Effects-Based Operations

Edward A. Smith, Jr.

The world in which we live is and always has been complex and filled with ambiguities and uncertainties, and the most complex part of this world has always been man himself – a point that operations in Iraq and Afghanistan underscore every day. Yet, in spite of this pervasive non-linearity, military efforts have tended to focus on linear, attrition-based solutions to linear warfare problems that often have little to do with our messy reality. Effects-Based Operations (EBO) focus on the single most complex aspect of this world: human beings and human organizations. They treat national power as a whole and consider its application not just to military operations but across the entire spectrum of competition and conflict from peacetime deterrence, to crisis response, to hostilities in all their varied forms, to the restoration of peace. They are not new. Their ancestry can be traced back to Sun Tzu and effects-based thinking has been evident in the actions of great generals and statesmen throughout history. What is new is the possibility of using information age technologies and thinking to harness the knowledge and capabilities of a whole nation in pursuing them.

Three 'Whys' and a 'What'

The driving force behind the current interest in effects-based operations is the need to deal with a dangerous security environment that mandates a focus on the human dimension of conflict. This driver translates into three 'whys'.

WHY #1: ASYMMETRIC COMPETITORS

Although asymmetries are usually defined in terms of size, strategies, and weaponry, the asymmetry that most affects the nature of current conflicts is one of *will* and *means*. The great wars of the last 150 years were largely driven by a symmetry of will and means. Because both sides had the will and the means to regenerate lost armies and navies, no single battle or campaign sufficed to defeat an opponent and the conflict devolved into wearing down opponents' physical ability to wage war until the psychological will to do so broke. In smaller conflicts, a different situation has prevailed with one side having great means but limited will often because it was engaged in a distant conflict that did not threaten its homeland, the other,

usually a local power or insurgency, having limited means but greater will. (Figure 1).

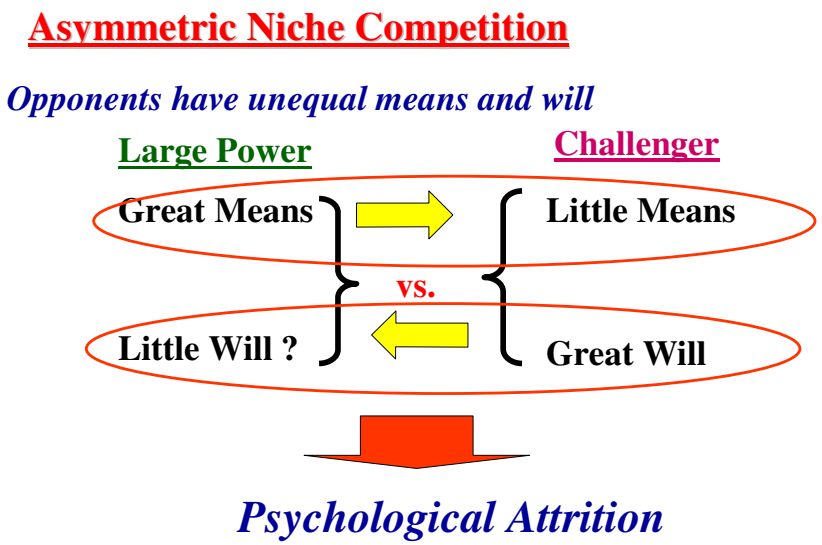

Figure 1

This implies two different asymmetries, one of means and one of will. Since successful warfare is largely about creating and exploiting asymmetries, the larger power usually exploits its advantage by attacking the inferior means of its opponent while the opponent exploits its perceived advantage in will with a damage infliction strategy aimed at the psychological attrition of the great powers' domestic will. However, if challengers minimize their reliance on 'targetable' means, they can negate the great power advantage and force a war focused on psychological attrition – a war that can only be won with an effects-based approach.[1]

WHY #2: SPECTRUM OF MILITARY OPERATIONS

While major combat operations are the *sine qua non* of a military, military operations really range from peacetime operations of deterrence, peacekeeping and humanitarian operations, to crisis response, to major combat, and post-conflict stabilization, a spectrum in which the neat

[1] This is the threat currently posed by insurgencies in Iraq and elsewhere. But, unlike previous asymmetric foes, al Qaeda has attacked and continues to threaten great power homelands potentially changing the asymmetry to one in which the great power has both great means and great will - making for a long but still effects-based struggle.

divisions of war and peace no longer seem to apply. Hostilities seldom follow a formal declaration of war nor does an end to major combat signal an end to hostilities. Instead, hostilities begin in a grey area between crisis and war or between law enforcement and military action. Likewise, the end of major combat often is merely an end to one form of hostilities and the beginning of another in a cycle of successive adaptations that continues until the one side exhausts all options or loses the will to fight with a return to peace that may only be evident in retrospect.[2] (Figure 2).

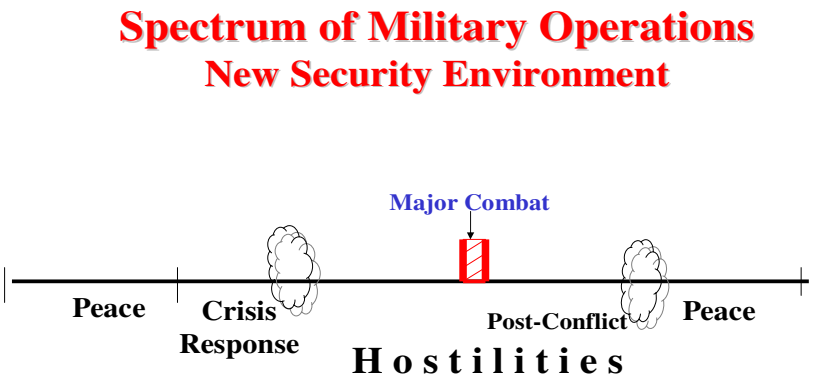

Figure 2

WHY #3: "REAL WORLD" OPERATIONS

If we carry this logic a step further, we have become so successful at putting the right number of the right weapons on the right target at the right time that opponents are driven to find ways to thwart it in order to survive, for example by creating complex identification problems where sensor networks no longer work well or by dispersing military units, taking troops out of uniform, and mixing them with civilian populations.[3] The new paradigm is a battle for minds in which the object is to take the right actions at the right time to

[2] This again is not new. In the closing days of the U.S. Civil War, General Robert E. Lee, faced with the inability of the Army of Northern Virginia to continue major combat operations, was urged to disperse the army and initiate a guerrilla war in the nearby mountains – an option he refused as leading to nowhere. S Foote, *The Civil War: A Narrative*, Vol. 14, Time-Life, Alexandria, VA, 2000, p. 149.

