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OOTW IMPACT ANALYSIS

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ABSTRACT

The conduct of Operations Other Than War (OOTWs) has become an extremely important part of the US military's responsibility since the end of the Cold War. The factors that influence success and failure in OOTWs are economic, political, sociological, cultural, and psychological factors more often than they are military factors. This paper explores the need for impact analysis support tools, provides a description of the required elements of such tools, and recommends a formal process for creating OOTW impact analysis tools.

1 INTRODUCTION

OOTWs consist of all operations (as opposed to training and daily existence) that are conducted by the military **other than war**. This set of operations comprise a wide variety of activities, including humanitarian assistance and disaster relief, peace operations (such as peacekeeping and peace enforcement), national integrity operations (such as support for counterinsurgency, counternarcotics, and nation building operations), and military contingency operations (such as enforcing no-flight zones, strikes and raids, and noncombatant evacuation operations (NEOs)) [Hartley, 1996]. In almost all cases, the military acts in support of another agency (such as the Department of State or the Federal Emergency Management Agency (FEMA)) and thus is not in charge. The goals and factors that influence the success or failure of OOTWs are sufficiently different from those of combat operations that many of the available military analytic tools are inadequate to support analysis of OOTWs.

Military personnel, including planners and analysts, are as familiar with combat as we can make them. We educate them about combat; we train them in combat operations; and we supply them tools to help deal with combat. Combat impact analysis permeates military decision making. At the highest levels, combat impact analysis is used to decide what forces we need, how they should be structured, what they should do (doctrine), and how to do it under fiscal constraints. In Desert Storm, the Center for Army Analysis (CAA) sent its combat impact analysis model into the war to aid in real-time planning. It has taken thirty years to reach our current state of capability to perform combat impact analysis.

However, military commanders and planners may overlook or fail to adequately consider relevant factors in OOTWs. It is not just a lack of experience or knowledge of the specific socio-politico-economic influences in a given situation, although this is a factor. The sheer number of potentially important influences make consistent and complete evaluations unlikely.

Every day of every year since the close of the Cold War (and before) we have been engaged in an OOTW somewhere in the world. Some of these operations have looked a lot like mini-wars - operations in which we dropped bombs and launched cruise missiles; many have been more like police activities - peacekeeping; many have been less combat-like - humanitarian assistance and disaster relief. As this is being written, we are dropping bombs in Yugoslavia; however, the measure of success is not the amount of damage done, but the psychological reaction of one man or the joint psychological reactions of many. The campaign in Yugoslavia is not being conducted as a war, but as a giant psychological operation. We do not have a single OOTW impact analysis model to aid us.

2 NEED FOR IMPACT ANALYSIS

Studies at the national level require <u>outcomes predictions</u> to compare to desired outcomes. And, ultimately, the evaluation of doctrinal or force changes at the force providers level requires <u>outcomes predictions</u>. Where the studies or evaluations involve OOTWs, they require the computation of the interaction of social, political, economic, and military factors. The course of events is forcing an increased interest in studies and evaluations of OOTWs.

The geographical Unified Commands stated a <u>need for course of action (COA) analysis</u>. In cases where more than one COA is possible (the majority of cases), analytical support in selecting the best (or at least in rejecting the worst) COA is needed. In some cases, this need is satisfied by the methodology used in force design: capability to do the required work, availability (several sub-factors), general satisfaction of security requirements, and cost (both in resource use and in dollars). However, in some cases, this methodology is not sufficient. Questions of capability are complex, such as the ability to keep the peace or create a working democracy. The interaction of social, political, economic, and military factors must be computed.

The geographical Unified Commands also stated a <u>need for engagement impact support</u>. The heart of "engagement" is performing actions that will prevent wars or other geopolitical actions against the interests of the United States. This also requires the computation of the interaction of social, political, economic, and military factors.

