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Discovering the Effects-Endstate Linkage: Using Soft Systems Methodology to Perform EBO Mission Analysis

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STUDENT PAPER

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ABSTRACT

Mission analysis is the foundation of JFC campaign planning. This paper examines how planners determine effects necessary to yield desired endstate during the EBO mission analysis process. The paper questions the suitability of applying the traditional task-focused mission analysis process to EBO planning. EBO's conceptualization of the adversary as a Complex Adaptive System, the increased requirements for unified action between various actors (military, government, non-government, and coalition), and the amorphous 4th Generation Warfare environment each pose new mission analysis challenges. EBO mission analysis is shown to be more problem structuring than problem solving. A new mission analysis process is proposed using a modified version of Soft Systems Methodology to meet these challenges. The discussion includes a general overview of how the new mission analysis would work based on a simple scenario. The paper is relevant to EBO planners and practitioners, especially those dissatisfied with trying to force EBO to fit within the current mission analysis process.

INTRODUCTION

> *"Command and Control is the ability to recognize what needs to be done in a situation and to ensure that effective action is taken"*[1] *- Joint Warfighting Center Joint Doctrine Series: Pamphlet 7: Operational Implications of Effects-based Operations*

Command and Control has always involved decision-making. This paper explores one aspect of how a Joint Force Commander (JFC) exercises C^2 within Effects-based Operations (EBO). Specifically, the paper examines the EBO mission analysis process. Within EBO, "recognizing what needs to be done" begins with answering the question "what effects will yield the desired endstate?" The JFC and planning staff answer this question during the mission analysis process by providing two outputs: (1) a specified set of effects believed sufficient to yield the desired endstate and (2) a shared understanding of the adversary system and the environment.[2] The foundation of effective C^2 is built upon the quality of these products.

EBO, Old Wine in a New Cask? Maybe

EBO is many things to many people. For the purpose of this discussion, Effects-based Operations are, "coordinated sets of actions directed at shaping the behavior of friends, foes, and neutrals in peace, crisis and war."[3] Conceptually, EBO views the adversary as a system of Political, Military, Economic, Social, Informational, and Infrastructure (PMESII) sub-systems (Figure 1). EBO coordinates and integrates Diplomatic, Informational, Military, and Economic (DIME) national Instruments of Power (IOP) actions to generate effects within these adversary systems to influence behavior towards an endstate (Figure 2).

In some ways, EBO is nothing new. Politicians and commanders have used warfare and the IOPs to influence adversary behavior throughout history.[4] Clausewitz' classic quote "war is merely the continuation of politics by other means" reinforces this idea[5]. Proponents argue EBO is new because it thinks about campaign planning, execution and assessment in a more "holistic" way.[6] This new way of thinking about campaign planning changes the how campaign planners develop linkages between tactical action and endstate.

In Effects-based planning (EBP), planners answer the *what to do* question during the initial portion of the EBO planning process "by clarifying goals and objectives, developing a systems understanding of the operational environment, crafting commander's intent, and determining the set of effects required to achieve desired objectives."[7] It is the last part of this definition that is new to the campaign planning process. In EBO, effects bridge the gap between campaign objectives and tactical actions as shown in Figure 2.

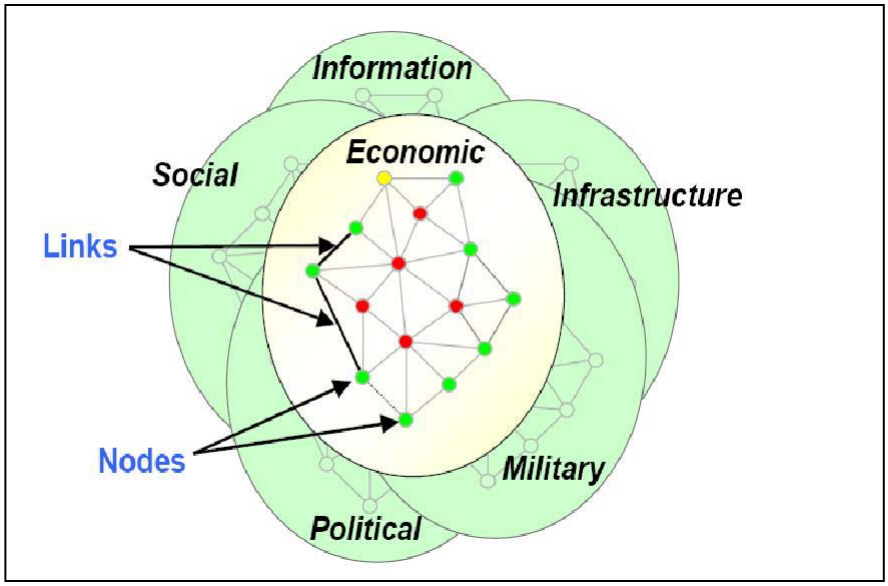

Figure 1: Adversary as System of PMESII Systems (JFCOM Model)[8]

The figure shows two distinct linkages. The first is the linkage between tactical-level action and the resultant effects. Most Western militaries are now pouring tremendous resources into developing technology and tools to better plan actions to achieve desired effects. United States Joint Forces Command (JFCOM) is currently developing and fielding tools supporting an Effects-Node-Action-Resource (E-N-A-R) process to help planners analyze, develop and orchestrate these tactical actions. Linking actions and effects is clearly a necessary EBO planning function, but is it sufficient? A re-examination of Figure 2 shows it is not.

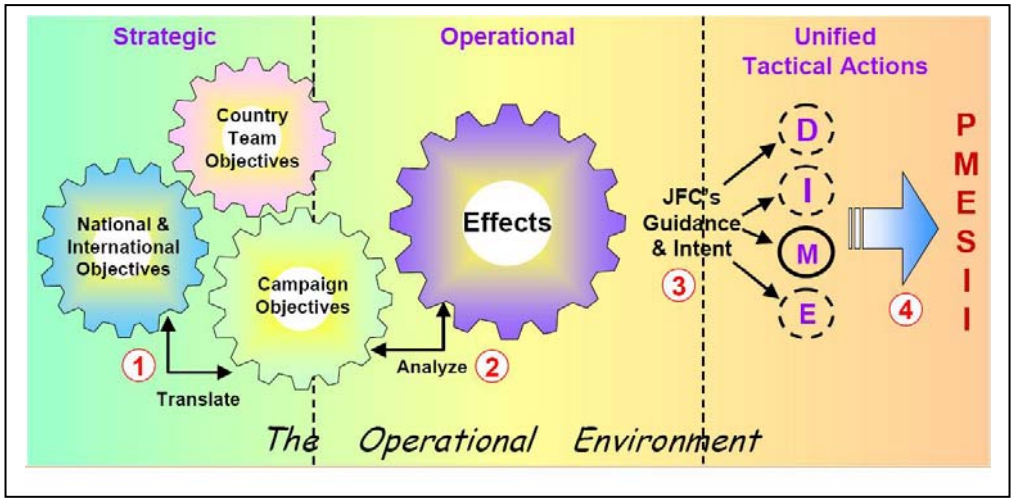

Figure 2. EBO Operational Planning Environment (JFCOM Model) [9]

There is a second linkage in Figure 2. This is the linkage between operational effects and campaign objectives. Planning staffs bridge this gap through the EBO mission analysis process. EBO mission analysis determines the effects required to achieve theater and national objectives.[10] Objectives in this context mean "operational or strategic goals, conditions, or outcomes, which describe the intended endstate from the combatant commander's perspective"[11] Endstate is used in this context throughout the paper.

The Endstate-Effects Linkage (E-E-L) describes the connection between the two and answers the questions "what effects will yield the desired endstate" and "why do planners believe this is so"? Currently, roughly the same traditional task-focused mission analysis process is used during EBP. This means EBO mission analysis lacks a distinct methodology linking effects with endstate.[12] This remainder of this paper proposes a new EBO mission analysis process to develop this E-E-L during campaign planning.

What Needs to be Done is Obvious…Isn't It?

The linkage between effects and endstate has not received much attention. Perhaps this is due to the fact planners already perform mission analysis using the traditional process. Using this rationale, one of two conclusions is easy to draw. The first is the military effects required to reach campaign objectives / desired endstate are relatively simple to determine and don't require any special methodology. The second is traditional mission analysis is adequate for EBO planning. Both are incorrect.

Table 1. Hypothetical EBO Simplified Planning Situation[13]

Situation: Two regional countries are contesting ownership of a set of islands. Both state that they have longstanding historical basis for their claims. Both are relatively equal in military capability, and **Country X** has placed limited military forces on one of the islands. **Country Y** is threatening a military response. A war between the two countries would destabilize the region, which the President considers a threat to US vital interests. He has decided to intervene and has established several strategic objectives that contribute to the desired end state.
Desired End State: Long-term peace and stability in the region.
US Objective: Countries X and Y resolve disputed islands issue peacefully.
Effect 1: Country X engages Country Y in diplomatic efforts to resolve crisis.
Effect 2: Country X withdraws military forces from the island.

Consider the hypothetical situation in Table 1. Country X engaging Country Y in diplomatic efforts to resolve the crisis may be a legitimate effect, but how did planners arrive at it? Consider what happens if the occupation is viewed from a different perspective. The leader of Country X may be using military action to send a non-military message to gain regional influence. Furthermore, it may be culturally unacceptable for Country X's leader to engage the leader of Country Y diplomatically. Negotiating may be perceived as a sign of weakness, thus further destabilizing the Country X regime and the entire region. Consider the possibility negotiations between the two nations might actually make the situation worse in the long term by causing them to unite against the U.S. The purpose of raising these issues is not to suggest diplomatic efforts are not a valid effect. However, the above questions do illustrate the linkage between effects and endstate may not be obvious and the wrong effect can have very negative consequences.

Human systems are notoriously complex. Complex systems behavior is often hidden and counter-intuitive.[14] The link between effect and endstate is difficult to establish because human systems are themselves not governed by rules like natural systems, designed systems or even designed abstract systems.[15] Behavior, especially at the system level, can rarely be simplified to cause-and-effect, nor is the interaction governed by a deterministic set of laws or rules.[16] Blindly assuming required effects are obvious or easily determined without a rigorous mission analysis process is a recipe for disaster. In other words, being able to plan, generate, and assess effects is important, but having a high degree of confidence the effects once executed will actually generate the desired endstate is *CRITICAL*!

EBO mission analysis is fundamentally different from the current mission analysis process. EBO mission analysis is less task-focused and more centered on connecting *effects* and *actions* to *objectives* and the *endstate.* The difference in emphasis is central to the value of EBP over current campaign planning.[17] At the Operational level, EBP is focused much more on effectiveness (doing the right things) than efficiency (doing things right). Current planning emphasizes translating campaign objectives into the right tactical objectives (tasks). EBP adds effects as an intervening step between tactical action and campaign objectives.

