Effects-Based Operations

A Grand Challenge for the Analytical Community

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A GRAND CHALLENGE

Effects-based operations (EBO) are defined here as operations conceived and planned in a systems framework that considers the full range of direct, indirect, and cascading effects—effects that may, with different degrees of probability, be achieved by the application of military, diplomatic, psychological, and economic instruments.

Current methods of analysis and modeling are inadequate for representing EBO, and this reality should be considered by the analytical community to pose a grand challenge. Addressing the challenge will require changes of mindset, new theories and methods, and a new empirical base. Fortunately, several research-and-development efforts toward this end are now under way, but it will take years for them to reach fruition. In the meantime, these efforts can benefit from some broad analytical considerations.

PRINCIPLES FOR AN APPROACH

The following principles are a useful guide for defining and conducting defense-planning analyses that take a broad view:

- Analysis in support of defense planning should embrace the paradigm of focusing on *mission-system capability*, which refers to the no-excuses ability to accomplish missions under a wide range of operational circumstances and to characterize the range of circumstances for which the capabilities are sufficient to

provide different degrees of confidence. Addressing EBO-related issues should be an important part of such analysis.

- Analysis dealing with EBO should fully confront the scope and magnitude of uncertainty and should deal explicitly with probability and randomness. For summary purposes, assessments of capability should refer specifically to most-likely, best-case, and worst-case outcomes (with "best" and "worst" corresponding to something like 90 percent limits, judged subjectively).

- Dealing with uncertainty will require low-resolution *exploratory analysis* for breadth, as well as more-detailed modeling and gaming for both depth and insight into underlying phenomena. This suggests a *family-of-models-and-games* approach in which information obtained from different members of the family is used to inform and cross-calibrate the whole body of knowledge. To be meaningful, as distinct from being merely slide-show material, such work requires major investment and effort—in additional models, empirical knowledge, and the analysis necessary to actually accomplish the cross-calibration.

- A key element of analytical work should be *qualitative modeling*, including *cognitive modeling* of the decisionmaking and behavior of commanders, political leaders, and even societies. Such modeling should be undertaken in an uncertainty-sensitive framework and can greatly enrich analysis while breaking down the barriers between "rigorous analysis" (usually quantitative, but rigid) and human gaming (often more realistic and innovative, but fuzzy). Here, as elsewhere in EBO analysis, the objective should be to increase the *odds* of success and decrease the *odds* of troublesome side effects.

- Because much of EBO is tied to affecting decisions and behaviors of people and organizations or the operation of complex systems and organizations, much of the related modeling should be organized around adaptive systems for command and control and other matters, rather than around the mass and physical characteristics of forces. This implies emphasis on the concepts and technology of *agent-based modeling* (albeit in many variations), as well as on system engineering.

- Because the questions asked in EBO analysis are so different from traditional questions, analysts should vigorously pursue a

new base of *empirical information*—including information obtainable from history and from a combination of gaming, man-in-the-loop simulation, and experiments in battle laboratories and the field. This information should be collected and framed in ways that illuminate complex and subtle relationships and that support uncertainty analysis. The goal should *not* be merely to inform "best-estimate" databases, because in EBO work, uncertainty is often inherent and best-estimate analyses can be misleading and even dangerous.

EXAMPLES OF REFLECTING EBO IN COMBAT MODELING

Much discussion of EBO is relatively abstract or even philosophical. It is often difficult to see how the issues can be dealt with in rigorous analysis and supporting models, except when those issues are amenable to systems engineering, as in precision targeting to halt the functioning of a complex facility without excessive or permanent damage. It is therefore useful to have down-to-earth examples demonstrating that much can be done by embellishing traditional combat models and adding new features to them. Examples can also demonstrate that some of the alleged dichotomies between attrition-based operations and EBO are not dichotomies at all.

Example 1: Interdiction with Long-Range Fires

One example addresses the operational challenge of achieving an *early* halt through interdiction alone—i.e., of halting an invading army before it occupies critical territory, and doing so without the benefit of ground forces. The problem has been studied heavily over the past decade, but not within the framework of EBO. When the problem is studied in conventional ways with the usual models and assumptions, the mission appears to be extremely demanding. However, when the problem is viewed from an effects-based perspective as described above—with serious attention paid to uncertainties and to indirect effects on behavior and decisions—the conclusion reached may be quite different in both form and content. For example, instead of conservatively assuming a brave and motivated enemy, analysis from an effects-based perspective considers the possibility that the halt could be achieved much more quickly than is predicted by considering massive attrition alone—especially

if the interdiction is focused. The analysis suggests that a particular force-employment strategy (e.g., a leading-edge strategy) is unlikely to be less effective than a baseline strategy and might instead be substantially *more* effective in bringing about a very early halt. That is, the strategy has a strong upside and only a modest downside.