One reason that there is no generally accepted analytical impact model for OOTWs is suspicion. There are several commercial games (such as SimCity™) that model the impact of many of the important activities and factors of OOTWs. There are also several government simulations (some are listed in Table 1) that model the impact of OOTW activities; however, most are used for training, not analysis, or have not been used extensively. (Section 7 discusses the issues concerning impact modeling for training versus for analysis.) Despite the existence of candidate models, the suspicion is that they are not valid models and their complexity prevents individual users from assessing their validity. (Section 3 discusses the transparency issue [whether the rationales of a model are obvious to a user] and Section 4 discusses the validity issue.)

Table 1: Available Tools

TOOL	DESCRIPTION
CarePlan	• Simulation system models persons and organizations; persons have demographics, perceptions, cultural, health, membership, specialty, agenda, and cognitive behavior attributes; organizations have resources, staff, agenda, behavior attributes. Human physiology models and a geo-referenced tools have been developed.
DEXES	• Training Simulation.
GCAM	• Simulation environment. The Force Sufficiency Assessment Tool (FORSAT) is a model built using GCAM and is used to evaluate a force structure; however, the model for any given OOTW may need to be created first.
NationLab	• Influence diagram of narcotrafficing in Bolivia, with relationships and data supplied by Bolivia. It permits the analysis of causes and effects of attempts to counter the narcotics trade.
SENSE	• Training simulation for multiple participants, using linked workstations, to exercise the interactions of socio-economic policy decisions.
	• Collaborative analytical tool using influence diagrams.
SIAM	• Commercial simulation game.
SimCity™	• Training simulation.
Spectrum	

The other reason that there is no generally accepted analytical impact model for OOTWs is ignorance. We are ignorant of the relationships among the important factors. We are not even sure which factors are the important ones. Section 5 discusses the specifications for impact analysis tools. As this section makes clear, modeling OOTWs for analysis is a hard problem. **However, each time we begin a new OOTW, someone has created a model and used it to decide what to do. Usually this is a mental model.** The question is whether a computer model can or will yield better results. Will its consistency ensure that significant elements are always addressed? Will it yield a spread of possible results to reduce the likelihood of tunnel vision? Can it be timely? Can it be improved over the years to yield order-of-magnitude predictions? Section 6 describes the consequences of such operational issues and Section 8 concludes with a discussion of the creation of an Mission Needs Statement (MNS) for impact analysis tools.

3 TRANSPARENCY

The word "transparency" is used to mean that the internal workings of a model are obvious and not hidden from view. More, it means that they are <u>easily understandable</u> (and preferably manifestly correct). This quality is clearly valuable in allaying suspicion; however, it often means that either the model is too simple for use or the complexity of the efforts to make the model transparent makes the model too difficult to use.

The most recent computer coding methodology to claim transparency advantages is object-oriented programming. (A previous methodology making similar claims was structured programming.) It is true that some models that use object-oriented programming are easier to understand than comparable models written using older methodologies **<u>for someone reading the computer code.</u>** However, once the number of objects grows into the hundreds or for anyone not reading the code, object-oriented programming does not (by itself) produce transparent models.

The most useful (current) technique for increasing the transparency of a model is the creation of a meta-model using influence diagrams. The meta-model has two levels. The first level is graphical, showing which factors influence each other factor and each decision. This makes it clear whether all significant factors have been considered. The second level is mathematical (and thus less easily comprehended). This level presents the functions, showing how the factors influence the decision or other factor. This concept is illustrated in Figure 1, in which the homogeneous Lanchester law is implemented as an influence diagram. The graphics clearly show the influences; however, the equations that form the second level, while complete, do not convey the complexity or the arguments that have revolved around Lanchester Theory. No less should be expected of OOTW Theory. While this meta-modeling technique is insufficient to completely produce the desired transparency, it does focus attention on the issues that need to be argued.