This means using the traditional mission analysis process for EBO mission analysis is incomplete since it does not consider effects. Using the current mission analysis process neglects the link between effect and endstate. This creates the possibility the possibility the JFC may plan and successfully win all the battles, but may still lose the war because of the broken linkage. The E-E-L aspect of mission analysis is too important to be ignored, too complex and ambiguous to be intuitive and too *soft* to be solved by deterministic rules or approaches. In either case, a new EBO mission analysis process is required. One way to do this is by exploring the nature of the linkage between endstate and effects (situation), then identifying a method to develop the linkage (strategy) and finally determining a suitable means to go about it (tactic).

THE SITUATION

"War is thus an act of force to compel our enemy to do our will"[18] -- Clausewitz

Puzzles, Problems, Messes and why it Matters to EBO Planning

In EBP, the JFC and staff are given a desired endstate with objectives and then *decide* on a course of action (an integrated set of effects in the form of a campaign plan) to satisfy the objectives and attain the desired endstate. What to do decisions fall into one of three classes; puzzles, problems or messes/ wicked problems. Puzzles are well-structured situations where it is generally clear what and how things need to be done to reach an objective. The decision process is primarily concerned with identifying ways to optimize task accomplishment.[19] Problems are also well defined or structured. It is generally clear what things need to be done, but it may not be clear how to do so. The decision process focuses on identifying how to accomplish the objective.[20] Messes or wicked problems are unstructured situations. These situations include "considerable disagreement about what needs to be done and why; therefore, it is impossible to say how it should be done."[21]

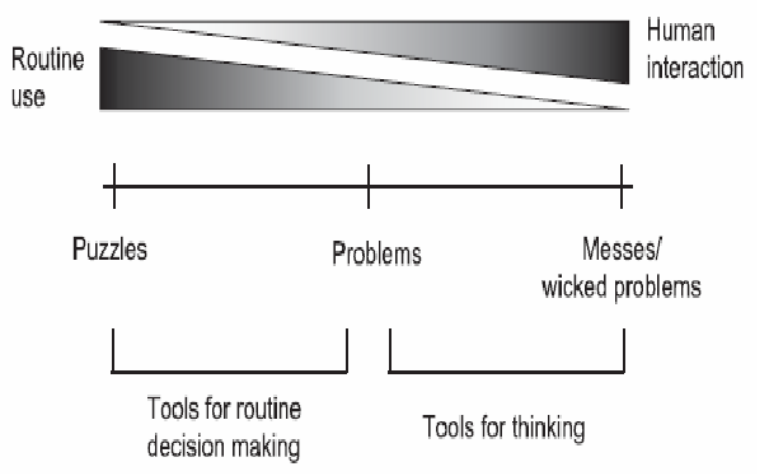

Figure 3. Tools Supporting Various Decision Types (Pidd)[22]

Fig 3 shows the appropriate tools for each type of situation. Puzzles and some problems can be resolved through tools for routine decision making. These tools include optimization models and other traditionally quantitative (Operations Research) or "hard" systems thinking techniques. Messes demand tools for thinking. Puzzles may require extensive thinking, but it is different than the thinking required for messes. Messes tend to be the most difficult to resolve. Examples include developing policy or perhaps even the family decision on where to go on next summer's vacation. EBO mission analysis is best described as a mess /wicked problem for several reasons.

A Wicked Problem

Without even knowing the definition, many campaign planners would likely describe the process of trying to identify the effects necessary to reach the desired objectives as a mess. This is due to several reasons. The adversary is a complex adaptive system, a high level of cooperation among friendly forces (including non-military) is required and 4th Generation Warfare Environment (4GW) is ambiguous and non-linear. The interlocking sets of issues and constraints confirm the situation is indeed a wicked problem.[23]

Using a Complex Adaptive System (CAS) metaphor to describe the adversary under EBO is appropriate, but complicates matters, particularly trying to plan effects to yield an endstate. CAS behavior (the thing EBO seeks to influence) is governed by the rules of complexity science. Therefore, EBO mission analysis must also consider them. There are three CAS qualities that are particularly important. CAS consist of a large number of interacting agents, they exhibit a property known as emergence, and this emergence property is not controlled by a central mechanism within the system.[24] Emergence is the growth of large-scale system behavior from aggregate interactions of less complex agents. This behavior cannot be predicted from the system's parts.[25] "Irrational" crowd action during a riot is an example of emergent behavior. Emergence is the single most important quality of a CAS and it contains the key for understanding why influencing overall CAS behavior through effects is difficult.[26] These three qualities mean CAS behavior is decidedly non-linear. This non-linearity frustrates efforts to accurately "predict" behavior.[27]

Friendly system cooperative behavior is one of the keys to successful EBO. This cooperation enables integrated application of Diplomatic, Informational, Military and Economic power. The current EBO concept calls for "virtual aggregation of individuals, organizations, systems, infrastructure, and processes to create and share the data, information, and knowledge needed to plan, execute, and assess joint force operations."[28] Likewise, holistic understanding of the adversary and environment is the key to this integration and forms the basis for all EBO planning, execution and assessment.[29]

Shared understanding is the foundation for cooperative behavior. However, building this shared understanding among Joint, Inter-Agency, and Multi-national partners, each with different ideas of the effects necessary to influence adversary behavior, will be difficult.[30] EBO planners are drawn from a variety of military and civilian, government and non-government backgrounds and organizations, each with its own culture and biases. This means each Inter-Agency planner will define the "problem" differently, according to their own unique social contextual interpretation.[31] They are not likely to initially see the situation the same way and there will likely be many different versions of what is happening, much less "what needs to be done." There are many stakeholders, determining a "solution" may be secondary to gaining buy-in from all agencies involved in implementation. There is also a requirement for accommodation among the various views in order to find a solution. This fits within the definition of a wicked problem or mess.[32]

Messes will likely dominate the 4GW EBO environment. EBO literature describes an operational environment consisting of interconnected complex adaptive systems.[33] The 2004 National Military Strategy identifies wider range of adversaries, a more complex and distributed battlespace, and technology diffusion and access as the three key aspects of this new security environment.[34] This matches the 4GW environment many envision. 4GW is non-linear, possibly to the point of having no definable battlefields or fronts. Actions will occur concurrently throughout all participants' depth, including their society as a cultural, not just a physical entity.[35] Within this environment, proponents expect EBO to obtain a desired strategic outcome or "effect" on the adversary system through the synergistic, multiplicative, and cumulative application of the full range of military and *nonmilitary* capabilities at the tactical, operational, and strategic levels.[36] 4GW threats lack structure. The need to add structure before making a decision is a property of messes. The Global War on Terrorism (GWOT) is an excellent example of this phenomenon. Defining terrorism and who is a terrorist depends on perspective. These structuring questions must be answered before any discussion can proceed about how to address terrorism.

Situational ambiguity, adversary CAS-like behavior, and planning team perspective diversity reflects "mess" or "wicked problem" criteria in Figure 3. Interpretation variety increases with situational ambiguity, especially if group members individually believe they understand the situation.[37] When planners' cultural and experiential diversity and CAS non-linearity is added to the situation, it becomes easy to see how EBO

mission analysis is a wicked problem. Consequently, the idea of "determining" effects required to reach the endstate (viewing E-E-L as a puzzle) is misleading, suggesting a degree of determinism that simply does not exist in the situation for a variety of reasons. A more informed perspective would be to view the process of attempting to influence adversary behavior towards desired endstate as an exploratory process (viewing E-E-L as a mess). The effects most likely to influence the adversary toward the desired endstate will probably not be obvious, but must be discovered or learned by planners.

STRATEGY

> *"Strategic theory, therefore, deals with planning; or rather, it attempts to shed light on the components of war and their interrelationships"*[38] *- Clausewitz*

A Way out of the Mess…Analysis as Learning

EBO mission analysis is a Mess or Wicked Problem. Vail coins the term "permanent whitewater" to describe Messy and ill-structured situations.[39] Learning is his solution to surviving and thriving in these types of situations.[40] Czerwinski echoes the same idea in recommending "aids" to learning as a way of understanding complexity. He differentiates between "aids" and "tools" noting in situations beyond mildly non-linear "nothing so overt as a tool can be preassembled." This is important since adversary emergence is a non-linear phenomenon. Instead, he insists the appropriate response requires use of more tacit "aids" that improve learning in novel situations.[41] He points out traditional problem solving really doesn't occur in complex, non-linear environments. Instead, individuals learn to "cope with the environment."[42] This means instead of looking for an analysis tool to link endstate with effect, planners do much better approaching the EBO mission analysis process as one of discovery using "aids" to help them learn, so they can understand the nature and eventually develop campaign linkages connecting effects generated by tactical actions with the desired endstate and objectives. Adversary, friendly system and environment each impose learning requirements on the learning "aid."

Conceptualizing the adversary as a CAS requires the ability to understand behavior as a whole, not merely reduce it into its PMESII sub-systems. Just because planners understand the parts, does not mean they understand the whole. Localized interactions within and between the various subsystems can create strikingly different and unforeseeable behavior at the aggregate system level. This means reductionism does not apply to complex systems.[43]

Developing shared understanding is a learning process.[44] It is also the necessary prerequisite to integrated action. Generating shared understanding is particularly difficult in complex, ambiguous situations. In these situations, people tend to resort to what they know. This means they rely on mental models formed over years based on both education and experience.[45] Therefore, building shared understanding requires a learning process designed to accommodate and then allow individuals to challenge their mental models.[46] This must be a deliberate social learning process. In order to have any hopes of building a shared understanding, a learning strategy must provide a means to make the various planners' mental models explicit so they can be discussed and debated.[47]

The value of using multiple perspectives in confusing situations has long been acknowledged.[48] The 4GW environment is ripe with confusion and uncertainty. The concept of "reframing" the environment was pioneered by Bolman and Deal as a technique to improve managerial understanding and decision-making in complex environments. Managers reframe by viewing messy situations through a variety of frames until they make sense.[49] The ability to reframe situations allows individuals to see and understand more of their environment and it is crucial to creating new opportunities and discovering new alternatives.[50] Thus, reframing becomes an important part of mission analysis learning

Technology as a Strategy

Despite the nature of the situation and the resulting need to employ a learning strategy within the EBO mission analysis process, there is a definite role for technology. However, this role, particularly how computers should be used, is important to understand. Computers will not structure an unstructured situation. They cannot, therefore, handle messes in isolation (without aids for thinking). Once the situation is structured, computers can help process data. In this way, computers don't solve the problems. Computers speed human learning and increase insight into how situational factors may influence overall system behavior. For example, even CAS behavior may be predictable within certain localized limits. The resulting predictions may be used as part of EBO mission analysis. However, the data is only a prediction (like the weather) and should never be blindly accepted as the solution just because it is what the computer spit out.

