures for dealing with attrition-based and largely tactical military problems. How then might we define that contribution? The real answer to this question probably lies in a blend of classic effects-based operations and first generation network centric thinking: an effects-based approach that is network enabled but human centered – one that treats human-decision-making as a necessary and valuable part of effects-based operations, but that equally treats networking as an essential tool. If the best capability that we have for dealing with the complexities and ambiguities of effects-based operations is still the human being, then it follows that the network needs to be built around that human decision-maker.

Such an approach requires answers to two questions: who are the effects-based decision-makers; and exactly what support do they need?[15] In this context, the five essential processes provide a road map. The breakdown allows us to identify where an effects-based problem becomes complex and no longer susceptible to linear solutions and, thus, exactly where and what

[15] One of the pitfalls of first generation thinking was the tendency to overwhelm the decision-makers with data and information. In a sense, the network sent "everything" to the decision-maker in the hope that "something" would be what was required.

kind of human intervention will be required. Armed with this, we can then begin to identify the many different kinds of humans "in the loop" and the specific functions of each: the information managers who must fuse data and information into awareness; the assessors and analysts who make sufficient sense of this awareness to support operations; the planners and commanders who will shape a response and decide on a course of action – all the way to national and coalition leaderships; those who will execute and, in so doing further shape the planned response – from strategic corporals, to tactical and operational commanders, to diplomats; and finally those who will guide or influence behavior and opinion by how they see the problem and the options available. Within the framework provided by these functions, we can further break the human tasks down to identify the specific actions that will be necessary to accomplish them such as tasking, collection, and fusion in support of awareness creation, contextualization and analysis in support of sensemaking, projected sensemaking and planning in support of decision-making, and adapting actions to the observers and situation at the moment of execution. We can then break each of these down further into still more specific problem areas and begin to identify specific ambiguities and complexities that might be bounded with further inputs of information and knowledge or the kinds of understanding that might be needed assess the risk of a particular course of action. Finally, with the problem sets more precisely defined, we can begin to sketch requirements for specific support and tools such as the use of data-mining and intelligent agents, or flexible, expandable libraries of analytical and social and cognitive modeling tools, or inputs from subject matter experts from the foxhole to academia. We can also carry this another step to outline a framework for a "tool-making tool kit," a process to manage and adapt the tools to the changing demands,[16] and to adapt communications and social networking architectures accordingly.

Second Generation Network Centric Operations

The version of network centric operations suggested by the above differs significantly from that which we have labeled "first generation." At the heart of that difference are the primacy of the human in the loop and the diversity of the support needed. In dealing with an essentially linear problem centering around moving data from one machine to another, it is natural to focus primarily on potential communications architectures, but when the requirement shifts to complex problems whose resolution centers on knowledge and understanding, the focus of the networking needs to shift to interactions between human beings. The focus of the

[16] That is, a three-way hybrid of knowledge mobilization and the interactive application of conventional linear analyses coupled with cognitive and social modeling and human expertise.

networking and the purpose of the communications architecture, thus, becomes that of facilitating the diverse human interactions that decision-makers' intervention may require. That means the networking must consider everything from the use of data mining to sort through a plethora of human reporting in open and closed source material, to intelligent agents and gaming techniques to assess the consequences of a prospective action, to cognitive, social, and cultural anthropological models, to the role of subject matter experts either in direct support or in putting a "reality check" on modeling and gaming efforts. Even more, the nature of the demands upon the network will continually change – sometimes very rapidly – as the environment and situation changes making a second generation network less a straightforward architecture than a continually evolving mesh of relationships that are unbounded in their scope.

The central idea in all of this is that the faster and more completely we can inform, organize, analyze, and communicate those elements of the problem we can know, the more tightly bounded the complex human decisions and assessments can be, the less the scale and scope of the decision-making that will be demanded of the human in the loop, and the greater the probability that the human assessments and decisions made will be correct. This suggests a threefold converse metric for network enabled effects-based operations and, by extension, for second generation network centric operations:

1. ***The more networking can reduce the uncertainties and ambiguities, the less human intervention will be required.***
2. ***The more networking can bound the complexities of the problem, the less the human in the loop will need to do.***
3. ***The more time networking can provide for decision-making, the less often the human in the loop will be the final resort.***