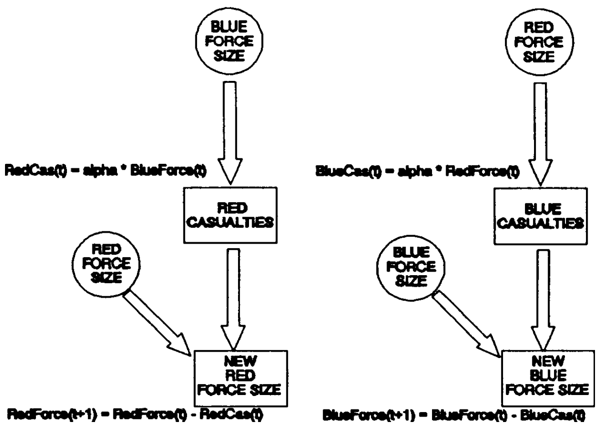

Figure 1: Influence Diagram for Homogeneous Lanchester Square Law.

4 VALIDITY

Beyond the suspicion that hidden equations can cause, there is the suspicion that the equations may be visible, yet still **wrong**. Fatigue and fear in combat are generally ignored in computerized combat models, which are designed for predictions (within limits), for generality, and to embody corporate memory. In these models, the questions being answered are restricted to those in which the psycho-social effects may be presumed to be constant over the domain of interest. This has been true, in part, due to a reluctance to defend conjectural human factors models. However, in modeling impact in OOTWs, equations are required to connect military actions to economic, social, and political actions and states. Even the most academically sound equations, those connecting economic events to other economic events, are not uniformly accepted all by economists. However, these events and states do interact and any impact model must contain such interactions. At this point, models must be transparent and the conjectured equations and influence diagrams must be openly debated. Section 6 on operational issues discusses various means to effect this transparency.

The initial expectations of validity for OOTW models must be low. Early analytical models should introduce consistency of factor consideration into OOTW analysis. The definition of a "good" model would be one that identifies all probable repercussions and produces rough sequences of likelihood. Recent investigations of validation of human behavior representations suggest means of improving the definition of "good" [Harmon and Youngblood, 1999]. Part of the technique involves dividing the validation into tests of the models at five levels of representation: domain, physiological, psychological, organizational, and physical. After several years of effort, a "good" model might be expected to generate factor-of-two correctness (a 10% prediction means not less than 5% and not more than 20%).

5 IMPACT MODELING SPECIFICATIONS

In the performance of OOTWs, what is attempted is based on what is thought to matter. That is, performance is driven by measures of performance (MOPs), whether external and imposed MOPS or internal and self-adopted MOPs. In designing a model of OOTWs, as in designing any other model, some elements of reality must be omitted to concentrate on what matters. An understanding of the MOPs used in OOTWs is necessary for the proper design of a model of OOTWs. Work has been done to help increase the understanding of just what does matter in OOTWs [Christopher, Dickson and Pritchard, 1999]. The broad result was that the things that matter are particularly dependent on the situation; however, the general areas that matter include political, economic, social, religious, and psychological components. Military factors also matter; however, they may be relegated to lesser status in some OOTWs.

Three stages of specifications are described here: representing the data, representing the influences among the objects, and representing active objects.

5.1 Representing Relevant Data

General specifications for impact modeling have been produced [Hartley 1995]. A key concept is dual level of resolution, illustrated in Table 2. The most important objects in the model are specifically enumerated, e.g., the heads of state and the key governmental and non-governmental organizations for each country. The rules for evaluating the impact of each potential factor (and the interactions) are developed specifically for each object, based on their known characteristics. These objects represent the basic level of resolution for the model.

Table 2: Attribute Attachments

SIGNIFICANT (NAMED) INDIVIDUALS 5 - 6 per Country
PARTICULARIZED GROUPS Ruling class Military elite Civil servants Moneyed class Factions NGOs/PVOs/IOs
DEMOGRAPHIC CATEGORY, BY GEOGRAPHIC LOCATION Ethnic, Religious, Economic
GEOGRAPHIC LOCATION Proximity

The second level of resolution of the model is concerned with the diffuse psycho-social attributes of the populaces (or sub-cultures) of the countries. Geographical and time related effects will be important, as well as innate characteristics. This level of resolution is important because some overtures are aimed at the populace and will show no effect unless there is a populace to be affected. The principal actors react not only to direct approaches, but also to responses by the populace.