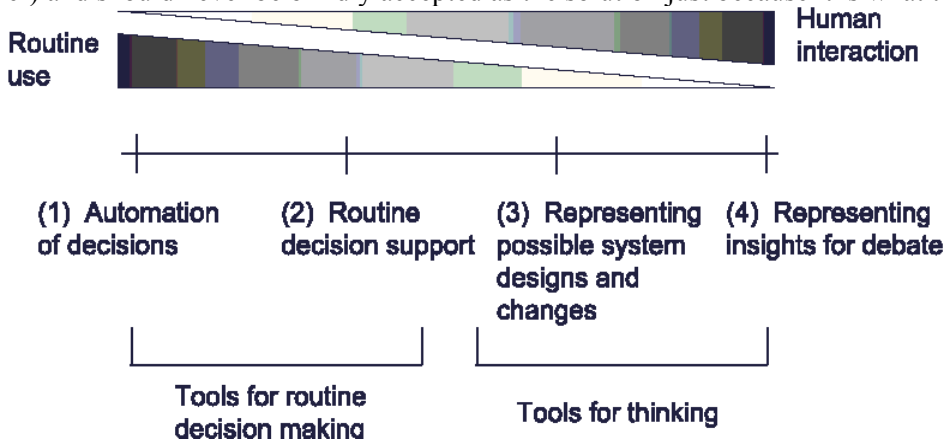

Figure 4. Technology Use in Various Decision Situations (Pidd)[51]

Figure 4 shows the use of technology and computer-based models across the various types of situations. As the situation becomes increasingly unstructured, the technology becomes more useful as an aid to debate. A lack of understanding about the nature of the relationship between EBO endstates and effects may inadvertently create a condition where mission analysis is viewed as a puzzle, prompting some to try and use computers for decision automation and routine decision support. This is counterproductive. Instead, technology should be used in EBO mission analysis to explore potential system changes and support planner learning through debate. Emphasizing technology without equal (or greater) emphasis on creating processes and methodologies to use the technology to facilitate learning invites its misuse within EBO mission analysis.

TACTIC

"Our behavior is driven by a fundamental core belief: The desire and ability of an organization to continuously learn from any source-and to rapidly convert this learning into action-is the ultimate competitive advantage"[52] – Jack Welch, CEO, General Electric

Using a Screwdriver for a Nail: Problems with the Current Approach

The current EBO approach to determining a set of effects to achieve the desired endstate is depicted in Figure 5. In broad terms, planners define the endstate in terms of individual Political, Military, Economic, Social, Informational, Infrastructure (PMESII) subsystem behaviors (B4, 5, 6). These endstate PMESII

system behavior characteristics are then compared to initial state PMESII system behavior (B1, 2, 3) in a "cut" method. The differences in the state of each individual system are identified as the required effects necessary to generate the desired endstate.[53] This method allows the use of advanced analytic models because the behavioral change is examined on an intra-system level (e.g. political endstate vs. political initial state). However, there are fundamental problems with this approach.

The most obvious problem is the reductionist nature of the approach. Reducing overall adversary system behavior into component subsystem pieces does not adequately address the CAS quality of emergence. According to Nobel Laureate Murray Gell-Mann, "when dealing with any non-linear system, especially a complex one, it is not sufficient to think of the system in terms of parts or aspects identified in advance, then to analyze those parts or aspects separately."[54] Overall adversary behavior at the system-of-systems level is an emergent quality, existing not within the various PMESII systems, but generated as a product of their interaction. Therefore, as an emergent property, system behavior cannot simply be "cut" into its component pieces without the probability of losing something. Failure to correct this problem means under the current approach, even if the identified effects are successfully generated within the individual adversary systems, the desired overall change in the aggregate adversary system may not be reached (thus not reaching the desired endstate). In other words, successfully changing the parts may not result in the desired overall change to the whole!

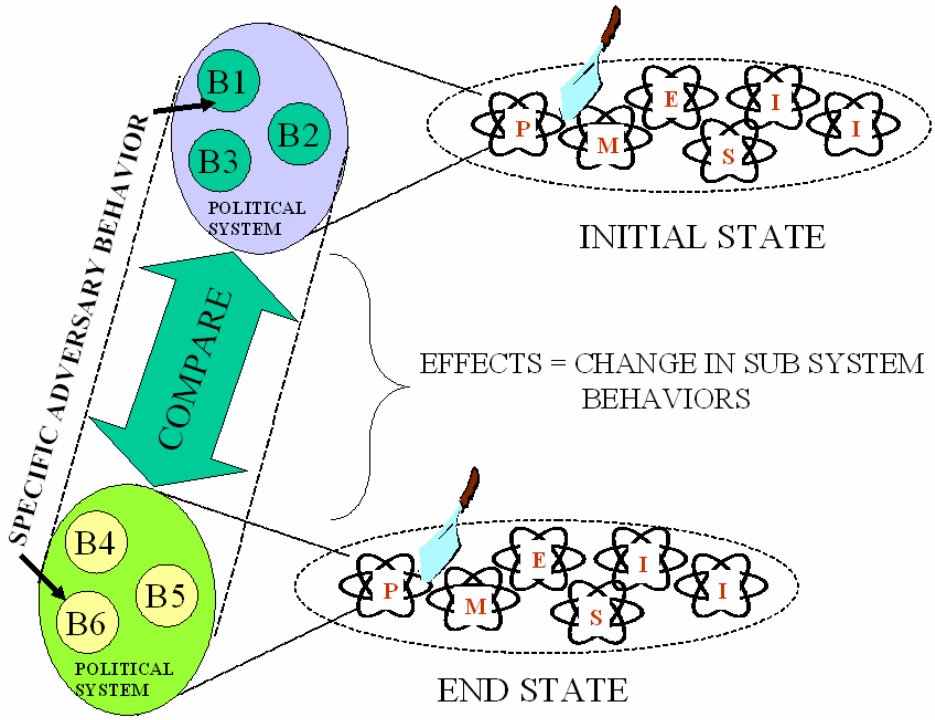

Figure 5. Current EBO Mission Analysis *Cut* Approach

The current approach lacks a means of accommodating the inherent ambiguity associated with the situation and the potential disconnects among various planner perspectives. Expecting State Department and Defense Department planners to agree on the exact problem is (much less solutions) is asking a lot. High level national policy disagreements within the US Government as publicized in the media during Operation IRAQI FREEDOM illustrate this point.[55]

Soft Systems Methodology (SSM) as the Tactic of Choice: A Better Way

SSM[56] or a similar qualitative approach appears to be the solution to developing an EBO mission analysis process. Within the EBO mission analysis context, the methodology is promising for a number of reasons. The approach departs from current practice and does not initially attempt to establish a cause and effect relationship between effects and endstate. SSM allows planners to instead use endstate as a lens to identify problematic adversary system behavior (Figure 6). This problematic behavior then becomes the subject of improvement efforts (EBO effects).[57] The SSM-based approach uses conceptual models to understand, learn about, and define the problematic adversary behaviors. The methodology's soft aspect allows planners to analyze adversary behavior as a whole using the concept of a Human Activity System (HAS). The HAS represents emergent adversary system behavior resulting from interactions and components spread throughout the PMESII systems. This approach resembles a "slice" approach as shown in Figure 6.

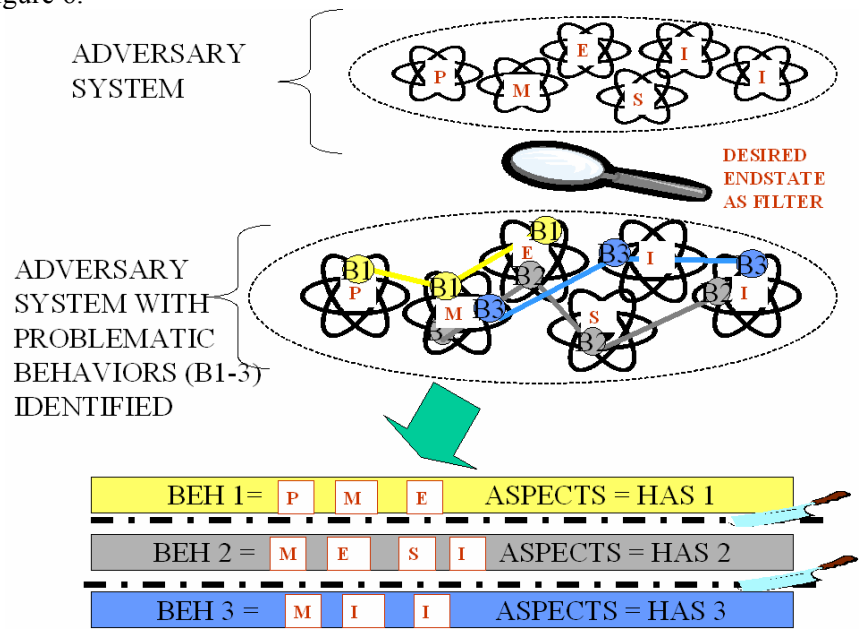

Figure 6. Proposed SSM-Based EBO Mission Analysis

Fig 7 shows the basic approach using SSM as a means of linking effects and endstate during EBO mission analysis.[58] The inputs into the methodology are the endstate and strategic objectives. The outputs are shared understanding and an initial set of effects. This initial set of effects serve as the basis for continued planning by subordinate commanders as part of the E-N-A-R planning process. Figure 7 also shows the overlap between the traditional SSM stages and the EBO mission analysis process.

The process is not a rigid checklist but an iterative process. It is likely planners will generate questions in subsequent stages forcing them to go back and re-examine earlier conclusions. For example, it is possible planners' discussions while building the rich picture in stage 2 will reveal missing data that should have been included in Stage 1. This does not mean stage 1 was performed incorrectly, only that by stage 2 planners have developed a deeper understanding of the situation and potential actors influencing it. In this way, SSM promotes problem structuring through learning.

