Complexity, Networking, and Effects-Based Operations:

Approaching the "how to" of EBO

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The central tenet of effects-based operations is that we can somehow purposefully[1] shape the interactions of players in our security environment so as to produce both individual and overall behavior that meets our needs. To do this, effects-based operations must be able to deal with complexity. The definition of effects-based operations as "coordinated sets of actions directed at shaping the behavior of friend, foe and neutral in peace, crisis, and war" underlines this complexity. It does not speak simply of "an action" creating "an effect" in a straightforward, if-this-then-that, cause and effect relationship, but of "coordinated *sets of actions*," that is, the use of multiple interdependent actions. And, it does not look to a single sharply defined effect as the outcome but rather to the actions "shaping" a "behavior" end-state. This is to say it sees both a process and an end-state that are neither precise nor solely the product of the actions we ourselves take. Even more, it does not limit this behavioral outcome to the foe's reactions, but sees "coordinated sets of actions" creating diverse arrays of effects on many different levels of many different actors in many different arenas. And, it underlines a requirement for a single set of actions to be able to create opposite effects on foes, friends, neutrals, and the domestic public.

This complexity is reflected in the basic rule set for effects-based operations:

- That actions have an effect on anyone who can observe them either directly or indirectly;
- That effects have both physical and psychological dimensions;
- That they occur simultaneously on tactical, operational, military strategic, and geo-strategic levels of interaction and in multiple political, diplomatic, military, and economic arenas; and
- That all these effects are interrelated and cumulative.

In short, complexity is intrinsic to effects-based operations and success hinges on mastering it.

The complexity of effects-based operations derives from the same point that is their greatest strength: that they are about the human dimension of conflict. They are, in essence, about stimulus and response interactions in which the stimulus takes the form of "actions" and the response that of "effects" and, ultimately, "behavior." Complexity theory and the "living systems" model lend considerable depth to this simple construct.

- Complexity theory tells us that the link between actions and behavior is complex because it involves many interdependent variables in interactions between multiple complex adaptive systems that are themselves continually evolving. Thus, a given action can produce a seemingly infinite variety of effects each of which can set off cascades of additional effects that will never be exactly the same. Still, there are some concepts that provide ways of dealing

[1] The word *purposefully* is used here to denote the fact that all of our actions be they specifically directed toward this end or not will tend to shape the behavior of the other complex adaptive systems both in the

with this uncertainty. Aggregation, bounding, building blocks, tagging and internal models provide ways of understanding how complex systems operate. The idea of "complexity by contamination" offers that, although a single complex step in a process, e.g. human intervention, suffices to make the whole process complex, not every step in the process need be complex -- raising a prospect of dissecting complex systems to identify what is complex and what is not, and of using linear analysis and modeling of the letter to bound the complex estimates and judgments that must be made.

- Living systems theory offers a framework for applying these tools by putting complex adaptive systems into an interlocking model in which each complex adaptive actor exists in the context of a series of ever more complex systems from which no individual system or interaction can be extracted without changing both its character and that of the system as a whole.[2] In this model as in the effects-based rule set, no interaction can be entirely isolated; each is part of a continuing, never-ending succession in which systems evolve and change; and each affects all future cycles in some way. The model also identifies sets of "essential processes" that are the product of millennia of trial and error evolution and that are, thus, are common to all living systems. (See Figure 1 below.)

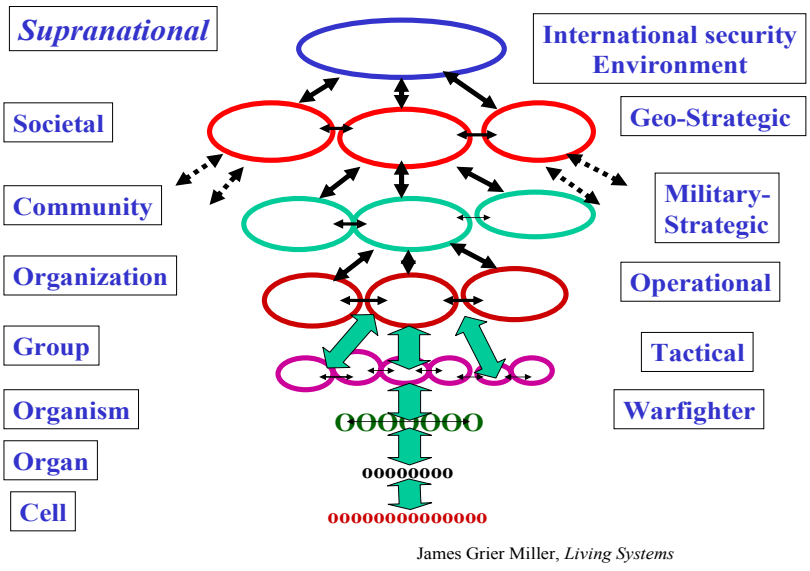

Figure 1

This suggests that: interactions between complex adaptive systems are not infinitely varied and can be bounded; that the basic functions of the effects-based action-reaction cycle can be extrapolated to multiple levels of the system of complex adaptive systems; and that we can identify

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immediate interaction and in the context of a larger, on-going history of interactions. A lack of action may also be purposeful and will similarly affect an on-going interaction.

subsystems of actors, functions, and processes in each part of the system and extrapolate them to other parts of that system as well as to other systems.

The Action-Reaction Cycle[3]

As defined, effects-based operations focus on the human dimension of the living system model: human beings themselves, and five successively more complex sets of human institutions -- groups, organizations, communities, societies, and an international "system." In the model, man is at the cusp, the product of long biological evolution and the creator of a sometimes tumultuous social evolution that spawned the human institutions. This fact is central to the "how to" of effects-based operations because:

- First, it underlines that the actions, effects, and behavioral end-states of effects-based operations are all, directly or indirectly, products of cognitive processes in which "human beings react to stimuli, come to an understanding of a situation, and decide on a response."[4]
- Second, it infers that these cognitive processes are both the "hard wired" product of hundreds of millennia of biological evolution, i.e., "nature," and the product of social evolution and human interactions such as education and experience, i.e. "nurture."
- And, third, it argues that the human institutions with which effects-based operations must contend are product of social evolution to the point that they will not reflect all possible responses but rather a limited if still changing set of responses that has worked in the past.[5]

These three distinctions are reflected in the action-reaction cycle at the heart of effects-based operations. (See Figure 2 below.) The stimulus is a physical action of some sort – anything from enemy fire, to a diplomatic note, to the initiation of a software program. For this action to stimulate or set off a cycle, however, it must enter the cognitive process through the eyes and ears of an observer/decision-maker or group of decision-makers who contextualize it in terms both of similar past actions and of their own mental models, attempt to make sense of it, and apply this understanding to judging their options for response. The chosen course of action then becomes both the behavioral end-state of the cycle and a return stimulus that sets a new cycle in motion, this time with the other side reacting. However, there is something missing. This cycle describes

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[2] James Grier Miller, *Living Systems*, University of Colorado, Denver, 1995pp. 854ff.
[3] The cycle was originally developed to assess how the shared awareness developed be networking was applied in decision-making. See *Report of the Workshop on Sense-making, 6-8 March 2001*, DODCCRP, Tysons Corner, Va., 2001.
[4] Smith, *Effects-Based Operations, Applying Network Centric Warfare in Peace Crisis and War,* p. xv.
[5] Complexity theorists would point out that the successful institutions exist in a precarious equilibrium between order and stagnation on the one hand and chaos and disintegration on the other, and that in this equilibrium, relatively small changes in initial conditions can bring large scale change – or collapse.