In dealing with the ambiguities and uncertainties of real world operations, it stands to reason that the better the quality of the awareness, the better the problem will be defined and the less an assessor, analyst or decision-maker will be forced to hazard a guess as to the "ground truth." Likewise, the greater the knowledge that can be applied to a complex problem, the less the human decision-maker will be forced to rely on his or her own instincts. And, the faster all of this can be gotten to the decision-makers in a usable form, the less they will be required to "fill in the blanks" in their own heads.[17] Putting all of these together, we come up with a fourth criterion:

[17] It should be noted that such naturalistic decision-making is not a coin toss but a conscious or sub-conscious effort to draw upon a mental library of analogies that might potentially be applicable to the situation. The better the experience and education of the decision-maker, the richer that library is the more

The better the quantity and quality of networking support available, the fewer and better the human interventions will be.

Phrased slightly differently, the better the networking as a whole, the higher the probability of a correct decision by the human in the loop is likely to be.

Scalability

This question of scalability is central to our ability to conduct "whole of coalition" effects-based operations and to efforts both to drive "Power to the Edge" and to create an "Agile Organization," as well as to succeeding in the kinds of asymmetric conflict that have characterized the post 9/11 world. But, any requirement for scalability in effects-based operations would seem to stand in stark contrast to an effects-based planning process that can be ponderous, time-late, and barely implementable even at the major command level. However, in the metrics outlined above, we can begin to see an approach to making network enabled effects-based operations scalable along three axes: a trade-off between the extent and quality of the networks and human intervention, a trade-off between communications and social networking, and a step-by-step, task-by-task cumulative approach to dealing with the challenges.

Networking vs. Human Intervention.

The rules of thumb and the metrics imply that a trade-off can be made between what the network can provide on the one hand and the degree and quality of the human intervention required on the other. This trade-off is significant not only for laying out how we might make effects-based operations better, but also because it begins to answer a major concern of those seeking to pursue effects-based operations on a limited budget. It says that, in the absence of the improved networking and tools discussed, an effects-based approach to operations does not become impossible. They simply will more closely resemble the classic, non-network enabled version of such operations cited earlier. In essence, the fourth trade-off becomes: smaller the budget and the fewer the networking resources, the more any effort will depend on the human intervention we are prepared to undertake.

This trade-off is doubly significant because it also indicates that a formal well-staffed effects-based planning process may <u>not</u> be a pre-requisite for all effects-based interactions. The trade-off between network enabled support and human intervention applies equally to less well staffed or supported commands. This scalability is especially important given a real world

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detailed and pertinent the analogies ultimately applied will be and the more likely a decision is to be correct.

security environment in which there are multiple "edges" at different levels each engaged in their own unique interactions with friend, foe, and neutral. At tactical “edge” interactions, for example, we would expect that decision timelines will be short and that the support available to resolve ambiguities and uncertainties or to bound the complexities will probably be minimal. But, this is not to say that such interactions are not effects-based evolutions. Clearly, they meet the criteria outlined earlier. They still focus on the human dimension of competition and conflict. They still are conducted across the operational spectrum and in peace, crisis, and hostilities. They still can involve non-military elements of national power or of coalition power. And they still are complex. The trade-off simply says that diminished network support means that there will have to be a correspondingly greater reliance on human intervention and, thus, that the essential processes of a tactical level interaction will largely be carried out in the head of the tactical commander who will need to plan and adapt on the fly in a rapidly changing series of action-reaction cycles with an innovative foe.[18]

Communications vs. Social Networking.

Networking for effects-based operations has two distinct dimensions. Whereas first generation network centric operations focused on the communications networking, the complexity of effects-based operations mandates human intervention at many different points with many different decision-makers. Good leaders historically have paid a great deal of attention to the social networking of building a team into an agile organization, but the ability to bring knowledge and expertise from across a nation or coalition to bear means that the requirement for agile organization now extends across the entirety of the network support from the foxhole to academe.