Table 3 lists several potentially important factors or attributes. Scalar field factors of interest might include support for democracy, support for autocracy, criminal activity, fear, capitalist activity, sloth, addiction, spying, or terrorism. Which are important and how they are interrelated will be difficult questions to resolve; however, estimates can be made and corrected as the data indicate.

Table 3: Potential Attributes of Interest

Fear
Suppression (of various activities)
Ownership, Work ethic
Democratic leanings
Economic competition, Espionage, Pirating
Religious conflict
Crime - general, Narcotics
Drug costs
Health levels
Political corruption
Spectrum of pro-country X sympathy
Spectrum of fervor for causes, percentage favoring
Spectrum of morale
Refugee flow rates
Terrorism level

In many situations, the effects produced by the second level of resolution of the model should be distinctly second-order effects, and not very important. However, the dissolution of the Soviet Union very strongly involved more than just the actions of the original principals. Nation building operations will depend heavily on affecting the populace. It is not clear when this level of resolution can be omitted and prudence thus argues for its inclusion in OOTW scenarios. One would first create a model of the region of interest and develop the first level of resolution objects, based upon best guesses of personalities and psychologies of the key individuals. Then the second level of resolution would be developed, based on general psychology and specific cultural influences.

An example of a humanitarian assistance operation will serve to illustrate the data and modeling complexity needed for these types of attributes. The details are omitted for brevity. The military will be transporting relief supplies and providing general support, including security for the operation to feed various population groups. The poverty load distribution, defined as the number of poor people divided by the number of wealthy people, is a measure of potential trouble. First, a topographic model is needed because elevations, slopes and spatial relationships affect such things as travel and desirability of locations for living and agriculture. Here, the desirable land consists of a valley and ridge province situated between a mountain range and a parallel plateau. The topography can also be used to connect resources to locations for industry.

After the topographic model has been created, overlays of natural and man-made features, such as rivers, roads, towns, and cities are required (Figure 2). The features here are constrained by the higher elevations, with the major city situated at the confluence of two rivers. While the display of these overlays is useful, providing information to the analyst, the overlays should be logically connected to the internal models of human processes for maximum utility. For example, travel should be slower or impossible where there are no roads.

The people in the area represent the most significant item of interest and require extensive data and modeling. They are not distributed uniformly, which affects activities and interacts with movements of both military units and displaced persons. Towns and cities are associated with population clusters, while density variations in the countryside are associated (in this example) with the more desirable valleys (Figure 3).

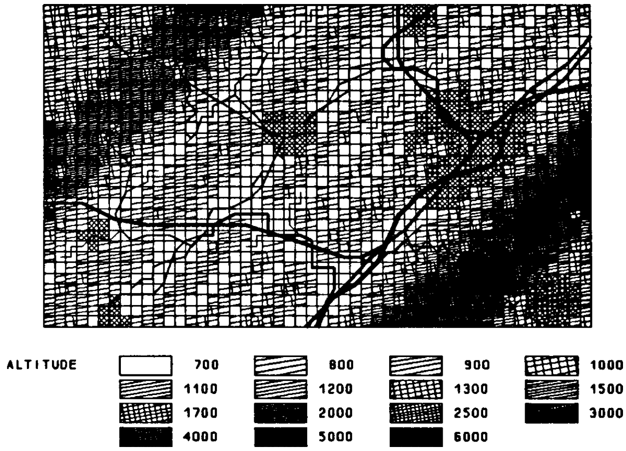

Figure 2: Modeling Natural and Man-Made Features.

However, the people who make up the population are also not identical. Ethnic or other divisions exist and are not distributed identically with the general population. Six ethnic groups are represented in this example, each with its own geographic centroid (only two are shown here). The K-ethnic group is located in the North and its members have historically been miners and rough laborers (Figure 4). The V-ethnic group is located in the Northeast and has a tradition of banking and plantation owning (Figure 5).