[3] This forces troops to make the identifications often under stress and under fire – provoking a higher probability of errors that in turn can be exploited in the media as part of the contest of wills.

create the right effects. Engagements are complex, will be seen differently by different audiences, have no precise beginning or end, and are part of a continuing, on-going interaction in which what was done in the past will shape the current engagement and in which the current engagement inevitably will shape the interactions of the future.

The three 'whys' paint a picture of a complex, messy 'real world' where attrition-based approaches to conflict no longer work. The result is a move to effects-based operations.

THE "WHAT": EFFECTS-BASED OPERATIONS

Effects-based operations can be defined as 'coordinated sets of actions directed at shaping the behaviour of friends, foes, and neutrals in peace, crisis, and war'.[4] In this definition, 'actions' encompass destruction and all other military operations and include as well as the diplomatic, political, and economic elements of a national response. Operations focus on a 'behaviour' end state that is scaleable from the tactical to the geo-strategic level and applicable to diplomatic, political, military, and economic efforts arenas. And, the 'behaviour' considered is as much that of friends and neutrals as it is of the foe. In short, effects-based operations are basically a stimulus and response approach to operations that spans an entire national response, the full spectrum of competition and conflict, and actors from the individual through the state.

Operations in the Cognitive Domain

Any stimulus and response approach must centre on the cognitive domain where humans perceive, understand, and make sense of a situation and decide on the course of action that constitutes their behaviour. The key to this process is the 'observer'. The central importance of the observer can be understood by dividing the process into a physical domain where the stimulus of physical actions take place, an information domain where actions are sensed and collated, and the cognitive domain where the decisions are made. In the below diagram (Figure 3), actions occur in the physical domain, are reported through the information domain, and become part of the shared awareness upon which an observer will draw. This awareness is a function both of what the action was and how it was detected and reported. The observer will then balance the awareness against what has happened before – the 'prior knowledge' that provides a cause and effect and time context, and his own 'mental model' or library of analogies for understanding what is seen. He will then attempt to make some 'sense' of this picture, evaluate the

[4] Note that effects-based operations are not defined here in terms of a 'process' for conducting them but rather in terms of what any process must address.

options available, and decide what action to take – the response to the stimulus. This re-action will then become the stimulus to which others will respond in ensuing cycles with the cycles repeated time and again in the course of an interaction.

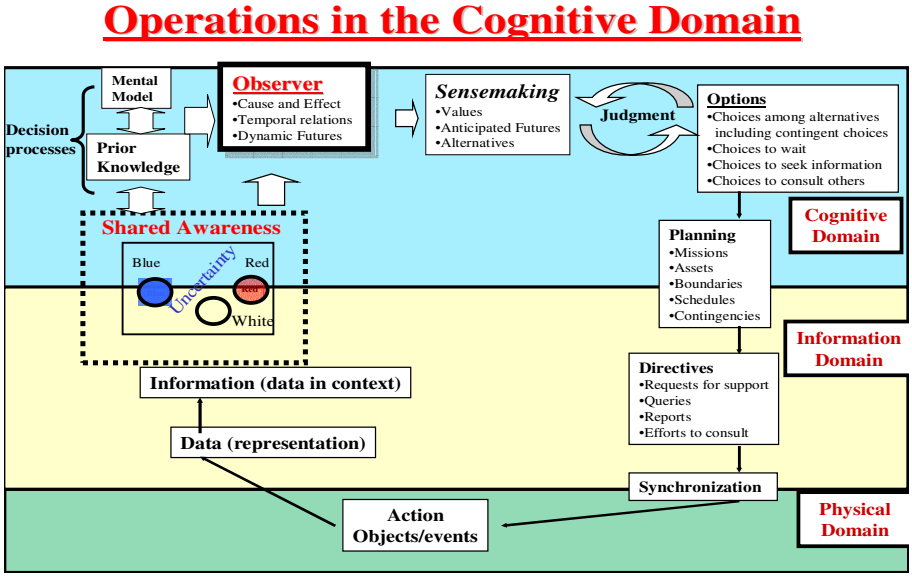

Figure 3

However, this process describes how human beings in general perceive, make sense, and decide. In effects-based operations, we also need to assess how particular observers or groups of observers will perceive, understand and make sense of an action and what options they will have. To do this, we need to look to a *social* domain[5] encompassing all of the factors colouring how they understand an evolving situation including who they are, their values and expectations, and the options available and which they may deem viable and acceptable.[6] (Figure 4). As the multiple arrows in Figure 4 below indicate, this social domain reflects multiple interdependent variables from history and religion to politics and education whose

[5] In their book, *Power to the Edge*, Alberts and Hayes introduce the idea of a fourth 'social domain'. In this case the author has used the term *societal* vice social to emphasize that the concern here is not with how societies in general perceive and decide, but how specific social groupings of 'friends, foes and neutrals', the objects of any attempt to shape behavior or reactions, will do so. D S Alberts and R Hayes, *Power to the Edge*, CCRP, Washington, DC, 2003.