The Action-Reaction Cycle

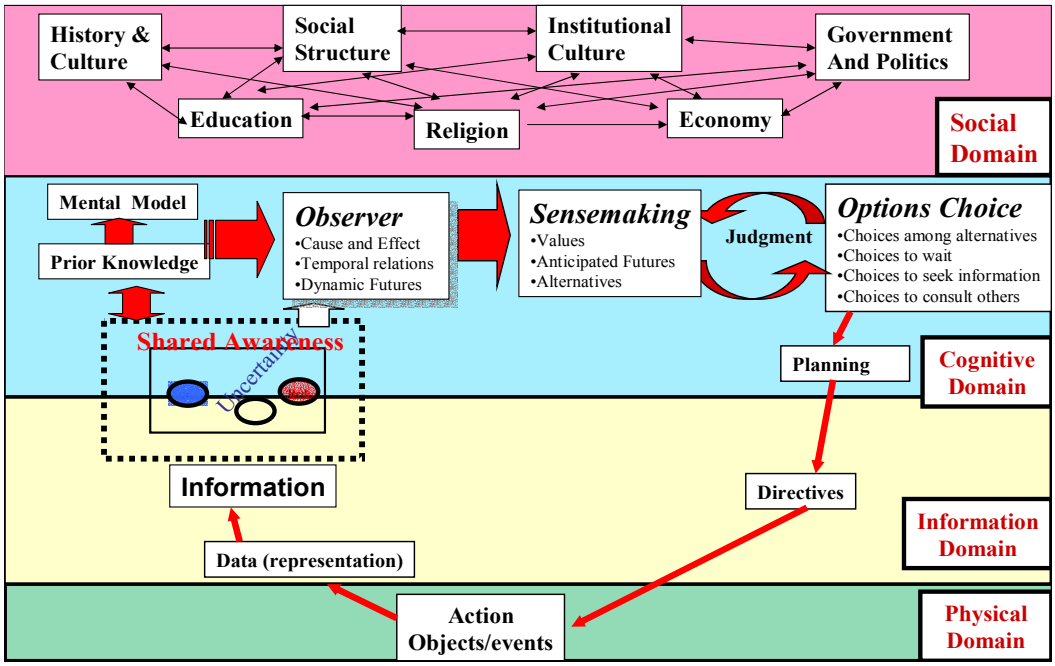

Figure 2

how humans and human organizations *in general* decide and act, a "rational" man logical framework that, given the nearly infinite of interdependent variables involved, will never fully apply to the situation at hand. For effects-based operations, we need to know not only how actors are the same but also how individuals and groups might *differ* either from one another or from a general model. To do this, we must add a social domain[6] that encompasses not only the primordial factors that govern how human beings relate with each other in social groupings but also all of the idiosyncratic variables that might influence how particular observers or groups of decision-makers might react *differently* in perceiving, understanding, making sense of a situation and viewing their options. This distinction is critical in deciding which actions, seen how, might shape behavior in a specific way. Moreover, in effects-based operations, this differential is to be applied not just to the foe, but also to friends, neutrals, and even one's own public. Under these circumstances – as demonstrated every day in operations in both Iraq and Afghanistan, it is not sufficient to define a social domain in terms of knowing how groups or society in general behave; the domain must also reflect all of the factors that make them different. In brief, it must have a "nurture" antipode to the "nature" of social and cognitive modeling.

[6] David S. Alberts and Richard Hayes, *Power to the Edge*, CCRP: Washington, D.C., 2003. p. 113.

The action-reaction cycle described above can be seen at all levels of the complex living systems "tree." At its most basic warfighter level, the cycle might be seen in an infantryman's "kill or be killed" encounter with a sniper: an action, shooting at a sniper, results in a direct effect, killing the sniper, which results in an indirect effect, panic among the other insurgents in the building, and a behavioral end-state, withdrawal of the insurgents from the building. This encounter is in turn integrated with other individual warfighter interactions and end-states in a tactical level cycle to form an action that produces a tactical direct effect, driving the insurgents from the neighborhood, and a cascade of indirect effects for the inhabitants' sense of security, and a tactical end-state in the pacification of the neighborhood. At the operational level, these tactical end-states might translate into pacification of an area with indirect effects, such as enabling reconstruction to proceed and the restoration of confidence in the local population contributing to a stabilization end-state. At the military strategic level of the theater commander or joint staff, such operational end-states on multiple different fronts might then translate into an end state defined in terms of progress in a global war on terror, while at the geo-strategic level of the national leadership, that progress might become progress toward an end state of free societies that are no longer a recruiting ground for terrorists. Thus, although one basic cycle applies at each successively more complex level of the "tree," the actions, direct and indirect effects and end-states differ.

These differences are also instructive. First, the cycles proceed at a different pace at each level as actors attempt to adapt to interactions at that level. The most rapid pace is at the level of the warfighter engaged in a firefight that may only last a minute, at the tactical level interactions may last hours, at the operational level perhaps days or weeks, and so on. Second, end-states exist both in the short term – at the end of an individual cycle and in a longer term at the end of some series of cycles, e.g. the tactical situation at the end of a day. Third, these end-states however imperfectly known are essentially additive, as might be expected in the a "tree" of successively more complex aggregations, with the rolling end-state at each level reflecting the sum of all subordinate end-states both positive and negative.

Dissecting the Action Reaction Cycle

Because the action-reaction cycle involves both a complex cognitive domain decision-making process and complex social influences, the cycle and its behavioral output will inevitably be complex. However, the notion of complexity by contamination suggests that we can dissect the cycle: to identify its component "essential processes"; to "drill down" to identify sub-processes at successive levels of each; and to separate those elements subject to conventional analysis. The object in this functional decomposition is not to produce a definitive, quantifiable

answer – it cannot in a complex system -- but to describe a range of possible outcomes by identifying the processes involved, by drilling down to ascertain precisely where and how a function is complex, and by using any analyzable aspects to bound the problem at each level. The processes and sub-systems, hence, become tentative internal models and building blocks in an on-going iterative process of refining and updating the results of which serve to bound a complex answer to a complex problem. In fact we can identify five such interconnected processes in the action-reaction cycle: 1. awareness creation, 2. sensemaking, 3. decision-making, 4. execution, and 5. social influences.