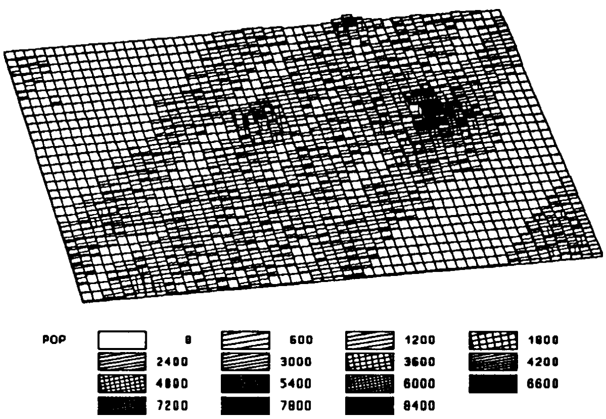

Figure 3: Modeling Population Distribution.

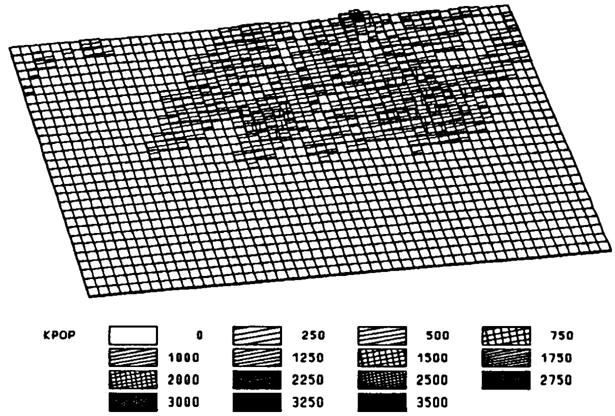

Figure 4: K-Ethnic Population Distribution.

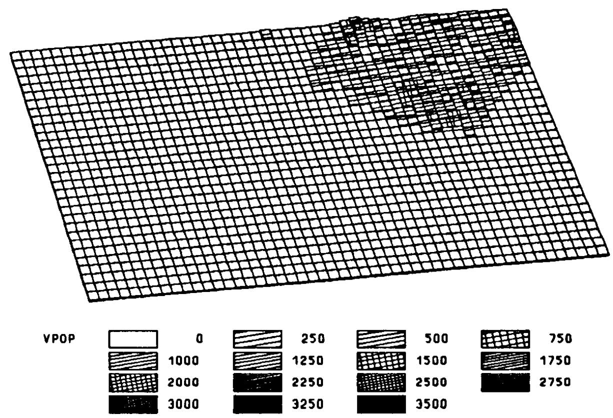

Figure 5: V-Ethnic Population Distribution.

The distribution of the poverty population is not random. There are more poor people in cities and towns because there are more people there. But often there is a differential increase, in part because the support systems are superior in cities and towns. Similarly, the number and the percentage of wealthy people is higher in cities than in the countryside.

In this example, there are other factors at work. Here the V-ethnic group is differentially wealthier. This accounts for the higher percentage of wealthy people in the Northeast. Areas with K-ethnic majorities are poorer than average and the people in the plateau (Northwest) region are poorer because the coal mines there are played out. These two factors account for the higher percentage of poverty along the plateau. (The overall poverty average is 21%, ranging from 13.1% to 27.3%, Figure 6.)

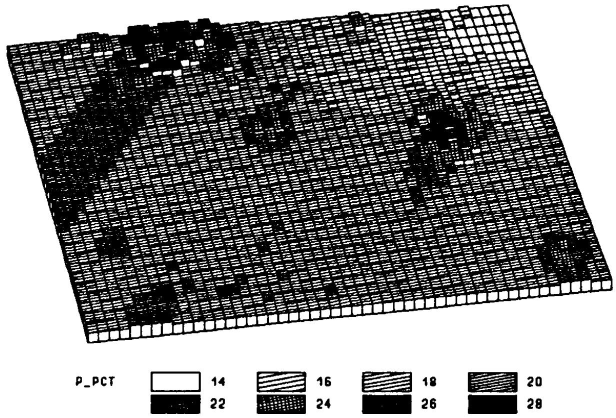

Figure 6: Poverty Percentage Distribution.