[6] These are the kinds of social factors that might have distinguished between a *Waffen SS* division and a *Volksturm* unit in World War II Germany.

relationships will continually change as the society adapts and reacts to its environment including our own actions.

The Action-Reaction Cycle

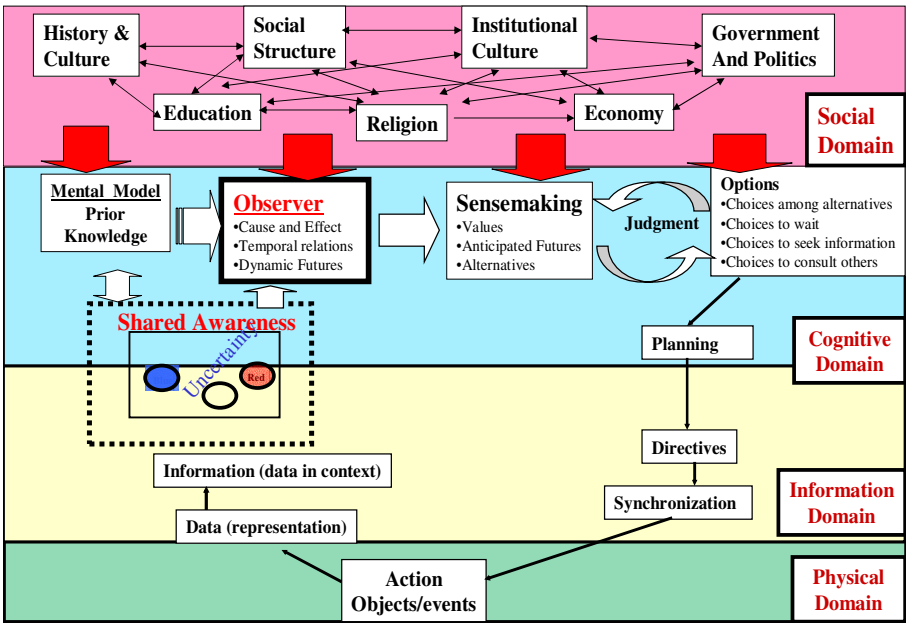

Figure 4

The two diagrams above suggest four general rules for effects-based operations:

- Actions will create effects on anyone who can see them and not just on the targeted opponent.
- These effects will be felt simultaneously on multiple levels – tactical, operational, military strategic, and geo-strategic – and in multiple arenas – diplomatic, political, economic, and military.
- All actions and effects are cumulative and interrelated.
- Effects are both physical and psychological in nature.

Because one action or effect cannot be isolated from another, effects-based operations are not only inherently 'joint' but also inherently 'national'.

Complexity

As the above underlines, effects-based operations are complex. The complexity is especially evident in two areas: the problems they address involve a large and changing array of interdependent variables, and the social and cognitive domains we intend to exploit are complex. But what do we mean by 'complex'?[7] A simple working understanding of these ideas can be derived from making a distinction between the words 'complicated' and 'complex.'

COMPLICATED

The engine in an automobile is complicated; yet pressing on the accelerator pedal dependably produces the same result -- the car moves. Moreover, this output is proportional to the input, the greater the pressure exerted on the pedal, the faster the car goes. This dependable repeatability and proportionality of inputs and outputs comes from the fact that the engine consists of a series of known and linear cause and effect chains. This linearity means that, if the car fails to perform as expected, an auto mechanic can work his way along that chain to determine which particular cause and effect is malfunctioning.

COMPLEX

If the engine in the car were complex rather than complicated, there would be no way to know exactly what might happen when the accelerator was pressed. We would not know what all of the interdependent variables involved were much less how they would interact; the chain of causes and effects that produced a particular reaction would be non-linear and probably never be the same twice; and the chain would change in ways that could not be known or predicted. In short, there would be no repeatability and no proportionality between inputs and outputs – and no auto mechanic who could fix it.

COMPLEX ADAPTIVE SYSTEMS

If the complex car engine were a 'complex adaptive system', this uncertainty would be taken another step. Not only would we be unable to define the cause and effect chains that made the engine react in particular ways, but the engine and its chains would change and adapt independently to any environment in which it found itself -- again in ways that we could not entirely

[7] The object here is not to explain these concepts or the mathematics involved, work that is already reflected in James Moffat's *Complexity Theory and Network Centric Warfare*. It is rather to provide a basic working understanding to enable the reader to use what James Rosenau called the 'intellectual tool' of complexity. J Moffat, *Complexity Theory and Network Centric Warfare*, CCRP, Washington, DC, 2003; J N Rosenau, 'Many Damned Things Simultaneously: Complexity Theory and World Affairs', in *Complexity Global Politics and National Security*, ed. Alberts and Czerwinski, National Defense University, Washington DC, 1997, pp. 78 and 82.

predict. In short, it would act like a living system and not a like a mechanical system, like a non-linear system and not a linear system, like a complex system and not just a complicated system. [8]

The human beings and human organizations that are the core of the security environment and the societal domain of the cognitive diagram are complex adaptive systems. By extension, peace, crisis, and war are interactions between complex adaptive systems in which outcomes are not fully predictable and not necessarily proportional to the amount of effort expended. Indeed, it is this latter potential for disproportionality of inputs and outputs that promises a non-linear pay-off for effects-based operations. And, it is this same disproportionality that lies at the heart of most successful operations by asymmetric competitors.

The action-reaction cycle points to five complex problem areas: 1) orchestrating actions to create the right perceptions; 2) deconflicting these actions across a multi-level, multi-arena set of actions; 3) defining the effects to be created or encouraged; 4) anticipating the chains of cause and effects that might be set in motion; and 5) ascertaining what effects are actually being created, that is, feedback.