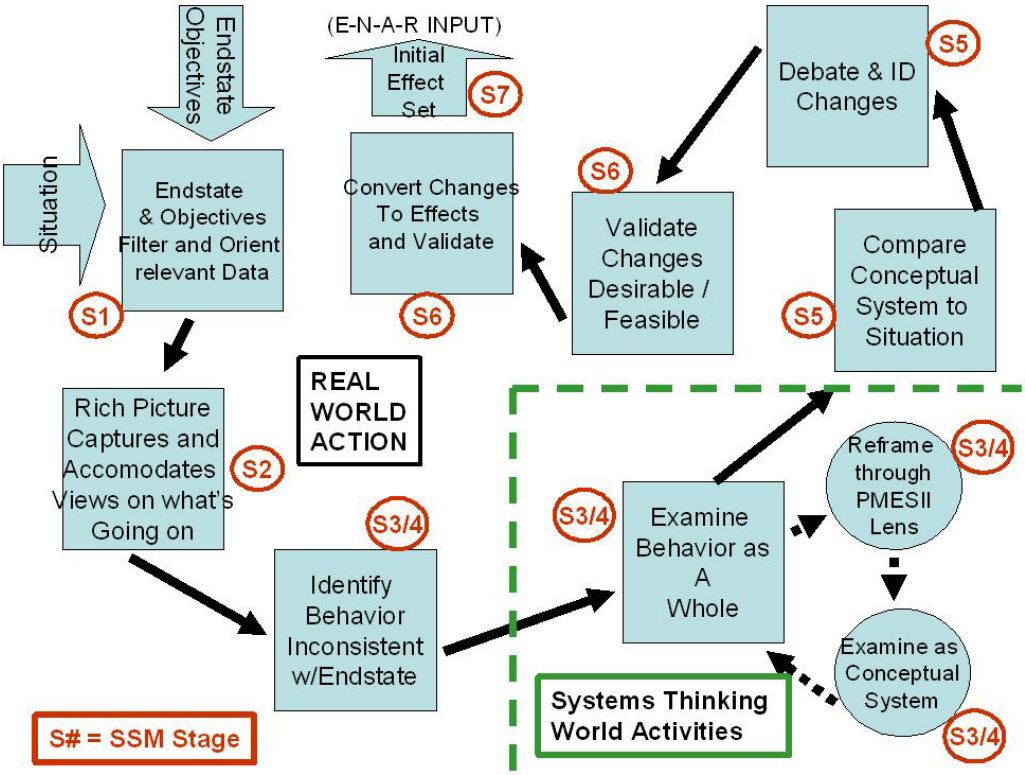

Figure 7. Basic Steps of Proposed EBO Mission Analysis based on SSM

Simplified Scenario Application

The scenario presented at Appendix A is a hypothetical situation to illustrate the basics of how an EBO mission analysis based on SSM might develop the link between endstate and effects[59]. The example is greatly simplified and introduces the general process. It does provide an overview and feel for how planners would hypothetically perform mission analysis by applying SSM to answer the question of "what effects will lead to the desired endstate?"

Stage 1: Situation Exploration - What Factors May be Influencing Behavior

The goal of stage 1 is to examine the situation without invoking preconceived notions. It is immersion-based, exploratory and iterative. The purpose is to get a "feel" for what is going on and the factors influencing the situation.[60] In this case, planners begin by identifying the key scenario behaviors or actions related to the endstate or objectives. This involves identifying actors, behaviors and other factors in the situation that initially seem to be important in understanding regional security (the desired endstate) and why Jupiter might invade (the strategic objective). Another way to think about this would be looking at the present in light of the future (desired endstate and objectives) to identify what things will be most important to understand. In this case, examples of key factors are listed in Table 2.

The stage may sound similar to the current Intelligence Preparation of the Battlespace (IPB) process, but it is not the same.[61] SSM data are gathered from numerous traditional and non-traditional sources, many of which are considered outside the bounds of current intelligence products. Both qualitative and quantitative data are collected, including instruments such as surveys, observations and measurements.[62] History, culture and even media reports may also be important to include. SSM's inclusion of broad, non-traditional

intelligence data is consistent with the latest suggested doctrinal changes to Joint Pub 2-0 *Intelligence* in light of EBO.[63]

Table 2. Examples of Key Factors from Scenario

Data Element	Inclusion Rationale
History of Region	Both nations were formed from Mercupiter, invasion may be seen as reunification
Culture	Jupiterians have distinct culture, invasion may be viewed as rational alternative if assimilation viewed as unlikely
Key leaders	Will make the decision to invade
United States	US trade is 40%, economic and personal ties
Terrorist Organizations	State-sponsored by both sides, escalating violence destabilizes relationship, may setoff an invasion
Russia	Potential to influence Jupiter behavior and dissuade against invasion
Industrial base of Jupiter	Failing due to high inflation and outdated production methods/ gov't must make radical unpopular changes / original reason for influx into JCY
Industrial Base of Mercury	Initial cause for 1951 influx into MCY
Saturn	Key Jupiter trading partner
Jupiter population	Will support invasion if viewed as just
MCY Jupiterians	Seen as Oppressed brothers of Jupiter population

EBO experiments in the United Kingdom confirm the value of this type of initial exploration of the situation prior to attempting to generate effects. During the first UK Effects Based Planning Experiment held in October 2003, the analysis team's initial task was "situating themselves in the data before looking at the database within the tools."[64] This represents the type of collective "sense-making" that should occur during Stage 1 of SSM applied to EBO.

Stage 2: Problem Situation Structured – Accommodating Different Views of What is Going On

The second stage of the process builds onto the first, but in practice, the two are typically performed simultaneously.[65] The purpose of stage 2 is to display the situation so a range of possible, and hopefully relevant, choices can be revealed.[66] In practical terms, Stage 2 produces a "Rich Picture" (RP) capturing key elements of structure, processes, climate and issues within the situation in graphical format.[67] The rationale for using a picture as opposed to narrative description is related to the old adage "a picture is worth a thousand words." More specifically, since the purpose of stage 2 is to rapidly gain an overall "sense" of an extremely complex and multi-faceted situation, a picture is a far better means to quickly capture the essence of what's going on.[68] The trillions of PowerPoint slides produced annually around the world also testify to this truth.[69]

RP contain certain elements. Structures are those aspects of the situation that are relatively fixed and slow to change.[70] In the scenario, these include elements such as the various countries, the MCY industry, the economic ties between nations and the religious ties between the Jupiter population and the Jupiterians in MCY. Processes are the key actions (physical or otherwise) carried out within the situation. They will typically be more transient in nature.[71] In the scenario, process elements include terrorism and the growing power of Jupiterians within MCY. Climate is the result of the interaction between structure and processes.[72] Jupiter's failing economy is an example of climate within the scenario. Issues are both hard facts and subjective opinions capturing the contentious aspects of the situation and may also represent attitudinal barriers to progress.[73] Jupiter's massing forces along the border while threatening invasion and Jupiterians view that their "brothers" in MCY are suffering oppression are issues examples.

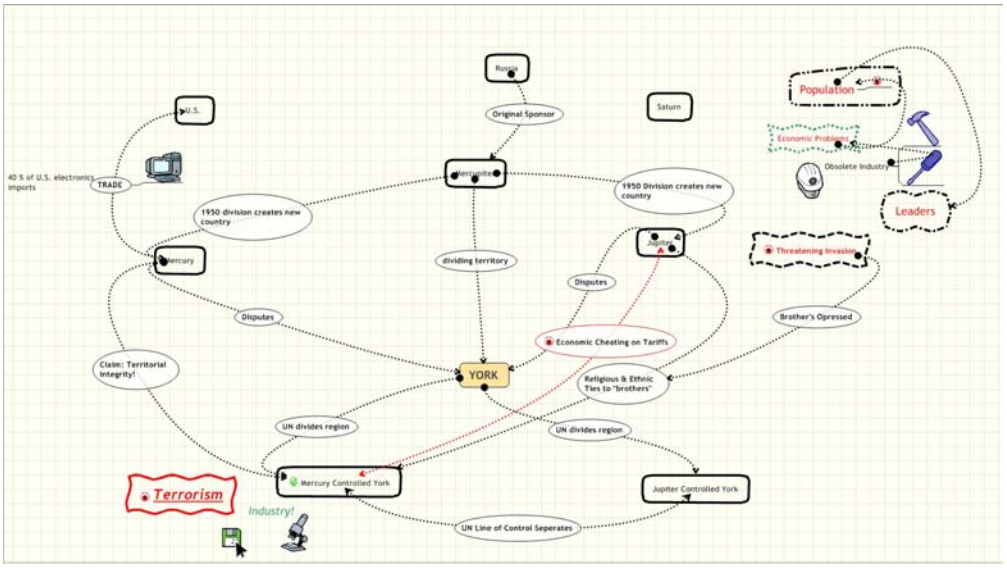

Figure 8. Example Rich Picture Drawn from Scenario[74]

Rich picture development is iterative and continues until the final version accommodates the variety of planner views of what's going on in the situation. Fig 8 is a Rich Picture developed based on the scenario. The picture simultaneously reflects a variety of behavior believed important to the situation. These include terrorism, Jupiter's internal problems, the military buildup and the historical roots of the dispute. The purpose of the rich picture is not to say conclusively which of these adversary system behaviors, if successfully influenced through EBO, is the answer to reaching the endstate, but rather to accommodate each of them as part of a larger system.

Stage 3: Root Definitions – Identifying, Viewing and Reframing Problematic Behavior

Stage 3 goes from real world *action* into the systems thinking world of conceptual *activities*. The purpose of the stage is to identify the aspects of the situation causing it to be viewed as a problem. In practical terms, this means identifying those behavioral aspects of the situation inconsistent with the desired endstate and objectives. Once planners perform this task, they develop a conceptual Human Activity System (HAS) based on viewing the behavior through a designated PMESII perspective or World View. Finally, planners "reframe" the behavior and define alternate systems based on different World Views.

Table 3. Example of Scenario Problematic Behavior (Themes) Based on Endstate

Behavior / Action	**Why Problematic**
Jupiter's threatened Military Invasion	Objective is to prevent invasion and invasion not seen as conducive to long-term regional security
Terrorism by Jupiter's Thunder	Destabilizing the region
MCY Jupiterians circumventing taxes and fees	Potentially negative unintended impact on already failing Jupiter economy

Figure 8 captures the various planner perspectives of what's going on in the situation. Problematic behavior within the situation must be identified next. In other words, why is the current situation in the region a problem for the JFC? The answer is based on using the endstate and objectives as the reference.

This idea is captured in Figure 6 by the magnifying glass. The magnifying glass is the filter through which the current situation is seen and interpreted. Table 3 lists several potential "problematic" behaviors based on the scenario endstate and objective.

Once these behaviors are identified, they are classified as "themes" and represent the set of adversary system behaviors in the situation inconsistent with the desired endstate. By definition then, these themes are the set of adversary behaviors that must be changed to make the desired endstate a reality. Changing these aspects of adversary behavior represent the most effective way of reaching the desired endstate. This is an essential element of the logic behind using SSM for EBO mission analysis. It is a qualitative, rigorous process forming defensible connections between effects and endstate. Theme identification also provides initial structure to the messy situation and forms the basis for the learning that will occur in subsequent stages. Stage 3 of SSM has also avoided the trap of assuming the "problem" is somehow obvious or objective.