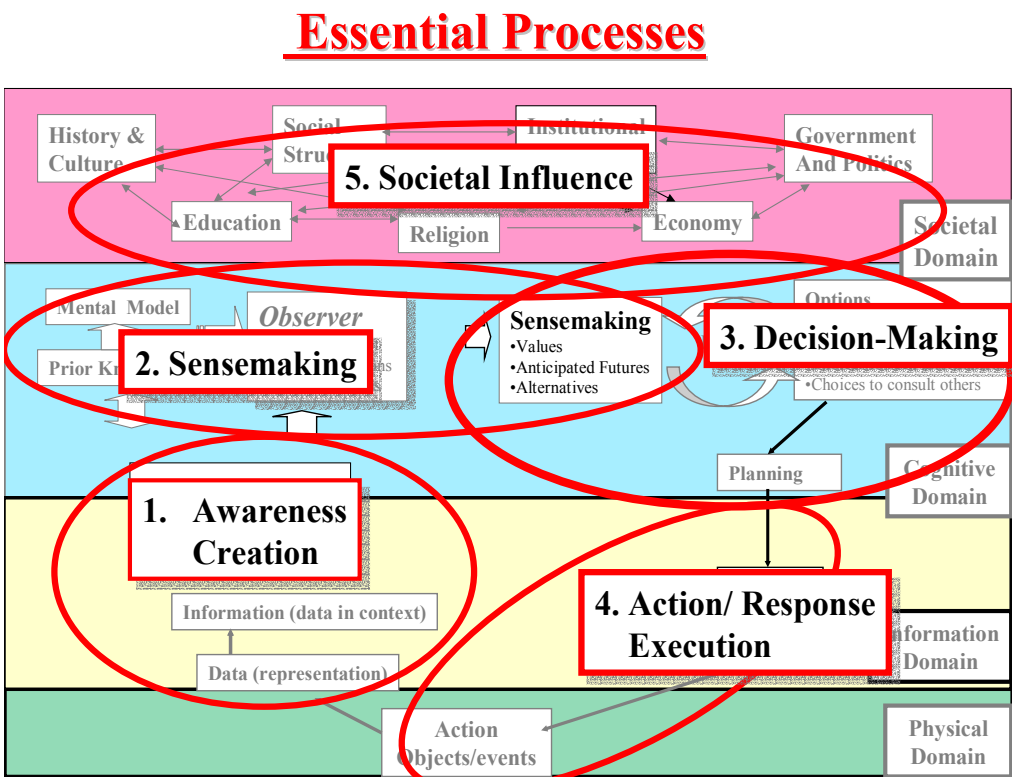

Figure 3

1. Awareness Creation

Awareness creation revolves about identifying the nature of a stimulus and processing the applicable data and information. This process can be broken into three sub-processes – tasking, collection and fusion.

Tasking. Because no information collection process no matter how large or sophisticated will offer a capacity for collection that is infinite either in numbers or variety, there must be some tasking sub-process to apportion the efforts of available assets.[7] The process is complex because

[7] This "tasking," thus, is as much a part of an al Qaeda effort to case a target like the World Trade Towers before an attack as it is of a major state's intelligence agency.

the required awareness will not be simply of one action but of many diverse actions competing for decision-maker attention and not for a single decision maker on a single level but for multiple decision-makers on multiple levels each of whom will have idiosyncratic functional and personal wants that demand complex and changing trade-offs. The distinctions suggest a further drill down to two component sub-processes: a roughly linear process for assessing available collection capabilities, and another nonlinear sub-process that prioritizes the tasking of available collectors so as to optimize their responsiveness to individual decision-maker needs. (See Figure 4 below.)

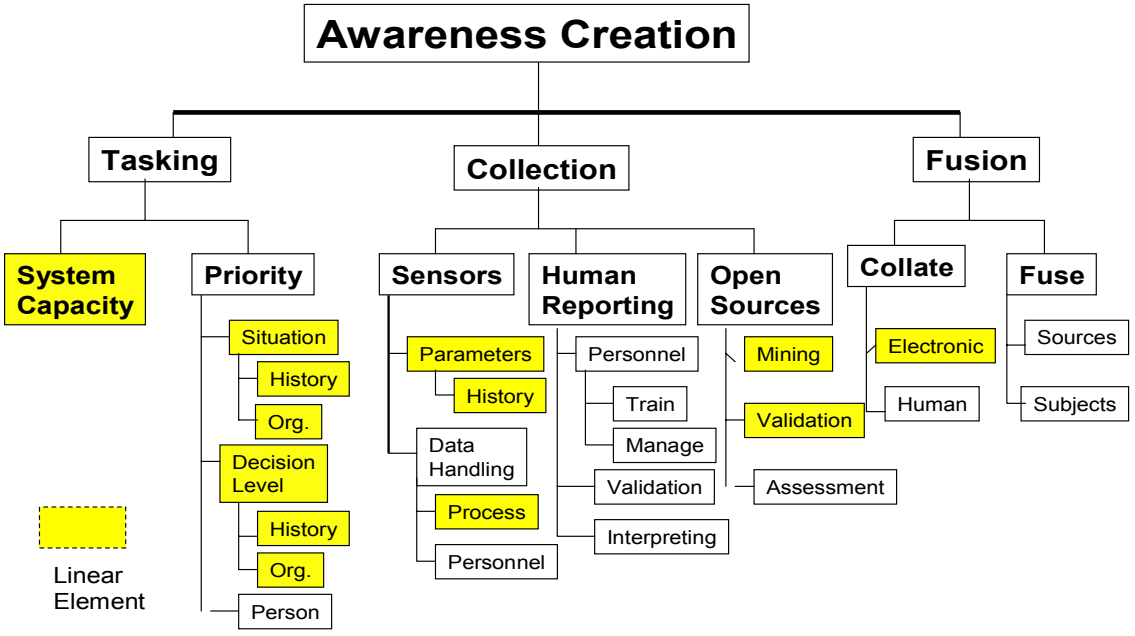

Figure 4

The *collection capacity assessment* determines where, what kind, and how much information can be collected and provides a linear index of how much prioritizing and trade-off may be necessary in the tasking process. The *prioritization* process reflects what decision-makers find most urgent, requirements that will vary from one situation to the next, one decision-maker to the next, and one level of command to the next[8] and will involve three types of interdependent variables generated by the situation, by the level or function of the decision-maker to be supported, and by specific persons. These variables suggest three further drill-downs: to one sub-process that remembers how certain types of situation in a given area have been surveiled in the past and,

[8] Logically, the greater the capacity of the collection system, the less pressure there should be to prioritize the tasking. Yet, experience teaches that the demand for information expands with capacity and that prioritized tasking is unavoidable however great or small the system may be.

thus, provides potential collection analogies; another related to the function of decision-maker(s) to be served and their requirements; [9] and third revolving about the idiosyncrasies of individual decision-makers. The "situation" and the functional aspects then might be further analyzed based on what is known of their organization or of historical patterns of responses.[10] If we likewise know the collection assets available, we can use the two sets of linear assessments to narrow the probable surveillance reaction to a fairly limited range of the most probable tasking actions.