ORCHESTRATING ACTIONS

The impact of actions is a function of what observers see. Effects-based planning, thus, must take into account both what action is and how it is executed: the kind of force or national power used; the scale of the effort; its geographic scope; the operational scope or the military and other power it demonstrates; its speed and duration and its synchronicity or how well was it coordinated with other actions so as to create a worst case for an opponent. For example, a stimulus involving 'boots on the ground' is likely to imply a far greater concern and commitment and thus have a far different impact from a relatively antiseptic missile strike much lass from a diplomatic note. Equally, demonstrating an ability to act in a given geographic or operational area, to act within a brief time, and to sustain that effort for some duration might set parameters for preventative deterrence. However, there is another consideration: which aspects of these actions are likely to be visible to the observer and how. In brief, there must be enough of an understanding of the observer's information domain and how information is collected and processed in that domain to estimate what that observer actually will see.

DECONFLICTION AND COORDINATION

The observer will see actions as part of an interrelated whole. Thus, actions in one area or arena can either multiply or negate the effect of actions in

[8] James Grier Miller offers a detailed explanation of the factors at play in and common to such systems from microbe to the international order. J G Miller, *Living Systems*, University of Colorado, Denver, CO, 1995.

other areas and, potentially, produce combinations of stimuli that can confuse or provoke the opposite reaction from that intended. Accordingly, actions need to be deconflicted in the manner of forces on a battlefield so as to avoid action-fratricide and to produce a unity of effects. Given that effects-based operations are national in dimension, this deconfliction problem can quickly assume enormous proportions. To make matters worse, the actions that interfere may include those unintended or unanticipated actions that are an inescapable part of interactions between complex adaptive systems.[9] While this deconfliction problem might suggest a need to minutely coordinate all aspects of military operations, the reality is quite the reverse. The nature of cross spectrum operations would indicate that a "one size" coordination solution does not 'fit all'. Instead, there is a need to balance coordination and self-synchronization, a balance that will shift during the course of an interaction. (Figure 5 below). The requirement for close coordination is likely to be least during normal peacetime operations but as peace turns into crisis, the need to coordinate the disparate elements of actions by military, diplomatic, political and economic actors mounts sharply and peaks just as major combat operations are about to be initiated.

At that point, complexity theory and military experience indicate the tight coordination must give way to a looser self-synchronization that permits forward actors 'on the edge' be empowered to adapt to the rapid changes of the battlefield. Then, as conflict moves to some form of politico-diplomatic solution, the need for close coordination of all the elements of national power resurges so as, first, to promote the solution and, then, to reinforce it. This coordination requirement, then gradually tails off until a normal peacetime profile is returns.

DESIRED EFFECTS

Because it is not possible to trace a cause and effect chain from a specific action to a specific response through complex cognitive and societal domains, it is also impossible to know exactly how the foe – or the ally or neutral – will react to a stimulus. This indicates a need to think in terms of the *kinds* of effects to be created and how these collectively might drive behaviour in one direction or another. The military effects, for example, might be divided into seven categories: destruction; physical attrition; chaos or a creating such confusion that a deliberate response is rendered impossible; passive foreclosure or the presence of a capability so potent as to discourage any challenge; active foreclosure or the demonstration of such capability as to force a re-evaluation of a challenge in progress; shock or a total collapse of any hope of creating a successful outcome, e.g. France May

[9] This is where the US Marine Corps' concern with the actions of the 'strategic corporal' is relevant. It is not that commanders want the corporal to make strategic decisions, but that some corporals will find themselves in situations where they will be forced to make split-second decisions that will have strategic effects.

1940; and psychological attrition or the gradual erosion of such hope, e.g. United States 1968-1975. These kinds of effects are not mutually exclusive are felt an overall effect including some elements of each category. And, the same single action will affect different observers in different ways and therefore, vary from one level of interaction to the next and over time.

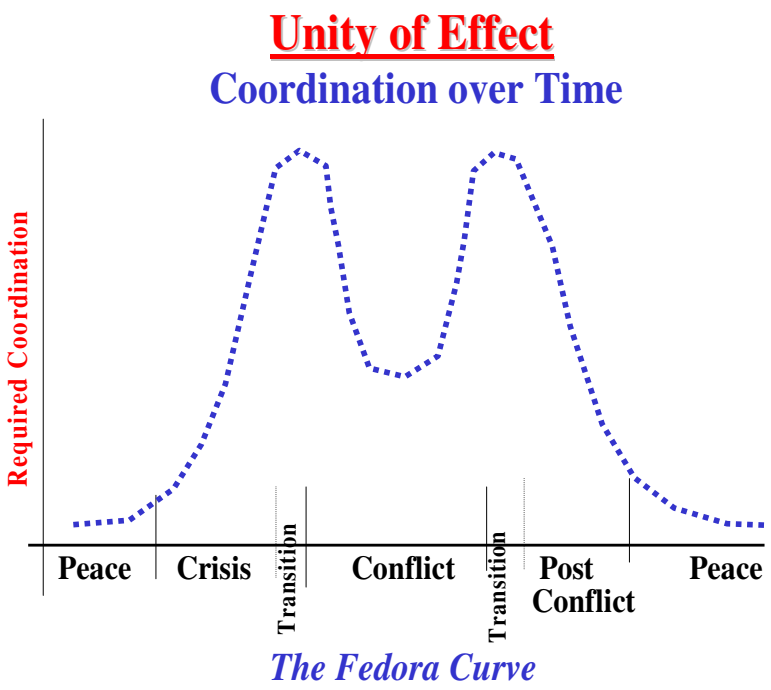

Figure 5

EFFECTS CASCADES

Each effect will also to set off a cascading chain of additional physical and psychological effects. However, given the complex nature of both the interaction and the friends, foes, and neutrals affected, the scope and speed of the cascade cannot be entirely predicted (see Figure 6). Moreover, the cascades of physical and psychological effects will propagate very differently with physical cascades resembling chain of falling dominoes whose full scope and dimensions may not be known but short sections of which can be predicted but with psychological effects resembling the chain reaction that is set off when a single ping-pong ball is tossed onto a table covered with mouse-traps upon which other ping-pong balls are balanced – an almost explosive reaction whose direction and end-state cannot be predicted. Even

more, this psychological cascade can be set off by either the initial direct physical effect or by any of the succeeding cascade of physical effects or by any of the psychological effects.