Because the two forms of networking, communications and social, are separate variables reflected in an overall level of support, we can see a separate trade-off. Obviously, if the physical ability to communicate falls to zero, then no social networking no matter how good will be worth much. Equally, no communications networking however good will be worth much if the people

[18] One particularly telling account of such an on the fly adaptation was reflected in a newspaper account of fighting in Najaf, Iraq: “a grenade arced over a wall and exploded beneath a Humvee. After the loss of one Humvee a week earlier, sparking a celebration by Sadr’s men, the soldiers refused to surrender this one. The resulting firefight turned into a six-hour defense of a burning car. “We weren’t going to let them dance on it for the news,” said Capt. Ty Wilson…”even with all the guys they lost that day, that still would have given them the victory.” The picture is that of a tactical "edge" commander with a firm grasp of an effects-based metric for victory and an appreciation of the multi-level, multi-arena impact of his actions executing an effects-based action on a minute by minute timeline.
Scott Wilson. "Over 60 Days, Troops Suppressed an Uprising," *Washington Post*, June 26, 2004.

it connects cannot understand each other. However, within these extremes, there is room for trade-off. The better the social networking, i.e., the ability to identify, organize, and tap expertise, and for decision-makers to understand them, the more rudimentary the communications network that a commander or decision-maker can tolerate. Similarly, the better the communications networking and the wider the expertise it can tap, the less the commander will have to rely on an institutional "who knows whom."

Cumulative Improvement.

The "road map" of essential processes and tasks point to a problem that is in fact divisible. We need not solve a monolithic whole to have an impact but can attack it bit by bit in a cumulative result. The key is the human metric. Our objective is to aid the human – or humans – in the loop in each of the individual tasks and functions delineated in the map. Each finite problem we solve, each tool we create, and each social or communications network we organize and implement contributes in some way to increasing the probability of the individual human making a correct decision and thereby, to the overall probability of success. By extension, the road map lets us identify what we can do with the particular resources and organization currently at hand, what we might do with specific new resources, information, knowledge, organization and tools, and what networking might work to put these pieces together.

The impact of this cumulative approach is also to be felt in a different way. The complexity of the effects-based problem infers that whatever networking we devise can never be a static given but must be a dynamic variable that will gradually be improved. This is to say not only that the task will not be accomplished all at once, but also that it is a process that can never really be completed. It is to say as well that we must think about network enabled effects-based operations as a continuing evolution to which each improvement contributes.

Whither EBO?
Putting the Pieces of Network Enables Effects-Based Operations Together

Although networking may be the defining element in a new approach to the long-standing concept of effects-based operations, networking is but one of four pieces in the puzzle. The first piece and driver of any answer is the complex nature of a multi-level, multi-arena international security system stretching from individuals to great states. Competition and conflict – now in the post 9/11 era dominated by asymmetric conflicts of psychological attrition – are part of an on-going, ever changing evolution of both the system as a whole and of its component parts.

Given such continual and often unpredictable change, there are no enduring or perfect answers and any architecture or procedure we devise for the support and conduct of effects-based operations must will itself continually change. What counts, therefore, is the ability to learn and adapt as the environment evolves and as the interactions between its actors change. It is the process rather than the network or tools that must be the focus of any effort to make effects-based operations better.

Complexity theory also provides a basic framework for this process. The complex adaptive systems with which we must deal (our own included) are just that: adaptive. The key to successful effects-based approaches -- and to being proactive not merely reactive -- is the capacity of complex adaptive systems from individual human beings to all sorts of human organizations at all levels to learn and adapt. Indeed, it is about the process of learning and adapting that the synergy we seek revolves. In the course of this paper, we have outlined three critical ingredients in this process (Figure 4.). Given the central role of the human decision-maker in network enabled as well as classic effects-based operations, the classic effects-based concerns with the choice and development of decision-makers and with agile organization are and will remain two crucial ingredients while the ability to network people, knowledge, and tools on a global basis provides the new and hopeful fourth ingredient. However, the real story in all of this is the synergies that can arise as all three interact and co-evolve.