Table 4. Examples of HAS based on Scenario Invasion Theme

Conceptual System	**WV**
Regime Stability System	Jupiter's Government desires to stay in power and is concerned with mounting internal pressures. Capitalizing on a legitimate external enemy will generate popular support for a conflict viewed as "just." Invasion is legitimate means of diverting Jupiter's population away from internal problems.
Economic Improvement System	Poor economy is caused by poor production capabilities. Mercury possesses advanced production capabilities in MCY. Invading Mercury will allow capture of the facilities and production capabilities required to improve Jupiter's economy.
Dispute Resolution System	All other means of resolving the dispute have been exhausted and military action is being used as a last resort. Mercury's recent activities are causing the dispute to be worse.
MCY Jupiterian Protection System	Jupiterians in MCY are being oppressed and persecuted through state-sponsored terrorism. Jupiter has a legal and moral right to protect the MCY majority from tyranny by the minority. MCY's close religious and ethnic ties to Jupiter justify intervention.
Defeat Mercurian Military Forces	Invasion is a prudent military act to prevent Mercury from gaining an unacceptable military advantage. Mercury's forces continue to gain a significant qualitative advantage and something must be done or the regional balance of power may be destroyed.

Themes become the starting points for developing conceptual Human Activity Systems (HAS). HAS are tools for thinking about the situation in a systematic manner. In developing them, the key question planners answer involves determining "what purposeful action is taking place in the situation and under what world view does it make sense?" Each action/world-view combination forms the basis of a HAS. HAS reflect "If (action theme) were a system, how might it be described?" Table 4 lists possible HAS based on the scenario.

Table 5. Example of Root Definition for Regime Stability HAS

Root Definition: A system owned by Jupiter's national leaders, operated by key military leaders to stabilize the regime by generating popular support among the domestic Jupiterian population; turning attention away from Jupiter's internal problems toward a worthy external cause focusing on an external enemy. The system maintains an heir of international legitimacy.

Table 6. CATWOE Elements for Regime Stability HAS

CATWOE Elements	Scenario Example
C - Customer	Jupiter government leaders
A - Actor	Jupiter key military leaders
T - Transformation	Regime unstable → Regime Stable
W - Weltanschauung	Capitalizing on a legitimate external enemy will generate popular support for a conflict viewed as "just." Invasion is legitimate means of diverting Jupiter's population away from internal problems (Political frame)
O - Owner	Senior Jupiter government leaders
E - Environment	UN 1950 Treaty / World Opinion /

HAS are expressed by generating a Root Definition (RD). Table 5 shows the Root Definition for the conceptual Regime Stability system. Developing the RD is structured to ensure all relevant aspects of the system are captured. By capturing the CATWOE elements (Table 7) in the RD, a coherent system is developed satisfying basic open system requirements.[75]

Specifying a PMESII Perspective as part of World View

Specifying a PMESII perspective is a modification to the SSM process. Weltanschauung is a German word literally translated means "World View" and is the most important element of the Root Definition.[76] It captures the viewpoint, explaining the action as part of a purposeful system. This is critical since the same real world action can be described simultaneously by multiple Human Activity Systems based on viewpoint. Consider the case of developing a HAS using terrorism as a theme and based on action by Jupiter's Thunder. If the HAS is developed based on a Mercurian perspective, Jupiter's Thunder might be described and modeled as a "terrorist" system. However, if viewed from a Jupiterian perspective, the same action might generate a HAS described and modeled as a "freedom fighting" system. Both are equally valid HAS, based on the observer's world view (WV).[77] The goal is not to decide "which model is right." Both are right based on perspective. What is important is exploring scenario action from multiple perspectives as a means of better understanding it and eventually developing changes to improve it.

The ability to interpret and understand the same action or behavior differently based on World View has serious EBO implications. EBO uses PMESII as a default model to describe the adversary. Returning again to EBO's goal of influencing adversary behavior, a potential problem emerges. The same adversary behavior can simultaneously be understood as part of several PMESII systems based on WV. This generates a requirement to specify a PMESII perspective for each HAS. Consider an EBO approach to Jupiter's threatened invasion. Planners might be tempted to focus their mission analysis on identifying desired effects within Jupiter's military sub-system only (viewing the problem as Jupiter's military forces being positioned near the border). They would then develop unified tactical action (Figure 2) to generate these effects. Consider a second perspective or WV on the same real world action where planners examine the threatened invasion as a regime stability system by Jupiter's leaders as reflected in Table 5. This would mean the HAS WV would be based on adapting a political perspective (concept of maintaining power). Tagging the HAS as a political-based system at this stage captures planner perspectives and also suggests the system framework (not necessarily the PMESII system) the effects must eventually be applied and understood within. Therefore, World View succinctly captures the assumptions planners make about the system.[78] Capturing PMESII perspective during this stage of the process forces planners to specify a viewpoint for the particular HAS and is an important record-keeping aspect of the mission analysis process. The eventual "effects" planners decide upon might be very different in the two cases. Just as in the previous example, the purpose is not to say which is right or wrong at this point. It is to examine the situation from a variety of relevant perspectives, since reality is probably a combination of both (Figure 9).

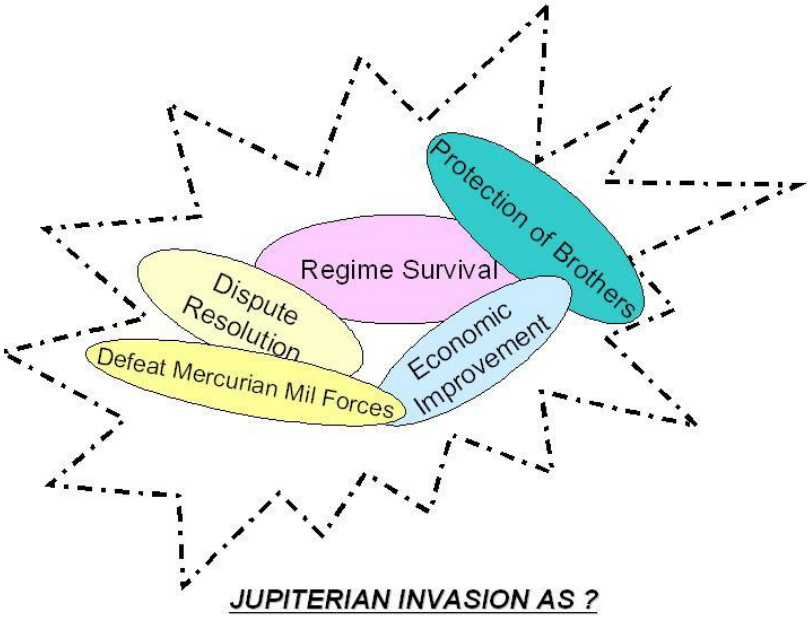

Figure 9. Combination of Perspectives to Examine Jupiterian Invasion

Forced Reframing

Reframing was one of the previously identified learning requirements. This is accomplished using the Ledingtons' Expectancy-Desirability-Importance (EDI) Matrix (Table 7).[79] HAS should be generated for all the themes identified in this stage of EBO mission analysis. The appropriate matrix quadrant for each is then determined. The HAS based on viewing a military invasion as a regime stability system would fall into quadrant II. Quadrant determination is subjective, but the discussion that accompanies the determination is valuable.[80] Planners must assess how important is viewing the action through the framework suggested by the HAS (Importance). They must also determine the degree to which they expect the model to be like the real world action (Expectancy) and the degree to which it is desirable to think of the real world action in the terms of the model (Desirability).

Table 7. EDI Quadrant Determination Matrix (Ledingtons')[81]

	HIGH DESIRABILITY	**LOW DESIRABILITY**
HIGH EXPECTANCY	**Situation ought to be like the model and the model is desirable in the context. (I)**	**Situation expected to be like the model but the model is undesirable. (II)**
LOW EXPECTANCY	**Situation not like model but model is desirable (IV)**	**Situation not like model and model is undesirable. (III)**

Using the HAS based on a regime stability system, the importance might be considered high. The scenario indicates Jupiter's leaders hold on power (regime stability) may be threatened due to the country's internal problems. Put another way, eventually effects must be generated to do something about this aspect of the problem. The expectancy is probably also high. It seems plausible focusing attention away from internal pressures by threatening an invasion could weigh heavily on Jupiter's leaders mental calculus as they consider the decision to invade or not. Desirability is low. From the U.S. planner perspective, Jupiter's use of an invasion as a means of staying in power is not desirable.

In a similar manner, planners ensure at least one HAS in each of the four quadrants is developed for each theme. In this case, planners would develop HAS representing quadrants I, III, and IV. This may initially appear hard to justify, especially since corresponding action may not be present in the real world. However, EDI matrix variety is important. Specifying a viewing perspective is a critical aspect of examining any complex system since any discussion of complexity is context-dependent, even subjective.[82] Additionally, each HAS is based on examining adversary behavior through a different perspective or "frame."

By developing conceptual systems, planners make their underlying tacit mental models explicit and open to debate. During the resulting discussions, they articulate why they believe certain aspects of the situation are related to the endstate and why they believe viewing the situation through the "frame" suggested by the HAS will be beneficial (providing insight and learning). Since the HAS is conceptual, planners are free from arguing the rightness or wrongness of the models and can, instead, focus on the insight gained from viewing the problematic behavior through the various frameworks suggested by the models.

Stage 4: Conceptual Models – A System Diagram

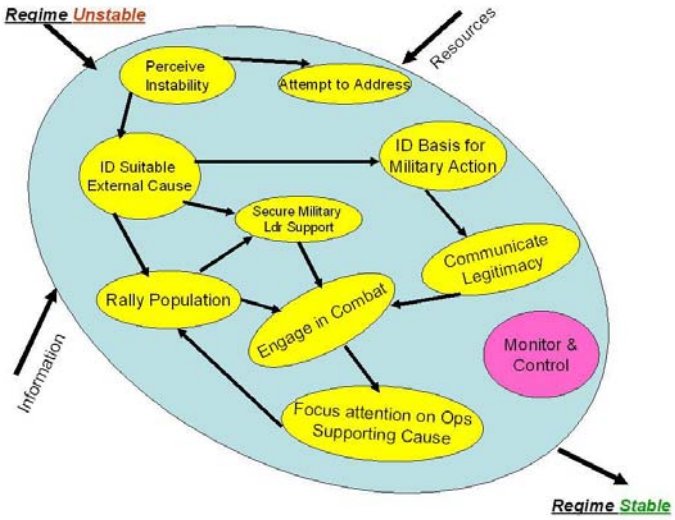

Figure 10. Example of Regime Stability Conceptual Model

Conceptual Models are representations of idealized systems. They allow planners the freedom to build idealized systems better understand the real world problem situation. CM capture and examine adversary system behavior as a whole, rather than forcing reductionism. Logical consistency, not fidelity, is the key to model utility.[83] CM are checked against their root definitions to ensure consistency. Other system thinking methods such as Systems Dynamics can also be used.[84] It is here where higher fidelity models (technology) can be used as tools to support thinking and learning. Their purpose is not to provide the answer, but to validate and enhance planners understanding of the factors influencing situation. Figure 10 is an example of a Conceptual model for the Regime Stability HAS based on interpreting the invasion (undesired behavior in light of the endstate and objectives) as a system to allow Jupiter's government to stay in power.