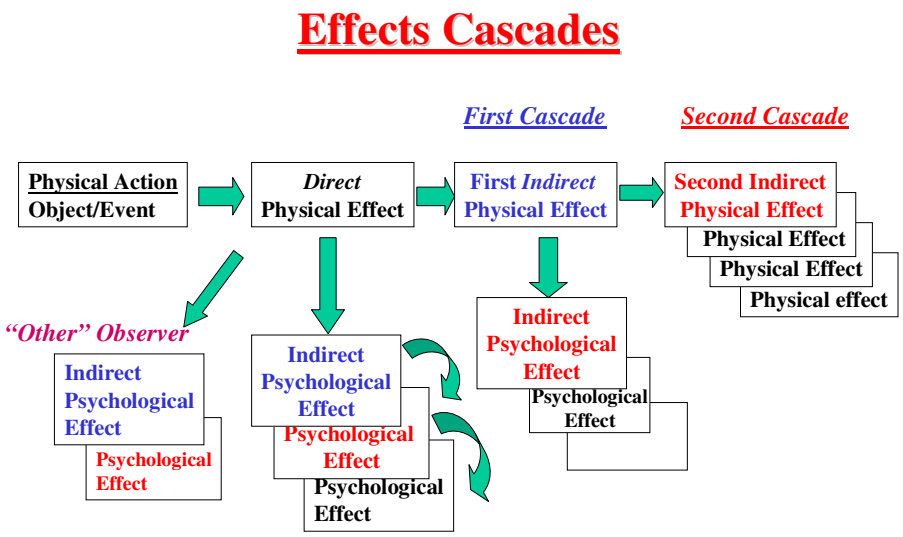

Figure 6

FEEDBACK

An on-going continuum of actions and operations and of interactions between complex adaptive systems implies that no action however well conceived will ever be definitive. The opponent will always react in some way at some interval and will usually endeavour to surprise. Accordingly, effects-based operations will succeed to the degree that they are able to adapt. This means feedback to commanders is essential. However, because the reactions of observers are neither entirely predictable nor entirely quantifiable, the feedback is likely to complex. This feedback is likely to take at least three forms: 1) an assessment as to whether the action executed was 'seen' in some way; 2) an assessment as to any changes in the observer's immediate behaviour; and 3) an assessment of changes in the actors' overall behaviour across multiple levels. The first might include traditional measures like bomb damage assessment, but would serve simply to determine whether the intended direct effect was achieved. The assessment of reactions would focus on identifying even slight deviations from behavioural norms using a sort of *index of improbability*, i.e. how often

an action or combination of actions has been seen before and under what circumstances. The third and probably least quantifiable assessment would reflect both the cascades of effects and any changes in decision-making at all levels drawing upon and fusing both open sources and classified sources. No single report is likely to be definitive. Instead, the feedback will of necessity be more in the nature of indicators, that is, pieces of information that are individually inconclusive but acquire real value when put together with what may be hundreds of other indicators in a specific context or algorithm.[10]

The dissection of the complexities of operating in the cognitive domain above represents a way to deal with the complexities of the military operational problem in a variety of ways: reducing the problem to a set of 'knowables', pruning the complexities to the point that they become manageable, and bounding the problem. None of these approaches is new and each can be traced through historical data bases of how these problems have been handled in the past reflecting the fact that the need to deal with complexity is not new any more than effects-based operations themselves are new.

Network Enabled Effects-Based Operations

A 'real' world of ad hoc, unpredictable, and complex challenges from asymmetric competitors leaves us little choice but to pursue effects-based operations. The real question is how to improve upon what might be termed 'classic' effects-based operations whose success depended heavily on gifted leaders. This is where networking and the technologies of the Information Age might be brought to bear in the planning, execution, feedback, and assessment of effects-based operations. The complex, human centric nature of effects-based operations makes true precision unattainable, but networking can make three contributions: an expanded range of options, the ability to mobilize knowledge wherever it may reside, and agility.

OPTIONS

The paradigm for operations in a world of ad hoc challenges is the saga of the Apollo 13, broken, alone, and unreachable in the depths of space. Any solution to the space ship's problems had to come from those capabilities

[10] Although this is akin to the Operational Net Assessment process originated by the US Joint Forces Command, it is also akin to what good intelligence analysis from the tactical to the strategic has always done. The history of how commanders have dealt with complex problems and feedback in the past in turn suggests that, in the heat of battle or a rapidly evolving situation, the feedback and assessment process may be conducted in the heads of tactical and operational commanders and their staffs if any. The better prepared the heads, the better the results are likely to be.

already available on board and the challenge was to find a combination of capabilities – some never intended to work together – to repair the ship and bring the astronauts home. Challenges from complex adversaries are much the same. There will be little advance warning of the exact threat, and there will be a need to create viable options from the capabilities at hand.

The effects-based approach expands the 'tool kit' of available capabilities into a national response that can tap the full power of a state. The law of requisite variety says that the greater the number of possible responses a system has, the greater its chances of survival.[11] Since the number of possible combinations of capabilities or potential responses grows geometrically as new capabilities are added, taking a 'whole of nation' approach dramatically increases the size of the tool kit. But, this expansion is only possible if the capabilities can be networked together. This means more than communications infrastructure. It means human interaction and, hence, social as well as communications networking.