Figure 4

Decision-Makers

While the process of producing the "right" decision-makers remains at the core of effects-based operations, networking introduces two potential synergies. We have already identified one: the ability to move beyond dependence on one human or a small circle of humans-in-the-loop and draw upon the collective resources of a whole nation or coalition. However, this network enabled expansion changes the scope of the selection process. It can no longer be limited to commanders or even their immediate staffs but now must extend to the broad range of other decision-makers – planners, analysts, and subject matter experts, and other actors – with whom they must interact to conduct effects-based operations. Although the abilities of the individual decision-maker to assimilate complex inputs and to learn and adapt must be a continuing criterion in any such selection process,[19] in a fast changing world, there must also be a continuing learning process to the ability of all to adapt. Networking offers a promising synergy enabling an on-going interchange among the diverse personnel in a "whole of nation" or "whole of coalition" learning and adaptation process and a continuing education and development process over the network.

Organization.

Where decision-makers in classic effects-based operations operated within the confines of a static, fixed organization, the biggest potential network derived synergy is perhaps about enabling the organizations themselves to learn and adapt. One obvious facet of this is making effects-based operations scalable so as to enable tactical commanders to adapt, plan, and re-plan effects-based actions on the fly,[20] but this equally implies enabling operational commanders to maintain a flexible balance between such freedom of action and the unity of effect needed to achieve desired end-states despite requirements that will vary over time and with the situation. Another synergy lies in extending agility of organization to tapping knowledge and expertise across a field encompassing other agencies, allies, non-governmental and international

[19] The author was once asked by VADM Cebrowski whether this meant that military commanders all needed to be regional specialists. The reply was that they could only develop a meaningful degree of expertise at the expense of their military operational expertise and that the real requirement was to acquire sufficient familiarity with a variety of disciplines to understand and appreciate the inputs of the experts that the network might provide.

[20] Dr. Anne-Marie Grisogono's pioneering work on learning and adaptation by complex adaptive systems and specifically human organizations begins to lay the groundwork for this additional thrust.

organizations, academics, the media and more, all also demanding organizations that can learn and adapt

Networking

If we accept that the network is a tool to be used to an effects-based end, then it follows that its evolution is not an inexorable process driven by new technology but rather something that is intimately tied to the evolution of the effects-based operations. Indeed, the potential synergies outlined above point to a symbiotic development process in which improvements in networking capabilities, human-decision maker selection and education, and new approaches to organization will all build kaleidoscopically on each other. In essence, in its technologies, information architectures, and social dimensions, the network will need to learn and adapt every bit as much as the decision-makers, organizations, and the processes that support them and will need to do so not only on the years long timescales of acquisition processes but on the minutes and hours long timescales of the real world battlefield.

Conclusion:
Learning and Adapting

What we seek in network enabled effects-based operations is not a solution but a process for on-going change to deal with a complex world whose challenges will never be the same from one interactions to the next. This paper lays out a conceptual framework for examining the way ahead for effects-based operations, the impact of complexity upon that evolution, and the potential synergies offered by networking. It is one part of a three paper series undertaken with Dr. Anne-Marie Grosogono of Australia's Defence Science and Technology Office because at the core of this evolution and particularly its synergies lies the whole question of how the complex adaptive systems especially man and human organizations learn and adapt to challenges – an area Dr. Grisogono will examine in her companion paper and that we together intend to address in a follow-on paper.

Much of this process of learning and adapting is already underway. Real world operations in Afghanistan and Iraq offer numerous examples. There have been repeated press reports of soldiers using lap top computers to buy off the shelf equipment via the internet at their own expense and have them shipped via FEDEX to meet pressing challenges where the acquisition system organization proved unable to respond. However, perhaps, the most telling synergy is be seen in the "Company Commander Net," an informal, non-record, junior officer

exchange using a networked lap top computers to get lessons learned and solutions from one war fighter to another in a matter of hours where the formal Army process for amassing combat lessons learned and translating them into formal tactics, techniques, procedures and doctrine might take years.[21] In both cases, the intersection of operational needs, new information technologies, the improvisation and innovative skills of tactical level decision-makers, and a flexible self-organizing local social and communications network resulted in a synergy that has permitted soldiers under fire to learn and adapt in new and impressively rapid ways.

[21] It should be noted that the U.S. Army and Marine Corps have taken up this challenge, not only accepting the Company Commander's Net as an essential ingredient in the process of adapting to a resourceful foe, but also have moved to move the more formal lessons learned through the system and into the class room at a pace that would have astonishing but a few years ago.
Tom Ricks, "Lessons Learned in Iraq Show Up in Army Classes." *Washington Post*, January 19, 2006. p.1.