Collection. Although the size and nature of collection systems vary greatly, we can discern thee basic types of input: sensors, human reporting, and media/ open sources. Each presents a different problem, but each is likely to have evolved processes to handle its own peculiar challenges.

- *Sensor-derived data* provide the most linear input. The value of each sensor is a function of: what the sensor can collect, i.e. its technical parameters and the speed, efficiency, accuracy, and kinds of information it can collect – relatively linear information subject to pattern analysis and modeling; and how well the raw data can be handled and melded with raw data from other sensors, something that is partially a function of organization and partially of the people assessing any conflicting data both potentially subject to historical pattern analysis.
- *Human reporting* – everything from local informants, to clandestine agents, to the regular reporting of government agencies, is complex on three fronts: reporting is often on complex questions, e.g. the perceptions and intentions, that demand equally complex insights on the part of the source; its value, hence, varies with the knowledgeability and reliability of the source; and it can take many and often mutually unintelligible forms, e.g. from other government agencies, non-government agencies, or contending parties in a conflict. These suggest additional sub-processes: for conducting the actual collection perhaps -- with additional sub-sub-processes for recruitment and training; for assessing the worth of the sources; and for exchanging, vetting, and interpreting information across institutional boundaries. This is to say that much of the utility of human reporting will hinge on human vetting and assessment and that it will remain complex.
- *Open source reporting* [11] offers any actor state or non-state access to a range, scope, and immediacy of information that would hithertofore only have been possible with the largest of in-

[9] For example, the nature of the awareness requirements of a fleet commander differ from those of a tactical commander searching for insurgents, or a terrorist casing requirements for planning a terrorist attack

[10] For example, if we know how the tasking process handled similar situations in the past, or how it supported different levels of decision-makers, or how it responded to the demands of a specific decision-maker, we can estimate how it will prioritize collection against a current stimulus.

[11] Open sources will be considered here to encompass the reporting and knowledge base that cannot be directly tasked by the collection system and is available to anyone, including media reporting and all published material electronic or otherwise.

telligence systems. But, open sources pose the same problems as human reporting and more: the overwhelming volume of open source material, their indiscriminate availability, the biases of those reporting, and the likelihood of misinformation and disinformation.[12] These challenges point to at least four additional sub-processes: one to mine the large volumes of data and information for relevant reporting; another to assess its validity; a third to assess what other observers and decision-makers will be seeing; and a fourth that might be termed a media damage assessment -- the information age equivalent of bomb damage assessment (BDA). The first and third offer opportunities for data mining and intelligent agents, while the second and fourth offer an opportunity for pattern analysis, e.g. to establish norms and differences, but each also demands more complex assessment, e.g. as to the impact of such sources on attitudes.

Fusion. The quality of the awareness created is also a function of how well the disparate kinds of information collected can be collated and fused.

- *Collation* encompasses all of the means by which information either from different individual sources or from the same sources over time is correlated to yield a more complete awareness. Where this information is electronic, it lends itself to machine collation, but human and open source reporting pose an exponentially bigger challenge. Not only are the comparisons to be drawn themselves more complex, but the reports themselves are laden with uncertainties and subjectivities that make collation a complex endeavor.
- *Fusion* involves putting together all forms of reporting on a subject. Since this process can demand insight into complex aspects of a subject's actions or inactions, the process is complex and may revolve about the role of "subject matter experts" and the organizational and communications networking available. Yet, these can to some degree be aided by modeling past successes and failures to focus and limit the scope of any subjective analyses.

2. Sensemaking

The sensemaking process expands awareness to a new level by putting any action into a retrospective context of previous actions, and prospectively by estimating where an interaction is leading and what it implies. Two sub-processes seem evident: contextualization and analysis.

Contextualization. Contextualization gives observers a set of norms that put an event into a context of similar events, a range of events, all events occurring within a given timeframe, or the

[12] Misinformation may be defined as information that is unintentionally erroneous usually from a reporter that did not understand much about what was being reported. Disinformation is that which is deliberately incorrect and used to mislead or otherwise shape behavior.

broad context of "history" whether of a running series of interactions or a long term social, political, and economic antecedents. The scope and timeframe of the contextualization will vary with the level and perspectives of the decision-makers to be supported, but we can identify three sub-processes: creating and using a historical data and information base; identifying and retrieving relevant knowledge; and accessing mental models, i.e. libraries of analogies derived from education and experience. (See Figure 5 below.)

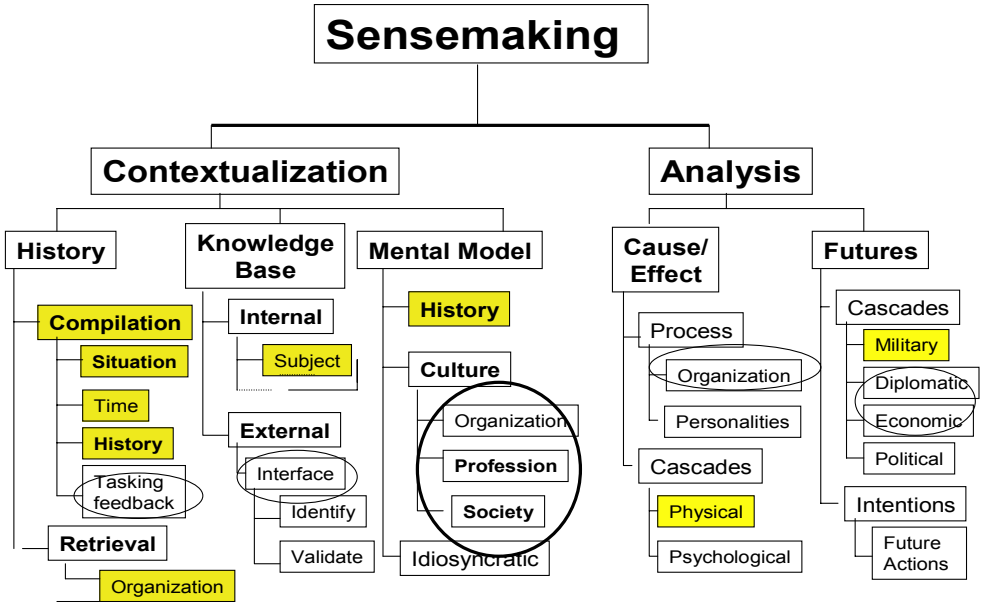

Figure 5

- *History* provides prospective internal models and building blocks for deciphering a complex problem and answers such questions as: when and how often an action has been seen before; under what circumstances; for what apparent reasons; with what follow-on events; how often; and in what time sequence. The answers to these questions indicate whether the action is purposeful rather than random and provide the basis for analogizing between current and past events so as to trace potential cause-and-effect chains. The history of past events also enables us to tag actors and actions either to assess on-going interactions or identify possible feedback. The requirements imply two sub-processes, one to compile and update a data base and another to retrieve the necessary information. Compilation involves assembling the data, information, and knowledge needed to compare a current situation with previous situations, with changes over time, and with events in any larger historical context – aspects subject to linear analysis and modeling. It also involves an update process with its own complex trade-off: the more detailed the data base, the more expensive in time and effort it will be to main-