We can think of these networked capabilities as defining a *decision-space*, that is, the range of all possible responses available to a decision-maker from which to fashion a course of action. Because our 'observer' will see the totality of what is done – political, diplomatic, and economic as well as military, and because networking lets decision-makers put the various attributes of these national capabilities together in different ways and, thus, to make them more than individually additive, it is possible to look at a decision space defined by the aggregate of all of the attributes of all the capabilities taken together, that is, an overall scale – the how much?; an overall scope – the 'how?', the 'where?', and the 'with what?"; and the timing -- the 'how fast' and the 'for how long'. (Figure 7).

In networked effects-based operations, a national response can be treated as a whole, the sum of the military, political, diplomatic, and economic actions that might be taken -– apples and oranges together – as they would be seen by friends, foes and neutrals to include the speed at which they might be executed and how long a given combination of actions might be sustained. To the degree that these various elements can be networked so as to multiply the possible combinations, the resulting decision space might resemble the below. (Figure 8).

[11] W R Ashby, *An Introduction to Cybernetics*, Chapman and Hall, London, 1957.

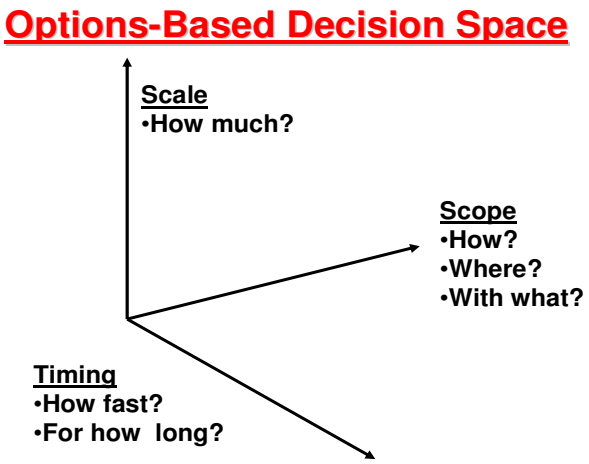

Figure 7

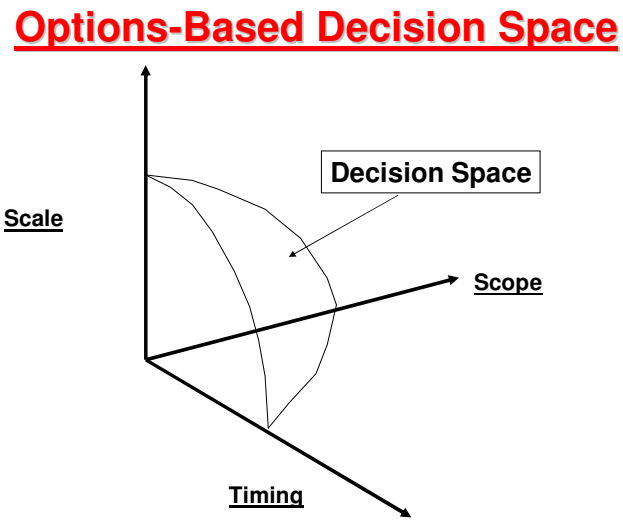

Figure 8

This options-based decision space generated by the capabilities and the ability to network them would comprise the tool kit available in a national Apollo 13 capsule. Where an ad hoc challenge (Threat #1) could be handled

within the scale, scope, and timing of available options, e.g. how fast could a military force of a given scale and capability be moved to an area and then sustained, the tool kit might be judged adequate. (Figure 9). When the challenge (Threat #2) requires a response that is too fast, too big, too long, or too different for the tool kit, then reassessment and rebalancing would be in order.

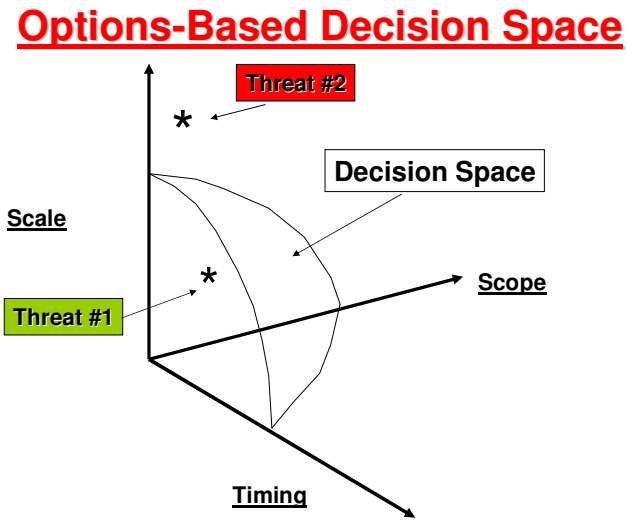

Figure 9

We could similarly identify the likely decision space of a would-be foe and any potential challenges for which there might be no viable response and might them address what measures might be taken to redress the situation. (Figure 10)

KNOWLEDGE MOBILIZATION

It is one thing to have options and quite another to pick the right ones. Much has been made of the ability of networks to get the right information to the right decision-maker at the right time to make the right choice whether in planning an operation or in a succession of rapid action-reaction cycles. However, what happens in the case of an ad hoc challenge whose entire purpose is surprise, and what happens in a contest with a complex adaptive adversary whose actions and logic are by definition neither fully apparent nor entirely predictable? Network centric operations must supply the wherewithal for making the right choices, but for the planning, execution, and feedback evaluation in effects-based operations, information and data alone are not enough; it is knowledge that is critical. This knowledge, moreover, is not