Stage 5: Comparison – Making Mental Models Explicit and Learning

During this stage, the conceptual models are compared to the real world action to examine similarities, differences. Planners use comparison results to suggest system changes. The output of the completed stage is a list of system changes and a direction for the changes (positive or negative) for each of the key themes identified in stage 2. This makes common sense and experience (in the particular action area) the key analytical skills.[85] There are a variety of ways to perform the comparison. One approach is to use a basic set of questions to make general observations about differences between the Conceptual Models and Real World Action.

Planners perform this comparison by examining the various conceptual models associated with each particular action theme. Each conceptual model represents a different interpretation of the action occurring. This provides an opportunity to examine the implications of viewing the problematic behavior within a certain frame of reference. For example, if the threatened military invasion is viewed as an attempt by Jupiter's leaders to stay in power, what system changes would be beneficial or detrimental given the current situation?

Model overlay is another type of comparison. The purpose of the model overlay is to suggest specific changes based on the EDI quadrant the model falls within. The Rich Picture is used to identify the key aspects of the real world action that are then captured in a rough HAS model template and compared to the CM. The real world action won't fit or necessarily completely match the HAS template. This is not a problem because the goal of the comparison is to stimulate and structure the debate over changes necessary to improve the real world.

Differences between the real world and the HAS model are recorded and specific changes are suggested according to the particular E-D-I quadrant rules in Table 8. The quadrants for Table 8 are determined using Table 7 quadrant descriptions. For Quadrant I, the model is expected to be like the situation and the CM is desirable. Activities without a real world action equivalent suggest planners should consider changing the system by adding a related action in the real world situation. Similarities between the real world and HAS suggest further analysis may be warranted to analyze the functioning of the sub-systems.

Table 8. EDI Comparison Table (Ledingtons')[86]

	HIGH DESIRABILITY	**LOW DESIRABILITY**
HIGH EXPECTANCY	**Identify weaknesses of situation in relation to model. develop ways of improving operation of activities (I)**	**Initiate action to remove (or constrain) operational aspects of situation that are like the model. (II)**
LOW EXPECTANCY	**Initiate strategic action to action to identify consider, decide, design, implement and develop appropriate purposeful action in situation. (IV)**	**Strategic action to identify any threats that unwanted activity might develop and develop preventative measures. (III)**

Quadrant II changes are based on finding similarities between the CM and real-world action. The CM represents a HAS expected to be like the situation, but the CM is considered undesirable. Similarities should be identified and recorded as suggested changes to reduce or eliminate the matching elements. In the example of invasion as a system to ensure regime stability, Jupiter is using its military power to divert

internal attention away from domestic issues by focusing the population on an external foe to generate popular support. Their purposeful action is not to start a major regional war threatening national survival, invite the US to intervene or pay more attention to the region (although planners might explore each of these as potential HAS in stage 3 and 4 if desired).

If "communicate legitimacy" was an activity in the HAS model (Figure 10) and occurred in the real world (through means such as a comprehensive Jupiterian international media campaign supporting their position), a desired system behavioral change might be to reduce Jupiter's ability to "communicate legitimacy." The change is targeted within the Political PMESII subsystem as identified in stage 3. This does not rule out eventual military action, but this would be a premature discussion at this point in the process. Military action is a means of generating effects, but may not be the best. Granted, the "problem" may appear on the surface to be Jupiter's fielded forces threatening to invade Mercury. However, in this case, the scenario suggests the invasion must at least be considered from more than just a military perspective. It also means the final set of effects should include system changes necessary to improve more than just the military aspects of the situation (and military subsystem). This means even the apparently military "problem" of the threatened invasion has behavioral aspects within the political sub-system. Using SSM helps identify these aspects. The invasion in this case must be viewed and evaluated through a political system PMESII lens and perhaps equally important, eventual actions and effects must be understood within this framework. Finally, this analysis suggests military action alone viewed within the military perspective as a change to the military sub-system (destroying the capability of Jupiter's fielded forces) will be insufficient to reach the desired endstate. Changing Jupiter's ability to communicate legitimacy is presented as one piece of a comprehensive set of changes (generated from all relevant HAS). The collection of adversary system changes represents improvements to the overall problematic behavior from stage 2.

HAS within Quadrant III will not normally have a real world action to compare against. This is because the HAS represents a system that is neither present nor desirable. What is the value of such a conceptual system to EBO planners? The system captures a viewpoint (the WV associated with the HAS) and a set of actions that do not necessarily exist, but would be detrimental to planners attempting to achieve the desired endstate and should be prevented through proactive action. HAS from quadrant III become the basis of undesirable effects the campaign plan must guard against.

Changes based on Quadrant IV are similar to those of Quadrant III except they represent WV and actions that should be developed and promoted. These HAS suggest new systems that might be beneficial and improve the situation. For example, there is no system for the U.S or Mercury to provide economic aid to Jupiter. Such a CM, if developed might be described as a system to improve Jupiter's failing economy. When compared to the actual scenario, specific changes throughout Jupiter's PMESII system might be identified. It's important to note the value of SSM in promoting a holistic view of problematic behavior. Even though the CM is based on improving economic conditions, the changes (and eventually effects) to achieve this are not confined to the economic system. Stage 5 concludes with a list of specific changes to the system discovered and logically developed through the first 5 stages of applying the SSM process.

Stage 6: Deciding on Changes – Going from Changes to Initial Effect Set

Stage 6 takes the list of system changes generated in Stage 5 and translates these changes into a specific list of system effects. This stage contains the greatest departure from Checkland's methodology. During this stage, EBO planners validate the proposed changes using Checkland's suggested criteria.[87] They next convert the changes into effects using Cain's Constructive and Destructive verbs (See Appendix B).[88] Finally, effects are validated against criteria developed by Turner, Preece and Round.[89]

Despite the rigorous process, the proposed changes to the adversary system must be validated. SSM literature proposes checking changes against two criteria; feasibility and desirability.[90] Each change is examined to ensure it is feasible to the key audiences (identified in the Rich Picture) in terms of the history, politics and culture associated with the situation. Reducing Jupiter's ability to communicate legitimacy must be *feasible* in light of the nation's politics, culture and history. It must also be desirable in the same terms

and not generate new "problems." Satisfying these validity checks, the changes are considered valid changes to the Jupiterian system and are next converted to effects.

Changes are converted into effects by using the description of the change and the direction (positive/negative) to assign an appropriate constructive or destructive verb according to Cain's EBO Universe.[91] Each HAS contains a WV and Transformation. These are used to help identify an appropriate effect. The Transformation identifies the type of action (verb) and the WV suggests the system the effect should be focused towards (but not restricted to) and the framework the effect must be understood within. This makes sense because the action is understood within context and the WV describes the desired context. Reducing Jupiter's ability to communicate legitimacy is a negative change. A potential corresponding effect would be to neutralize Jupiter's capability to communicate the legitimacy of their invasion to the international community.

Planners may have determined this was an appropriate effect using intuition, without applying SSM to perform mission analysis. However, the value of SSM is the structured systematic process planners used to develop the linkage between this effect and the desired endstate. Rather than planners simply suggesting changes based on their mental model (which others may not necessarily understand or agree with), using SSM captures and makes linkages explicit in each progressive stage. Debate is generated and a shared learning environment results.

After converting changes to effects, the effects are subjected to a second validity check. The validity check is based on criteria identified by Turner, Preece and Round.[92] Valid effects are viable. Friendly forces should have the capability to achieve them. Friendly forces should also be willing to execute the tactical unified actions required to generate them. Finally, they must be measurable. An effect successfully passing these criteria is considered valid and is added to the effects set for the given system.

Identifying the initial set of effects completes the new EBO mission analysis process. Returning to the EBO planning process initially presented in Figure 2, the mission analysis is integrated as shown in Figure 11. In this way, SSM-based mission analysis serves as a front end for the more quantitative E-N-A-R process. In this way, the mission analysis proposed in this paper is really a problem structuring approach.

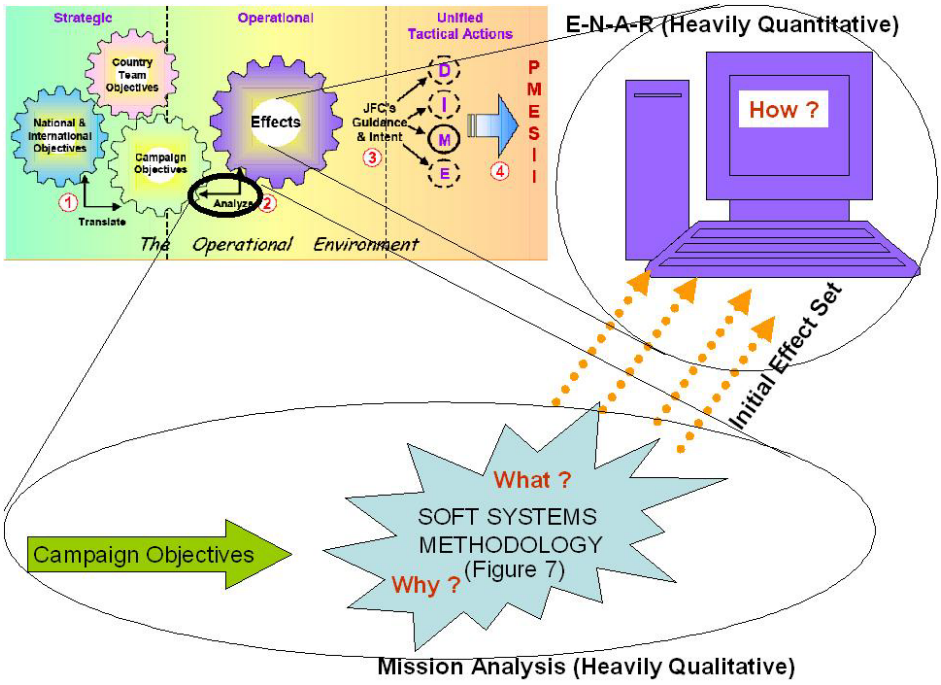

Figure 11. SSM-based EBO Mission Analysis as Qualitative Front End

Limitations

An EBO mission analysis process based on Soft Systems Methodologies does have limitations. Perhaps the most obvious is the same as is commonly leveled against SSM; it does not fully develop the campaign plan. Identifying a set of effects is not a campaign plan. As the adage says, "the devil is in the details." This is quite true, planners identified neutralize Jupiter's capability to communicate the legitimacy of their invasion to the international community as a desired effect, but who will take what action to achieve it? SSM does not answer this question. However, it's important to note mission analysis does not focus on answering the how question. The E-N-A-R process would take the effects and begin to identify the actions necessary to generate them. This next level of specification would fall primarily to subordinate commanders.