tain and update, or given fixed resources, the fewer the actors upon which extensive information can be maintained. It also must include some way of determining the kinds of information to be inserted into the base and how they are to be organized. The greater the scope and detail, the more complete the knowledge base will be, the greater the depth and diversity of the analogies, internal models, building blocks and tags that are likely to emerge, and the better the decision-making support. *Retrieval* processes revolve about knowing what to retrieve, but because the information is to provide analogies between pieces of information that do not necessarily resemble each other, the process can be complex. Information technology in various forms has a role to play in permitting retrieval of complex information from established data bases and in lessening the trade-offs involved in maintaining a data base of sufficient scope and currency to support rapid action-reaction cycles.

- *Knowledge Base*. In effects-based operations, we need to distinguish between two forms of knowledge: that which is the sum or aggregate of pieces of information; and that which represents an internalized understanding of a complex subject with many changing interdependent variables.[13] The former is relatively linear; the latter is both complex and essential for effects-based operations whose object is to shape behavior, i.e., to produce a complex reaction a complex adaptive system. From a functional standpoint, this knowledge will reside in two places: *internal* to the organization either in information already amassed on a given subject, e.g. an Operational Net Assessment, or in its subject matter experts;[14] and *external* to the organization that might be tapped to deal with the challenges beyond the scope of the organization's data bases and knowledge, e.g. knowledge and expertise in academe or industry,. In both cases, accessing this knowledge will require some form of tasking, validation, and fusing function and in the case of the external knowledge, the interfaces to contact outside experts and interpret their inputs.
- *Mental Model.* The intellectual framework for drawing analogies from the contextualized situational awareness is the mental model. Although idiosyncratic by nature, it is also the base of understanding common to a decision-maker group – a logical short-hand that permits the rapid communication of complex ideas in the absence of which an entire logic tree of explanations would have to be built from scratch at each interface between decision-makers. Although the model is complex by nature, we can identify two distinct inputs: a bounded pat-

[13] In many languages, this distinction is drawn by using to separate verbs for the English "to know." In French, for example, the verb *savoir* connotes knowledge that is the sum of information, while the verb *connaître* implies the understanding or a complex human interaction. German makes a similar distinction between the verbs *wissen* and *kennen*.

tern of perceptions built by the history of past actions, individual experience, and social influences; and a set of complex thought process applied to understanding what a particular action actually means -- understanding shaped by social and idiosyncratic variables. Again analysis of the former whether by a detailed history of previous situations observed or by deliberate perception management can be used to bound the complex estimates of the latter.

Analysis. The analysis process translates contextualized awareness into a basic understanding or sense of the situation centered on answers to two basic questions: what is happening and what is likely to happen next. The questions imply two sub-processes, one to estimate the chain of causes and effects leading to an action, and another to project the chain forward.

- *Cause and Effect* assessment implies two sub-processes: one to understand the roots of other actors' decisions and actions; and another to identify and track the cascades of indirect effects accruing from those actions and their direct effects. The *decision assessment* sub-process builds on the contextualized history of previous action-reaction cycles and what is known of the decision-making process from which that action derived. The former is aided by the contextualization process while the latter demands some assessment of both the decision process itself, i.e., its formal and informal organization,[15] and the actors in it. The *effects cascade tracking* process serves to identify the direct effects and indirect effects resulting from a particular action. This retrospective tracking has two dimensions, one physical and effects and the other psychological, but with the latter cause and effect chain in particular resembling much more the web of diplomatic, political, military and economic interactions set off much more than a single chain.[16] The former has been the subject of targeting analysis for decades; the latter is far more complex but can be modeled in some degree. [17]
- *Futures* assessment looks to two things: the end-states that would likely result from the continued cascade of these indirect effects, and the present and future intentions of the actor in question and, thus, what new actions might be expected. The estimate of *potential cascades* both physical and psychological applies to friends, foes, neutrals and us, while the estimate of intentions focuses on how these might be manifest in further actions and how these actions might translate into further direct and indirect effects. Although modeling may contribute to

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[14]The most important of these subject matter experts will be the forward commanders down to the foxhole expert on a particular firefight – the true experts on a particular tactical or operational situation

[15] In this process, the formal organization is likely to be relatively linear and can be used to "tag" key decision-makers, while the informal organization actually making the decisions can often be inferred from the first and may be subject to some form of iterative modeling.

[16] For further discussion of physical and psychological cause and effects chains and their behavior, see Smith, Effects-Based Operations, pp. 302ff.

bounding these estimates, they remain complex. This assessment provides the basis for a risk calculus in decision-making; the more threatening the unimpeded progress of an estimated cascade, the greater the risks that will be acceptable in efforts to push it in another direction.

3. Decision-Making Process

In the decision-making process awareness and sense-making translate into action. Logically, there are two parts to the process: a forward projection of sense-making in the form of alternate scenarios or prospective courses of action exploring the likely impact of each on the estimated cascades of effects; and the process of planning a course of action. (See Figure 6 below.)