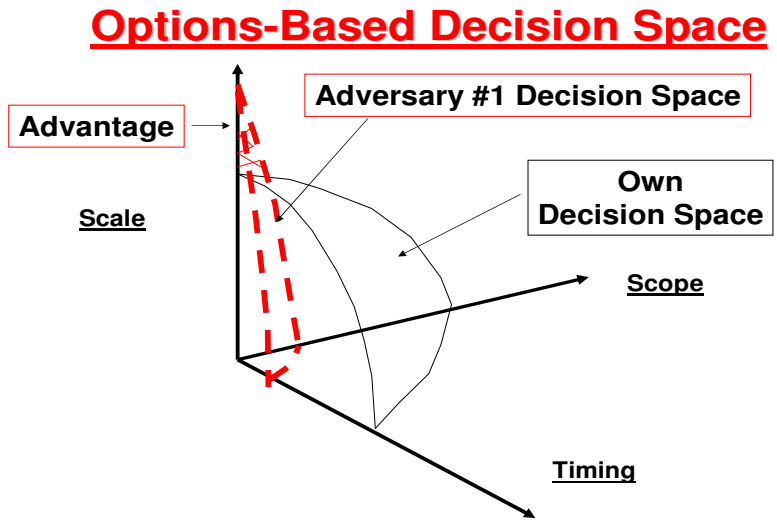

Figure 10

simply an aggregation or collation of data and information but an internalized working understanding of a complex problem of which the sensor-derived data is but one part. Similarly, the ideas of complex adaptive opponents and the ad hoc nature of likely challenges – as well as the experience of operations from Grenada to Iraq – suggest that almost any existing 'data base' will not contain all of the data or knowledge needed. Therefore, the challenge will not be one of managing data and information, but of somehow mobilizing that knowledge from across a government, a nation, or a coalition to answer commander's needs, a challenge that is much that of organization and thinking as of technology.

It is in knowledge mobilization that effects-based operations pose the greatest challenges for network centric thinking: fusing very different kinds of information and knowledge; and dealing with some very different kinds of interfaces.

- Knowledge Fusion. Creating knowledge and understanding to support effects-based operations requires the fusion of three different kinds of information inputs: the sensor-derived electronic or mechanical information, human derived reporting, and expertise. Of these, the sensor derived data are relatively clean cut and amenable to present data and information networks. However, the human derived

information[12] so necessary to operations in Iraq and elsewhere has a very different character. By nature, it is at once subjective, ambiguous, and uncertain and usually can be validated only by putting it into some context whether that of the subject and situation or that of the experience, knowledge, and past reporting by the same source, all of which require some form of human evaluation. Expertise again has a distinctly different character that derives from an individual's mastery of some complex subject, a mastery that often seems almost intuitive but is very likely based on an internalization of a large variety of complex factors. Although there is a tendency to think of such mastery in terms of subject matter experts, there is an equally pertinent expertise exercised by those in the field who are closest to an evolving situation and have the best 'feel' for the situation. Understanding the societal domain, for example, would require expertise.

- Interfaces. Fusion is more than linking dissimilar information sources. It is equally about the interfaces that enable the fusion a complex array of information to occur.[13] Successful fusion involves three such interfaces: machine-machine, man-machine, and man-man – the 3M2. The machine-machine interface has been the staple of most discussion of network centric operations and despite the challenges involved is the easiest of the three. The man-machine interface is a greater challenge but has been the focus of effort and experimentation both military, notably at the US Joint Force Command, and civilian, notably in industry efforts in ergonomics. However, the interface, between one man and another, poses the biggest problem because it involves the communication of different perspectives of a complex subject from an expert in one field, e.g. the forward commander, to one in what could be a very different field, e.g. the regional expert or a worker in a non-governmental agency, when there is no common short hand.[14] Networks can provide the connections that permit experts to talk, but the organization, training, and social networking are the keys to making the interface work. Indeed, it is the human requirements that will dictate the form that any network takes.

[12] The author uses the term human-derived information to encompass all that information, e.g. press reporting, that would not normally fall under the better known heading 'human intelligence'.

[13] The author is here drawing upon the experience of 30 years in Naval Intelligence including tours of duty in the Navy's Ocean Surveillance Information System and as the deputy director for intelligence in the Office of Naval Intelligence.

[14] Notice that this does not assume that the forward commander needs to be a regional specialist, especially since adequate training in a regional specialty to make the commander the 'expert' would likely come at the expense of his mastery of combat or other military operations and likely not be exportable to a different region. The requirement is rather for sufficient familiarity with the region or subject area to appreciate and take action upon what the expert can provide.

The above suggests a requirement for an effects-based situational awareness for individuals, commands, and governments that include complex knowledge and expertise as well as data and information and a flexible networking both social and physical to form and sustain that awareness.

AGILITY

In the Apollo 13 example, it was not enough to know which capabilities were aboard the space ship; NASA scientists and engineers had to figure out ways to use those capabilities differently and the astronauts had to carry out their suggestions, all against a short and potentially tragic time line. The same is true of translating options into actions. The whole idea of a contest between complex adaptive systems is that each side will adapt to the actions of the other in new and unpredictable ways and that this interaction and change is not a one time engagement but an on-going process that continues until one or the other runs out of options or will.[15] In such a face-off, having a wide range of options from which to fashion actions and being able to mobilize the knowledge needed to make the best choices must be accompanied by a third element: agility.

In Power to the Edge, Alberts and Hayes point to six 'dimensions of agility': robustness, the ability to maintain effectiveness across an range of tasks, situations and conditions; resilience, the ability to adjust to perturbations; responsiveness, the ability to react to change in a timely manner; flexibility, the ability both to use multiple ways to succeed and to move smoothly between them; innovation, the ability to do new things or to do old things in new ways; and adaptation, the ability to change processes and organization.[16] Applied to interactions between complex adaptive systems that are at the centre of effects-based operations, this concept of agility takes added meaning. Agility in this context is all of the six dimensions embodied in an ability to create options that deal with the unexpected and then to adapt the options chosen and actions undertaken continually as a multifaceted interaction unfolds. It is the ability to adapt to a rapidly changing situation very much the same manner as other complex adaptive systems with the added impetus of a Darwinian caution that those systems that do not adapt well enough or fast enough are doomed to extinction.