To reach this conclusion, it is necessary to revise the models used to permit considering a range of plausible break points, building a qualitative model of what determines the break point, and recognizing that even with such a model (in the reductionist form of a table), the break point should be treated as a random variable. Further, the analysis requires modeling direct physical effects of the leading-edge strategy, which depend on the enemy's scheme of maneuver (number of axes, dispersion along the axes, etc.). Despite this apparent complexity, the analysis reproduces the reasoning of a hypothetical sensible commander interested in upside potential and downside risk, not just nominal predictions. In that context, such a commander would be quite willing to consider soft factors such as the enemy's apparent cohesion, morale, and motivation. Although break points are quintessential examples of soft factors resistant to precise assessment, they can be represented analytically. Further, the analysis demonstrates how an attrition-based model can be modified to reflect quite a range of softer effects and to become, in essence, a model for assessing EBO.

Example 2: Halting an Invasion with a Combination of Fires and Early-Intervention Ground Forces

A second example considers the combined use of long-range fires and early-intervention ground forces inserted nominally at a forward defense line. Estimating likely outcome, best-case outcome, and worst-case outcome now has a different flavor. In this instance, the downside risk of inserting ground forces would be very high: the lives of those being committed. In some circumstances, that risk might be tolerated; in others, it would not. An imperative would be to reduce the size of the downside risk, e.g., by considering a deeper defense line, delaying or slowing the advance through early and well-focused strikes, improving the capabilities of the ground force, slowing the enemy's rate of advance, or increasing the magnitude of the long-range fires and their assured ability to support the ground

force. If such measures were not sufficient to greatly reduce the downside risk, ground forces would not be employed.

As part of this example, a simple cognitive model of the commander can be used to essentially formalize the logic described above in words. The commander's decision is whether or not to insert the ground forces. Although simple, this example demonstrates that building useful decision models is possible and that such models could be used to broaden and sharpen conclusions of human-conducted war games in which only one of many paths is taken, to represent plausible enemy behaviors in effects-based analysis, and to better characterize historical events. Computer programs embodying such models are examples of agent-based modeling.

CONNECTIONS TO FORCE PLANNING

The two examples above revolve around the problems of a hypothetical future commander, not the reasoning of a current-day force planner. Traditionally, operations planning and force planning are considered to be very dissimilar, with force planners providing only raw capabilities motivated by deliberately stereotyped scenarios. However, planners should consider the *customers* of today's defense planning to include tomorrow's President, Secretary of Defense, and military commanders. Thus, it is appropriate in today's force planning to evaluate capabilities in more-realistic frameworks. That does not mean adding greater detail to the scenarios, as though the relevant details are known. To the contrary, it means exploratory analysis over a *broader* range of assumptions, but a range that explicitly considers realistic variations in the qualitative factors that so dominate real conflicts. The consequences can, paradoxically, work in both directions. On the one hand, such exploratory analysis can highlight additional vulnerabilities and thereby raise "requirements" (e.g., for capability to cope with short-warning scenarios). On the other hand, it can demonstrate that capability sets that would be manifestly inadequate in highly conservative, stereotyped scenarios would be highly valuable in others—so much so as to merit investment. It should be remembered that airborne, air-assault, amphibious, and special-operations forces would never have been developed had they been evaluated only in stereotyped attrition scenarios underplaying the role of surprise and special tactics. Nor is the issue

confined only to "special" capabilities. Consider the debate about two-MTW (major theater war) capability. By evaluating affordable force structure against inflated versions of a two-MTW conflict, and by using analytical methods focused on straightforward attrition warfare, one can conclude that two-MTW capability is not feasible and that the strategy should be relaxed—perhaps one threat is enough. Alternatively, one can do the exploratory analysis and conclude that two-MTW capability is feasible for quite a range of currently realistic threats and scenarios but is not feasible in other cases. In that analysis, the conclusion is not that the idea of two-MTW capability should be dropped, but that it should be defined better. Another step is to recognize the tradeoff between conducting other operations (including small-scale contingencies) and short-term *readiness* for (as distinct from *eventual capability* for) two concurrent MTWs.

NEXT STEPS

An important motivation for this monograph was the belief that analysis methods need to be improved so that they can be useful in studies and operations undertaken from an effects-based perspective. Such improvements appear to be quite feasible, but they will depend on new attitudes, principles, and norms—as well as on the use of modern modeling technology such as that for exploratory analysis under uncertainty and the development of agent-based models. Further, the improvements will depend on developing an expanded and enriched empirical base. The next steps should include in-depth application of the principles enumerated here in efforts to obtain insights and data from history, training, exercises, and experimentation (both in the "laboratory" and in the field).