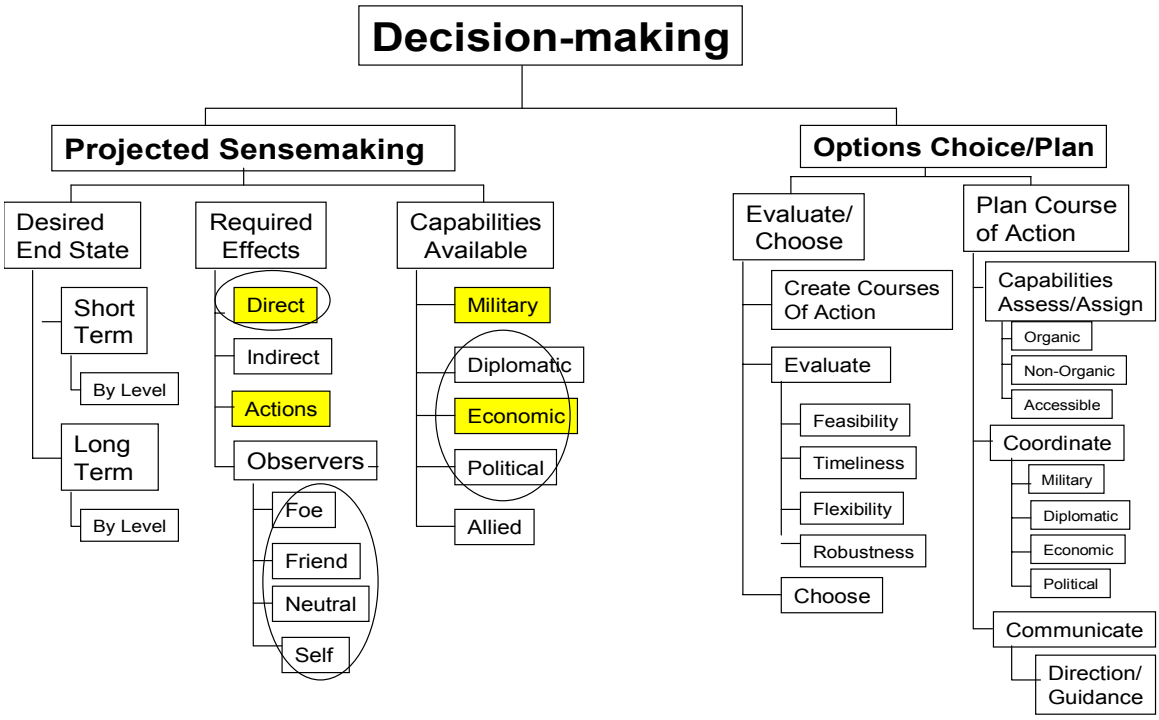

Figure 7

Projected Sensemaking. If the outcomes foreseen in sensemaking are unacceptable, actors will seek to re-shape them toward more desirable end-states. This entails understanding what actions and direct/ indirect effects might create such end-states, and which capabilities in what configuration of actions might produce the required effects. To that end, it projects alternate "what if's" into a dynamic future to test how various options might achieve a given desired end-state.

- *Desired End-states*. In dealing with a multi-level system of complex adaptive systems, it stands to reason: that end-states will seldom occur at only one level of one arena or affect

[17] This is to say it may have impacts across the Political, Military, Economic, Social, Information and Infra-

only one observer, and that given an on-going spiral of interactions, outcomes can never be confined to a single cycle but will to some way change behavior in succeeding cycles. Accordingly, we must distinguish between short term and longer term end-states[18] and balance these prospective outcomes by arena and observer, e.g. accept a short term negative result to attain a more important long term goal or accept a short term negative result in one arena to attain a long term goal in another arena. The challenge is to estimate effects cascades and outcomes for each prospective course of action both in a succession of individual cycles and in the complex aggregations of effects and end-states across the multiple levels of human society involved. Although aspects of each of these functions might be modeled and might certainly be supported by better contextualization and knowledge, they remain fundamentally complex.

- *Required Actions and Effects*. Given an interaction with a complex adaptive system, it is also unlikely that any option examined will be confined to a single action creating a single effect. Indeed, the multiplier in effects-based operations derives from the ability of a single action to create a cascade of effects that together will achieve the desired end state. Even more, the fact that effects-based operations encompass diplomatic, economic and political capabilities and not just military capabilities says that the actions are likely to take many forms and will create not just one particular effect setting off one cascade of follow-on effects, but rather "coordinated sets of actions" creating different effects in different arenas setting off multiple different cascades. Determining which action, effects, and cascades are required to achieve a desired outcome – short term or long term – therefore assumes some way of evaluating potential actions, effects, and cascades across two time dimensions, multiple arenas, and over a set of actors that is denominated not only in simple categories of friend, foe, and neutral but also needs to be broken down by states and non-state organizations. In brief, what is required is less the identification of an action to take than it is the identification of a multi-faceted course of action within which any individual action and the effects it creates will be but a part. Modeling can help to define many aspects of these complex interactions, especially in their "nature" context, but the real help for decision-makers is likely to come from an interactive hybrid of such models and human subject matter experts who have mastered the idiosyncratic "nature" side of the problem.

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structure or PMESII construct.

[18] Given that effects-based operations are about shaping reactions and behavior, the latter long term end-state would logically encompass at least two further action-reaction cycles – our action in the current cycle, and then, his reaction and our reaction to that response.

- *Capabilities Available.* Capabilities are the reality check in any decision-making process. In most short term challenges, especially the *ad hoc* threats posed by asymmetric challengers, new capabilities cannot be created in a short enough time to be applicable. Instead, options must be engineered from those capabilities already on hand that might actually be applied to creating a desired effect, in which combinations and contexts, how, and with what timing. Given our broad definition of effects-based operations, such capabilities extend across a spectrum of political, military, diplomatic, economic action whether by nations, coalitions, or terrorist cartels. Together these capabilities define a tool-kit of capabilities that bound the courses of action that are open to a decision-maker in responding to a stimulus.

Choosing and Planning Courses of Action. Translating the capabilities into courses of actions involves a choice as to which potential applications of capabilities in which combinations might achieve the effects and outcomes sought and, of these, which is the best. This implies: a "rational" process to assess simply whether a given course of actions might be physically possible in a particular situation, i.e., a linear problem of a type traditionally pursued in military operational analysis; and an evaluation process to assess which of the actions that may be physically possible best meets the needs of the situation or has the greatest probability of achieving the desired effects and behavioral outcome in the larger contexts discussed above. Again, although the ultimate decision as to what course of action is deemed viable remains complex, a drill down and then linear analysis of what is physically possible and pattern analysis or cognitive modeling of a decision-making process can contribute to bounding the range of possible actions. The culmination of the decision-making process centers on putting prospective options into a planning process of some sort to review them, evaluate them and choose one course of action to execute. That is, the function can basically be divided into two functions, one centered on exploring options, evaluating them and choosing a preferred course of action; and the other on planning it.

- *Evaluate/ Choose*. Exploring and evaluating prospective courses of effects-based action essentially means works backwards from an overall end-state, e.g. a desired geo-strategic end-state, to the lower level or local end-states required to achieve it, to the effects cascades required to induce those end-states, the direct effects that could set those cascades in motion, to the actions needed to create these direct effects – with the latter a function of what aspects of the actions observers, friend, foe and neutral will see. Given a complex world, a set of interconnected end-states defined in terms of behavior rather than targets destroyed, and cascading effects whose course cannot be entirely predicted, the process of evaluating and choosing the correct options to pursue is emphatically complex. It also implies that the evaluation process will hinge on two factors: a relatively linear process of weeding out those options that are not

physically possible, e.g. due to a lack of capability; and a more complex process of what amounts to the application of a set of qualitative metrics, e.g. the relative risk given the estimated threat, the feasibility of the action given available resources, the timing – speed, duration of action, and synchronization – required, the flexibility or ability to foresee and adapt to any response both in the current cycle and in following cycles, and the robustness, the tolerance of unknowns and absence of a single point of failure.