All three of the network centric contributions come together in this process of adaptation and survival. (Figure 11). The tool kit of options knitted together and enabled by networking, provide a range of options, the decision space

[15] Alan Beyerchen points out that Clausewitz uses the example of two wrestlers to describe a complex interaction the course of which neither wrestler can know in advance but which is instead shaped by the response of each to the other as the match evolves. A Beyerchen, 'Clausewitz, Nonlinearity, and the Unpredictability of War', *International Security*, vol. 17, no. 3, Winter 1992, pp. 63ff.

[16] Alberts and Hayes, pp. 128 ff.

encompassing all the actions that might potentially be taken. The knowledge comprises both a situational awareness sufficient to support effects-based operations and a continuing of sensor and human derived information and expertise that enables the informed choices that increase the probability of success. The agility provides the speed, flexibility, responsiveness, robustness, innovation, and resilience that permit a course or multiple courses of action to be altered to deal with new permutations of the threat.

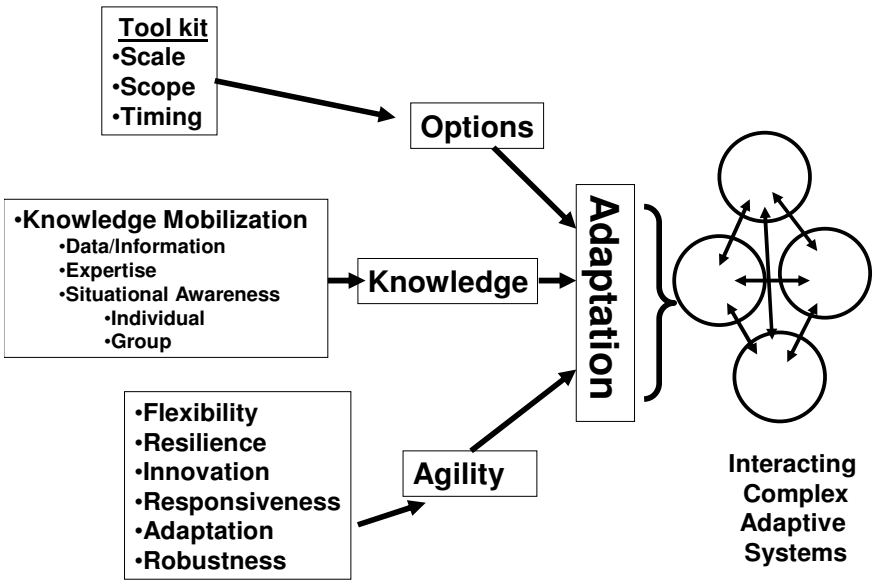

Figure 11

Conclusion: Effects-Based operations and Second Generation Network Centric Operations

Effects-based operations are not new, but they do represent a way of thinking about competition and conflict that differs from the attrition-based focus with which warfighters, operational research analysts, and acquisition personnel are most familiar. More to the point, effects-based operations are peculiarly suited to the kinds of military operations mandated by the post Cold War/ post 9-11 security environment. Because they are human-centric, they offer a way of confronting the complexity inherent in a struggle minds and a way of dealing with challenges that know no border between peace and war or between the political, diplomatic, military or economic. However, this inherent complexity and the requirement to operate in the cognitive

domain point to the need to rely more on one complex adaptive system – man – to deal with other complex adaptive systems – men, states, and non-state actors.[17]

In many respects, the turn toward a more human centric view of military operations mandates a change in how we have tended to view network centric operations. Whereas most discussion of network centric and Information Age operations over the past five to ten years has centred on targeting and on removing man from the loop so as to speed up a time critical strike targeting process, complexity and effects-based operations demand that the networking address the role of man *in* the loop and the role of the network in supporting him. This role can no longer be defined simply in terms of supplying machineable data and information from sensor to shooter but now must extend to creating understanding and providing commanders at all levels with complex knowledge the ambiguities and uncertainties of which can no longer be evaded.

This challenge suggests that we are the cusp of a new, second generation of network centric operations focused on the human side of networking and how to give decision-makers at all levels and arenas the information and knowledge needed to make informed choices in a complex environment. The need is immediate. Like it or not, effects-based operations are a part of day-to-day operations in Iraq, Afghanistan and elsewhere. The challenge, therefore, is not to find perfect models, links, or decision aids or to conduct perfect effects-based operations. In a world of competing complex adaptive systems, true perfection and precision are unattainable. Rather, the challenge is to conduct effects-based operations better and better as the concepts and technologies mature and our experience expands. The result will be second generation network centric operations concepts and technologies that are shaped by and in turn shape the effects-based operations to which they must be applied.

Dr. Edward A. Smith, Jr. Captain U.S.N. (Ret), is the author of Effects-Based Operations: Applying Network Centric Warfare in Peace, Crisis, and War *published by US DoD Cooperative C4ISR Research Project (CCRP) in 2003 and of a new book,* Complexity, Networking, and Effects-Based Operations*, to be published shortly by the CCRP. During a 30-year Navy career, he served in Vietnam and on the staff of the Battle Force US Sixth Fleet during the Achille Lauro and Libyan contingencies in 1986 and 1987. He also served in the Defense Intelligence Agency, on the staff of the Commander-in-Chief, Atlantic Command and Supreme Allied Commander Atlantic, in the Office of Naval Intelligence, and on the personal staff of the Chief of Naval Operations. Upon his retirement from the Navy he joined the Boeing Company's Studies & Analysis think tank as Executive Strategist.* edward.a.smith-jr@boeing.com.

[17] Paul Davis has pointed to the inability of existing operations research models to deal with complex adaptive systems and described the challenge of supporting effects-based operations as the 'grand challenge' of the operations research community, one that will require 'changes of mindset, new theories and methods, and a new empirical base'. P K Davis, *Effects-Based Operations: A Grand Challenge for the Analytical Community*, Rand, Santa Monica, 2001, p. 79.