EBO mission analysis based on SSM as presented still requires refinement. Only the general steps of the process have been presented here. Integrating the process into the current campaign planning process will require overcoming several cultural and doctrinal barriers. Using SSM to support understanding and developing E-E-L through EBO mission analysis is largely a qualitative process. It is also very much situationally dependent. It will be applied differently in every situation by different users. This means exact results will not likely be reproducible. This is not really a problem because every adversary and situation will be different.

CONCLUSIONS

Deciding what to do has always been the first priority of successful command and control. Within EBO campaign planning, this makes the mission analysis process critical. EBO mission analysis requires more than the traditional task-focused process can provide. In the complex 4GW environment, planning unified tactical action to achieve desired effects is a serious challenge requiring due diligence in the development of tools and processes to better enable it. Yet, being able to better plan, execute and assess effects is only half of the solution. Planners must understand and develop a linkage between endsate and effect as part of a comprehensive EBO mission analysis process.

This paper has presented an alternative to the current mission analysis process. A new process based on using Soft Systems Methodology appears to resolve several of the shortcomings of using task-focused mission analysis to perform EBO planning. SSM provides planners the rigorous, defensible methodology necessary to explore, debate and eventually decide on a set of adversary system effects most likely to generate the desired endstate. The process leverages the power of multiple human perspectives to do what no computer model can, structure an ambiguous situation. The methodology allows the JFC to leverage the smarts of planners to improve the overall quality of planning effort as multiple perspectives are accommodated. This multi-frame approach will likely be the key to enabling planners to provide the JFC with the well-developed systems understanding necessary to cope in an uncertain future.

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[1] United States Joint Forces Command (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo)," ed. United States Joint Forces Command (2004), 5.

[2] Ibid.

[3] Edward R. Smith, *Effects Based Operations: Applying Network Centric Warfare in Peace, Crisis and War*, *Information Age Transformation Series* (Washington, D.C.: Command and Control Research Program, 2002), xiv.

[4] Ibid.,xiv-xv.

[5] Peter Paret Michael Howard, ed., *Carl Von Clausewitz on War* (Princeton, NJ: Princeton University Press, 1976), 87.

[6] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"6

[7] Ibid.,12.

[8] Ibid.,10.

[9] Ibid.,7

[10] Ibid.

[11] Ibid.,12.

[12] USJFCOM Mark Seeley, SJFHQ(CE) S/T, Telephone interview, 13 Jan 05 2005.

[13] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"13.

[14] Tom Czerwinski, *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*, ed. Institute For National Strategic Studies (Washington, DC: National Defense University, 1998), 10-12.

[15] Elizabeth S. Guy, "An Introduction to Soft Systems Methodology: Is 348 Text," in *IS348: Problem Solving in Information Science*.

[16] Czerwinski, *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*,33-35.

[17] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"21.

[18] Michael Howard, ed., *On War*,75.

[19] Michael Pidd, *Systems Modelling: Theory and Practice* (Chichester, England: Wiley and Sons, LTD, 2004), 7.

[20] Ibid.

[21] Ibid.

[22] Ibid.,8

[23] Ibid.,203-04.

[24] Nino Boccara, "Modelling Complex Systems: Graduate Text in Contemporary Physics," (Springer, 2004), 3.

[25] Czerwinski, *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*,14-15.

[26] Boccara, "Modelling Complex Systems: Graduate Text in Contemporary Physics."

[27] Pidd, *Systems Modelling: Theory and Practice*,22.

[28] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"9

[29] Ibid.

[30] Ibid.

[31] Vicki Rast, *Interagency Fratricide: Policy Failures in the Persian Gulf and Bosnia* (Maxwell AFB, AL: Air University Press, 2004), 45-46.

[32] Pidd, *Systems Modelling: Theory and Practice*,203-04.

[33] US Joint Forces Command, "Joint Forces Command Glossary," (2004).

[34] Richard B. Myers, "National Military Strategy of the United States of America," ed. U.S. Department of Defense (Office of the Chairman of the Joint Chiefs of Staff, 2004), 4-6.

[35] Colonel Keith Nightengale (USA) William S. Lind, Captain John F. Schmitt (USMC), Colonel Joseph W. Sutton (USA), and Lieutenant Colonel Gary I. Wilson (USMCR), "The Changing Face of War: Into the Fourth Generation," *Marine Corps Gazette*, no. October 1989 (1989).

[36] United States Joint Forces Command, "Joint Forces Command Glossary."

[37] Thomas H. Davenport, *Information Ecology: Mastering the Information and Knowledge Environment* (Oxford: Oxford University Press, 1997), 95-96.

[38] Michael Howard, ed., *On War*,177.

[39] Peter B. Vail, *Learning as a Way of Being: Strategies for Survival in a World of Permanent White Water* (San Francisco: Jossey-Bass, 1996), 10-14.

[40] Ibid.,19.

[41] Czerwinski, *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*,55-56.

[42] Ibid.,57.

[43] Steven M. Rinaldi, "Complexity Theory and Airpower: A New Paradigm for Airpower in the 21st Century" (paper presented at the Complexity, Global Politics, and National Security Conference, Washington, DC, 1996), 255-56.

[44] Ikujiro Nonaka, "The Knowledge Creating Company," in *Harvard Business Review on Knowledge Management*, *Harvard Business Review* (Boston, MA: Harvard Business School Press, 1999), 26,28-30.

[45] Ibid.,27-30.

[46] Michael Schrage, *Serious Play: How the World's Best Companies Stimulate to Innovate* (Boston, MA: Harvard Business School Press, 2000), 13-14.

[47] Pidd, *Systems Modelling: Theory and Practice*,6

[48] Thomas H. Davenport and Laurence Prusak, *Working Knowledge: How Organizations Manage What They Know* (Boston, MA: Harvard Business School Press, 2000), 60-61.

[49] Lee G. Bolman and Terrence E. Deal, *Reframing Organizations*, Second ed. (San Francisco: Jossey-Bass Publishers, 1997), 15.

[50] Ibid.,379-80.

[51] Pidd, *Systems Modelling: Theory and Practice*,2

[52] Art Kleiner Peter Senge, Charlotte Roberts, Richard Ross, George Roth, Bryan Smith, *The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations* (New York: Doubleday, 1999), 22.

[53] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo)."

[54] Czerwinski, *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*,59.

[55] Bob Woodward, *Plan of Attack* (New York, NY: Simon and Schuster, 2004), 280-85.

[56] For a detailed explanation of Soft Systems Methodology, see Checkland or Patching.

[57] SSM is applied within this context not as an organizational intervention, but as a problem structuring and learning methodology. Although never intended for mission analysis, SSM has been used for a variety of purposes as outlined in Patching, chapters 9-15.

[58] The basic 7-stage or Mode 1 SSM process is used for this application. Patching and Checkland both recommend this version for new users. A newer, less regimented version (Mode 2) was later developed by Checkland. The structure of Mode 1 makes it a better fit within the military planning process.

[59] The scenario is meant only to provide a very basic background. It is a very short overview and orients the reader to the situation. The actual scenario is published by the College of Aerospace Doctrine Research and Education (CADRE) at Maxwell AFB, AL and is 140 pages. This level of detail is omitted for the sake of brevity since the purpose of the paper is not meant as an instructional manual, only to provide an overview and show the utility of SSM-based EBO mission analysis.

[60] David Patching, *Practical Soft Systems Analysis* (London: Pitman Publishing, 1990), 45, 53-54.

[61] Warfare Studies Institute, *Joint Air Estimate Planning Handbook*, second ed. (Maxwell AFB, AL: College of Aerospace Doctrine, Research, and Eductation, 2003), 12-13.

[62] Guy, "An Introduction to Soft Systems Methodology: Is 348 Text."

[63] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"20-21.

[64] Paddy Turner, "Findings from the First Uk-Led Effects-Based Planning Experiment" (paper presented at the 2004 Command and Control Research and Technology Symposium: The Power of Information Age Concepts and Technologies, Copenhagen, Denmark, 2004), 5.

[65] Peter Checkland and Inc NetLibrary, *Soft Systems Methodology a 30-Year Retrospective* (Chichester; New York: John Wiley, 1999), 165-66.

[66] Patching, *Practical Soft Systems Analysis*,70.

[67] Ibid.,55-56.

[68] Ibid.,54-55.

[69] Edward R. Tufte, *The Cognitive Style of Powerpoint* (Cheshire, Connecticut: Graphics Press, LLC, 2003), 3.

[70] Andrew Monk and Steve Howard, "The Rich Picture: A Tool for Reasoning About Work Context," *Interactions.*, no. March + April 1998 (1998): 23-24.

[71] Ibid.: 24.

[72] Patching, *Practical Soft Systems Analysis*,55.

[73] Guy, "An Introduction to Soft Systems Methodology: Is 348 Text,"22.

[74] This is a sample Rich picture based on only the aspect of the scenario discussed. Both Patching and Checkland suggest drawing rich pictures by hand. In this case a hand drawn Rich Picture was transferred into MindJet's Mindmanager program for ease of inclusion in the paper. There is no real right or wrong Rich Pictures, nor is there a universal style.

[75] Gareth Morgan, *Images of Organization 2nd Ed.* (Thousand Oaks, CA: SAGE Publications, 1997), 40.

[76] Patching, *Practical Soft Systems Analysis*,74.

[77] Peter Checkland, Jim Scholes, and Inc NetLibrary, *Soft Systems Methodology in Action a 30-Year Retrospective*, New. ed. (Chichester, Eng.; New York: Wiley, 1999), 309.

[78] Patching, *Practical Soft Systems Analysis*,76-77.

[79] P. W. J. Ledington and J. Ledington, "The Problem of Comparison in Soft Systems Methodology," *Systems Research and Behavioral Science* 16, no. 4 (1999): 3-7.

[80] Ibid.: 5-7.

[81] Ibid.: 2-7.

[82] Murray Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (New York: W.H. Freeman and Co., 1994), 33.

[83] Checkland and NetLibrary, *Soft Systems Methodology a 30-Year Retrospective*,175-77.

[84] Ricardo Rodriguez-Ulloa and Alberto Paucar-Caceres, "Soft System Dynamics Methodology (Ssdm): A Combination of Soft Systems Methodology (Ssm) and System Dynamics (Sd)," in *Proceedings from 43rd Meeting of the International Society for the Systems Sciences* (Pacific Grove, CA: International Society for the Systems Sciences, 1999), 6-11.