- *Plan.* The purpose of the decision-making process is to plan the right actions to create the right direct effects setting off the right cascades of indirect effects to achieve the right end-states both at the level of the interaction and at succeeding levels. This implies at least three sub-processes: one to assign roles for each of the capabilities to be exercised in the course of action; another to coordinate the actors involved so as to at least de-conflict the actions and effects and at best achieve a unity of effect; and another to communicate an understanding of the plan to those who are to execute it. *Capabilities Assignment* seems to have a natural division into three sub-processes: one for the tasking of those capabilities that are organic to the command or organization in question; another for those assets that are not organic to the organization but that may be tasked and used; and a third for those actors that cannot be controlled in any meaningful sense but with whom actions and effects must at least be coordinated to achieve a desired end-state. As the latter suggests, *coordination* of actions so as to attain a unity of effect in an effort that includes diplomatic, political, and economic action as well as military is likely to involve complex networking – social and communications. The same is true of the communication of a plan that must strike a balance between minutely directing actions and providing guidance as to intent that permits those in faster paced interactions to adapt to the equally fast paced actions of a foe.

4. Execution

The execution of the option chosen is the response phase of one action-reaction cycle but can, simultaneously, be the stimulus setting off an additional cycle or cycles of interactions either in the original actor or in a host of other observers. In a complex world that is continually changing and never entirely predictable, the execution process cannot be limited to simply carrying out a directed plan but must provide for adapting it to changing circumstances both to avoid potential negative consequences or to optimize impact. Similarly, because any action is part of a continuing succession of action-reaction cycles, feedback is essential. This signals three additional sub-processes: one focused on how the action is executed, another on the context within which it is executed, and a third on the feedback from the operation. (See Figure 8 below.)

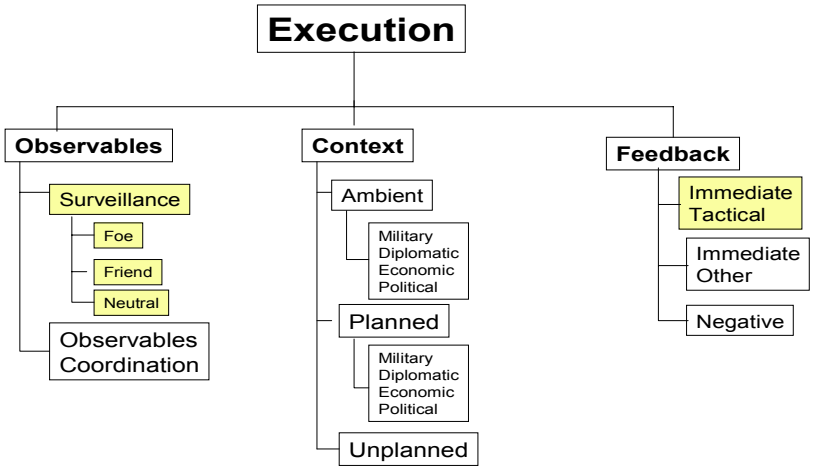

Figure 8

Controlling Observables. Because effects derive from what observers see, the key to success in execution lies in ensuring the right observers see the right aspects of an action at the right time to create the desired effect. The first of the sub-processes involves reducing the action to a set of observables, i.e., which facets or attributes of the action will be "seen" by observers and create the effects needed to shape their reactions.[19] Each of the variables offers an opportunity for further drill down. All are relatively linear in nature and may be considered in the details of an execution order. In essence, they are the fine tuning of the response to bound when and what the other side – or friends and neutrals -- will see through the filters of their surveillance/ collection systems. This suggests at least two sub-processes: one to model how the surveillance systems of observers will "see" any action – a necessary element of ensuring that the right aspects of the right actions are detected; and one to coordinate the units applying the stimulus to ensure that each creates the right impact.

Controlling Context. A more difficult task is assessing the context in which an action as executed might be seen by an observer or, perhaps, by successive levels of observers and decision-makers. This context will vary with the level of the observer and may stretch far beyond the original action in terms both of the contextualization of the direct effect at various levels of decision-making and of the cascades of indirect effects that may ensue.[20] Since the context, especially

[19] Eight such observables appear obvious: what the action was; what kind of force, diplomacy, or other application of power was used to execute it; on what scale; where; over what operational scope; how fast; for how long; and with what demonstrated degree of coordination. These are explained in more detail in *Effects-Based Operations*. Smith. pp. 234-250.

[20] It is important to note that, in this context, there is no action that is not "joint" and indeed no action that is not "national." Similarly, military actions will not be seen as independent of overall national actions re-

at upper levels of the hierarchy of social groups, will span all the elements of a "whole of nation" approach, there no actions that are not joint, no actions that are solely military, and no actions that are not national -- or, in the case of al Qaeda, organization-wide, e.g. the actions of al Zarqawi as the al Qaeda affiliate in Iraq for better or worse cannot be entirely separated from those of Osama bin Laden. This suggests further sub-divisions of context control, for example, in political, diplomatic, economic, and social arenas, and/or in coalition actors.

Feedback. In the feedback process, the execution phase begins to turn into the awareness creation phase of the next cycle. The principal feedback from those executing a plan will be whether the action was carried out or not and any evidence that the action was "seen," e.g. electronic sensors being activated, but the actors executing the plan may also be able to provide other indications from other activities of the local observers. Together, these will comprise an initial input to the larger assessment process.

5. Social Influences

The *social influences,* e.g. religious, educational, political, economic, etc., do not constitute a function in the same sense as the other steps but instead are the way in which the system maintains its identity and cohesiveness, a requirement that shapes the decisions made in each of the other steps. These influences describe the limits to a social system's ability to adapt to a situation without undergoing a transformation that could change the relationships between its complex subsystems or, conversely, define the degree to which the system must change in order to adapt.[21] In each of the crossovers into the cognitive processes of observers and decision-makers shown in Figure 9 below, it is not possible to point to a single social variable that will provide the key to an influence, perception, or decision. Instead, social influences as a whole will affect any social and cognitive modeling assumptions we must make in bounding outcomes. [22]

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gardless of whether the actions were intended to be part of stimulus or not. For observers, all actions must be seen as somehow interrelated because they cannot afford to do other than assess a worst case in which all actions are deliberate and related to the point that even un-coordinated and contradictory actions are likely to be treated as the imperfectly understood actions of a complex adaptive system to attain a specific goal.

[21] In a nation-state system, this function would fall to the political leadership. In the period between Hitler's attack on Poland and the Japanese attack on Pearl Harbor, for example, President Roosevelt knew that any direct American participation in the war would depend on changing a deep isolationist streak in the American societal self-image. His introduction of "lend-lease" to aid a flagging Britain, therefore, resorted to metaphors that used a different aspect of the self-image "neighborliness" to explain the aid in terms of a lending a garden hose to a neighbor whose house was on fire.

[22] While it certainly seems that social models can be developed to aid in the process, the development of such tools and the ability to create such a models for at least the foreseeable future appear prey both to problems of modeling ever-changing complex adaptive systems and to a garbage-in-garbage-out Catch 22 -- that you to have an expert to decide what goes into the model and the quality of the resulting

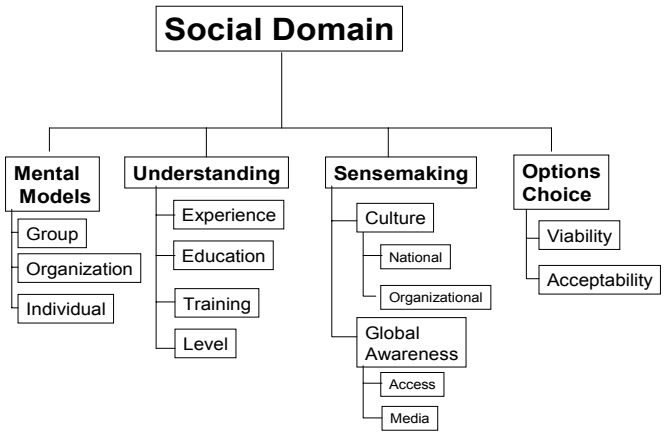

Figure 9

That is, whereas the social and cognitive modeling address the "nature" dimension of how human beings and human organizations in general act and react, the societal influences reflect the complex "nurture" dimension of how specific human being's and human organizations might react. The result is again to refine and bound the outcomes of the modeling.

Scalability and Timeliness

However, once again there is something missing. Effects-based operations clearly need to be both dynamic and scalable down to the tactical level. Yet, there seems to be a stark contradiction between the rather ponderous and time-consuming process of dissecting action-reaction cycles on the one hand and the requirement for executing precise actions against an adaptive foe in an ever-changing situation on the other. It would, therefore, be easy to conclude that effects-based operations can only be planned and assessed at the operational level of war or higher, i.e., where time-lines are longer and where the assets exist to undertake such a detailed process. This would be to say that effects-based operations are neither scalable to the tactical level nor able to be conducted on a dynamic basis. Yet, this would also be to fly in the face of what we are already doing. One good example is the response of a young U.S. Army Captain to a journalist's query as to why he and his unit had just engaged in a six hour firefight with insurgents over a burnt-out Humvee: "We weren't going to let them dance on it for the news…even with all the

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model will then vary with the quality of the expert. But, the more the society in question diverges from a usually Western norm, the less applicable the modeling by itself is likely to be. What we seem to require is a hybrid in which the social and cognitive modeling provide a framework for looking at how people or societies in general act and react, the expert can provide a mastery of a complex subject area for which there is no model.

guys they lost that day, that still would have given them the victory."[23] The Captain was aware of the multiple dimensions of the firefight, had a sense both of the diverse observers of the interaction and of the role of an effects-based metric for "victory" in his decision-making and execution. And, he was able to use his understanding of command intent to execute action-reaction cycles at the minute by minute speed of battle. How did he do it? The answer probably lies in looking at the action-reaction cycle not as an intricate and exhaustive staff planning process but as nothing more than an elaborate Observe, Orient, Decide and Act (OODA) loop in which the awareness creation is the *observe* phase, the sensemaking the *orient* phase, the decision-making the *decide* phase, and the execution the *act* – all of which can be jammed into a cycle that may last but 90 seconds. (See Figure 10 below.)

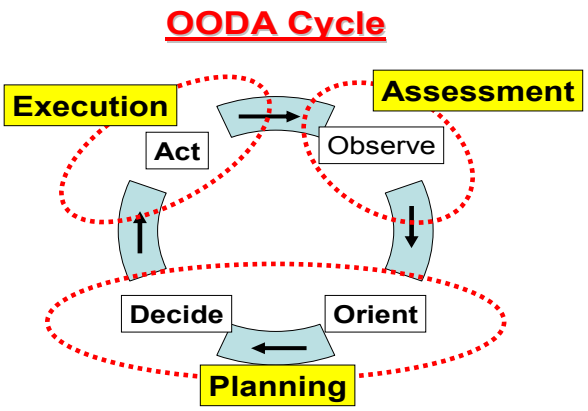

Figure 10

As a model of effects-based operations, the OODA loop offers three advantages: it is rapid; it is scalable; and it is cyclic and, thus, continuous. Even more, the OODA loop also presumes a continued interaction between two or more actors with changes in the actions of one driving the changes in the action of the other, much as it was carried out by pilots in aerial maneuvers. The OODA loop recognizes an underlying reality both of military operations in general and of effects-based operations in particular: that timing is everything. There simply will not always be time for an involved planning process. Rather, the OODA loop has to be internalized by training and experience to the point that it became almost intuitive.[24]

For effects-based operations, there must also be a way to assess, plan, and execute effects-based operations that does not involve a cumbersome staffing process. Treating the action-reaction cycle as an OODA loop suggests not only that an abbreviated form of the process is pos-

[23] Scott Wilson, *Washington Post*, June 26, 2004.

sible but also that it is scalable up to the geo-strategic level. From an effects-based perspective, the OODA loop also seems to hint that the real key to success is less simply getting "inside the other guy's OODA loop" than it is a question of providing the right actions or stimuli at the right time to *drive* an opponent's OODA loop in the right direction – while being able to react quickly and resourcefully enough to deal with the responses.

Conclusion: The Aggregation Rheostat

The drill-down model outlined should not be construed as a definitive rendition of all the ways in which we might deal with complexity or dissect the cycle, or of all the linear elements we might identify and analytical approaches we might apply. It is instead an illustration that such dissection and drill down is possible and that, in a wide variety of areas, it can demonstrably help bound the scope of the complex judgments needed to deal with complex problems.

All of the above clearly adds up to something that is far from a cookbook of recipes for effects-based operations. What we have done is to describe a general logical framework for an effects-based "how to" and an aggregation rheostat as a tool for dealing with its inherent complexity. In a way, the aggregation rheostat provides a sort of logical Christmas tree on which we can hang the "how to" problems of effects-based operations. By using the rheostat, we can move alternate between aggregating into meta-systems and dissecting the action-reaction cycle into essential processes and drilling down to successive sub-processes. In essence, we can use the drill down as a road map for identifying both where the human belongs “in the loop” to deal with complex problems and where various types of networking, analysis, and modeling might be useful in helping that human bound the complex problems involved with the result of yielding decisions that are neither guesses nor the flash of insight of a military or political genius of traditional effects-based operations, but decisions focused on attaining higher probabilities of being correct despite all of the complexities involved.

The utility of such a logical tree, moreover, is not limited to military operations just as effects-based operations cannot be limited just to their military dimension. It also applies to states as to international terrorist organizations, to the diplomatic, economic, and political as well as the military, and to the civilian world as well as to that of governments, and potentially, across the breadth of complex human interactions.

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[24] This, indeed, was the point of Colonel John Boyd’s initial teaching of the OODA loop, a reaction to American fighter losses during the Korean War.