[85] Patching, *Practical Soft Systems Analysis*,99-100.

[86] Ledington, "The Problem of Comparison in Soft Systems Methodology."

[87] Checkland and NetLibrary, *Soft Systems Methodology a 30-Year Retrospective*,180-83.

[88] Anthony C. Cain, "Ebo Universe," (Air Command and Staff College, 2004).

[89] Andrew Preece Paddy Turner, Mark Round, "Effects Based Planning - a Uk Research Perspective" (paper presented at the 2004 Command and Control Research and Technology Symposium: The Power of Information Age Concepts and Technologies, Copenhagen, Denmark, 2004), 8.

[90] Patching, *Practical Soft Systems Analysis*,112.

[91] Cain, "Ebo Universe."

[92] Paddy Turner, "Effects Based Planning - a Uk Research Perspective",7-8.

APPENDIX A

Brief Scenario Overview

Situation: Jupiter is massing forces and threatening an invasion of Mercury. The Regional Combatant Commander (RCC) has established a Joint Task Force to address the situation. A planning team of experts from the RCC's Standing Joint Force Headquarters has deployed to begin the planning process[93]. They have been augmented by other experts from other government and non-government agencies. The planning team begins the process by performing a mission analysis to identify effects most likely to achieve the RCC's campaign objectives and endstate.[94]

Sample Desired Endstate: Regional Security and Stability

Sample U.S. Campaign Objective: Maintain Mercurian Territorial Integrity

Scenario Excerpt

Tensions between Mercury and Jupiter

Pegasus has enjoyed a relatively peaceful 250 years aside from minor conflicts that fell mainly along religious and ethnic lines. The recent tensions between Mercury and Jupiter can be traced to religious feuds that erupted after both countries' independence over 60 years ago. Until 1950, Russia controlled both countries as Mercupiter and kept religious and ethnic differences in check. After Mercupiter's peaceful independence from Russia in 1950, Protestant-dominated Mercury and Catholic-dominated Jupiter separated into two countries and immediately disputed the territory of York, a region in the southern areas of both countries. Soon after independence, the United Nations (UN) established a Line of Control (LOC) in York splitting the territory between Mercury and Jupiter, creating a Mercury-controlled York (MCY) and Jupiter-controlled York (JCY). While both countries recognize the LOC, both sides also dispute the right of the other to occupy any portion of York. This decades-old dispute has brought both countries to the brink of war.

The seeds for conflict were sewn in 1951 as a large influx of Jupiterians, who were fleeing economic hardships in Jupiter, began to enter (legally and illegally) MCY. Pressures of increased immigration remained in check until the late 1970s when MCY, led by the city of Gammon, began to develop into the main industrial area for the Pegasus region. The large number of computer manufacturing jobs based there created another major influx of immigrants. Mercury's fast-growing, capitalistic-oriented, industrial economy that lured the Jupiterians was mainly responsible for an ethnic Jupiterian population explosion in MCY. The majority of the workers in MCY factories are Jupiterians while management remains Mercurian. Most were hired due to the fact they were willing to work for lower wages than the Mercurians. It is this huge MCY Jupiterian population that has been a major source of instability in the region.

Recently, there has been a rise in terrorism in MCY. Groups such as Jupiter's Thunder have begun taking aggressive action to force Mercury to cede control of MCY to Jupiter. For its part, Jupiter is Jupiter suffers from outdated production facilities and working practices. Inflation is high and the government will need to take drastic and probably very unpopular action if the country is to be spared complete bankruptcy. The country is rich in natural resources, especially coal, iron ore and water, and this has sustained the economy for many years but can no longer mask production and trade imbalances with more technologically advanced countries, especially Mercury.

[93] (JFCOM), "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo),"3-4.

[94] The scenario excerpt is only meant to provide readers some back ground on the situation to understand the application of the methodology.

APPENDIX B

Cain's EBO Verb List[95]

Constructive Verbs
Educate - Stimulate or develop mental or moral growth
Confirm - Support or establish validity
Sustain - Keep in existence or maintain
Encourage - Inspire with hope, courage, or confidence
Construct - Form or build by assembling or combining parts
Heal - Restore to health or soundness, to set right
Feed - Supply with nourishment, to serve food to
Restore - Bring back to original condition
Comfort - Soothe in time of distress
Protect - Keep from being damaged, stolen, or injured
Liberate - Set free
Legitimate - Give legal force to

Destructive Verbs
Deny - to prevent the use of
Destroy - to ruin completely, to render useless or ineffective
Delay - to cause to be slower than expected
Isolate - to cut off from others
Neutralize - to render ineffective
Disrupt - to throw into confusion or disorder/to impede progress or movement
Inform (Deceive) - to mislead
Inform (Enlighten) - to inform or instruct
Inform (Confuse) - to cause to be unable to think with clarity or act with intelligence or understanding

[95] Based on Cain, "Ebo Universe."

Bibliography

(JFCOM), United States Joint Forces Command. "The Joint Warfighting Center Joint Doctrine Series Pamphlet 7: Operational Implications of Effects-Based Operations (Ebo)." edited by United States Joint Forces Command, 2004.

Boccara, Nino. "Modelling Complex Systems: Graduate Text in Contemporary Physics." Springer, 2004.

Cain, Anthony C. "Ebo Universe." 1: Air Command and Staff College, 2004.

Checkland, Peter, and Inc NetLibrary. *Soft Systems Methodology a 30-Year Retrospective*. Chichester; New York: John Wiley, 1999.

Checkland, Peter, Jim Scholes, and Inc NetLibrary. *Soft Systems Methodology in Action a 30-Year Retrospective*. New. ed. Chichester, Eng.; New York: Wiley, 1999.

Command, US Joint Forces. "Joint Forces Command Glossary." 2004.

Czerwinski, Tom. *Coping with Bounds: Speculations on Nonlinearity in Military Affairs*. Edited by Institute For National Strategic Studies. Washington, DC: National Defense University, 1998.

Davenport, Thomas H. *Information Ecology: Mastering the Information and Knowledge Environment*. Oxford: Oxford University Press, 1997.

Deal, Lee G. Bolman and Terrence E. *Reframing Organizations*. Second ed. San Francisco: Jossey-Bass Publishers, 1997.

Gell-Mann, Murray. *The Quark and the Jaguar: Adventures in the Simple and the Complex*. New York: W.H. Freeman and Co., 1994.

Guy, Elizabeth S. "An Introduction to Soft Systems Methodology: Is 348 Text." In *IS348: Problem Solving in Information Science*.

Howard, Andrew Monk and Steve. "The Rich Picture: A Tool for Reasoning About Work Context." *Interactions.*, no. March + April 1998 (1998): 9.

Institute, Warfare Studies. *Joint Air Estimate Planning Handbook*. second ed. Maxwell AFB, AL: College of Aerospace Doctrine, Research, and Eductation, 2003.

Ledington, P. W. J. Ledington and J. "The Problem of Comparison in Soft Systems Methodology." *Systems Research and Behavioral Science* 16, no. 4 (1999): 8.

Mark Seeley, USJFCOM, SJFHQ(CE) S/T. Telephone interview, 13 Jan 05 2005.

Michael Howard, Peter Paret, ed. *Carl Von Clausewitz on War*. Princeton, NJ: Princeton University Press, 1976.

Morgan, Gareth. *Images of Organization 2nd Ed.* Thousand Oaks, CA: SAGE Publications, 1997.

Myers, Richard B. "National Military Strategy of the United States of America." edited by U.S. Department of Defense: Office of the Chairman of the Joint Chiefs of Staff, 2004.

Nonaka, Ikujiro. "The Knowledge Creating Company." In *Harvard Business Review on Knowledge Management*. Boston, MA: Harvard Business School Press, 1999.

Paddy Turner, Andrew Preece, Mark Round. "Effects Based Planning - a Uk Research Perspective." Paper presented at the 2004 Command and Control Research and Technology Symposium: The Power of Information Age Concepts and Technologies, Copenhagen, Denmark 2004.

Patching, David. *Practical Soft Systems Analysis*. London: Pitman Publishing, 1990.

Paucar-Caceres, Ricardo Rodriguez-Ulloa and Alberto. "Soft System Dynamics Methodology (Ssdm): A Combination of Soft Systems Methodology (Ssm) and System Dynamics (Sd)." In *Proceedings from 43rd Meeting of the International Society for the Systems Sciences*. Pacific Grove, CA: International Society for the Systems Sciences, 1999.

Peter Senge, Art Kleiner, Charlotte Roberts, Richard Ross, George Roth, Bryan Smith. *The Dance of Change: The Challenges to Sustaining Momentum in Learning Organizations*. New York: Doubleday, 1999.

Pidd, Michael. *Systems Modelling: Theory and Practice*. Chichester, England: Wiley and Sons, LTD, 2004.

Prusak, Thomas H. Davenport and Laurence. *Working Knowledge: How Organizations Manage What They Know*. Boston, MA: Harvard Business School Press, 2000.

Rast, Vicki. *Interagency Fratricide: Policy Failures in the Persian Gulf and Bosnia*. Maxwell AFB, AL: Air University Press, 2004.

Rinaldi, Steven M. "Complexity Theory and Airpower: A New Paradigm for Airpower in the 21st Century." Paper presented at the Complexity, Global Politics, and National Security Conference, Washington, DC 1996.

Schrage, Michael. *Serious Play: How the World's Best Companies Stimulate to Innovate*. Boston, MA: Harvard Business School Press, 2000.

Smith, Edward R. *Effects Based Operations: Applying Network Centric Warfare in Peace, Crisis and War*, *Information Age Transformation Series*. Washington, D.C.: Command and Control Research Program, 2002.

Tufte, Edward R. *The Cognitive Style of Powerpoint*. Cheshire, Connecticut: Graphics Press, LLC, 2003.

Turner, Paddy. "Findings from the First Uk-Led Effects-Based Planning Experiment." Paper presented at the 2004 Command and Control Research and Technology Symposium: The Power of Information Age Concepts and Technologies, Copenhagen, Denmark 2004.

Vail, Peter B. *Learning as a Way of Being: Strategies for Survival in a World of Permanent White Water*. San Francisco: Jossey-Bass, 1996.

William S. Lind, Colonel Keith Nightengale (USA), Captain John F. Schmitt (USMC), Colonel Joseph W. Sutton (USA), and Lieutenant Colonel Gary I. Wilson (USMCR). "The Changing Face of War: Into the Fourth Generation." *Marine Corps Gazette*, no. October 1989 (1989): 22-26.

Woodward, Bob. *Plan of Attack*. New York, NY: Simon and Schuster, 2004.