Once all of these factors are represented, the poverty load distribution can be calculated (Figure 7). The average load is 3.5 poor people per wealthy person; however, this attribute reveals a very high regional load in the less accessible northwest region (up to 6.6). The implication is that there may not be enough wealth locally to feed and clothe the needy. In addition, the low poverty load in the northeast region (as low as 1.5) and the fact that the difference is associated with K-ethnic and V-ethnic groups may drive tensions between the groups.

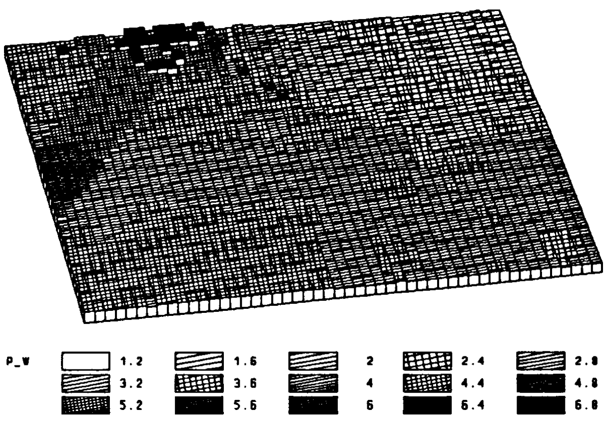

Figure 7: Poverty Load (on the Wealthy).

Calculation of this poverty load attribute would be part of the analysis. The location of the hungriest people might be evident from reports on the ground in an actual operation; however, in a contingency planning situation there would be no reports. Even in an actual operation, the reports might be incomplete and the calculation would serve to indicate areas needing investigation. Estimates of where security might be most at risk would be required in any case. In this example, the areas in the Northwest would be likely to experience high levels of need and transport in the area in the North between the areas of highest and least need might experience the greatest threats to security.

This illustration covers only one attribute. Others may also be significant. In this case, no problem was associated with the major city: the high level of poverty there is balanced by a high level of wealth. However, in some oligarchies, such divergences are endemic and are very definitely associated with problems. In that situation, a different poverty load calculation, dividing the number of poor by the number of middle class may be useful.

5.2 Representing Relevant Influences

The previous example is completely static, that is, no events and the changes that result are modeled. Modeling the impacts of single events is shown in Figure 8. The line of E's marching down the figure represents events that have potential impacts. Each event has time of occurrence and location information, as well as information about its nature. In this figure, Event 4 (E_4) is the current event. The two heavy, solid lines originating at E_4 indicate that it impacts both levels of resolution, enumerated objects and demographic categories. The specifically enumerated objects are represented in the figure by three people (P_1, P_2 and P_3, in circles) and three particularized groups (G_1, G_2 and G_3, in ellipses). The diffuse populaces are represented by three demographic categories (C_1, C_2 and C_3, each with a territorial coverage representation, including population density).

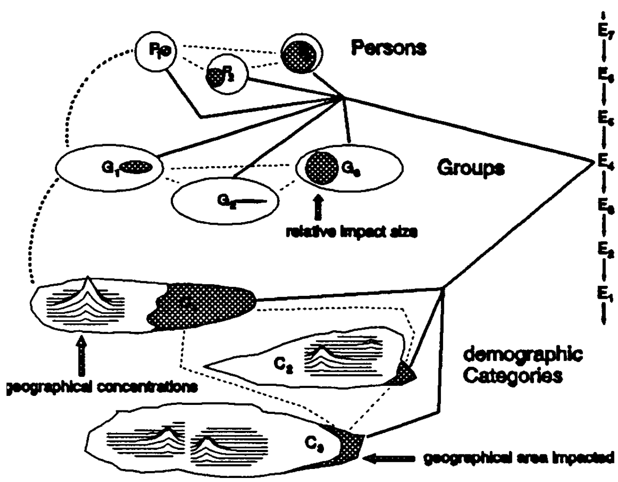

Figure 8: Event Interactions

The demographic categories are indicated as occupying distinct geographical areas (the overlap must be imagined in this figure), with population density variations within the areas (indicated by the three-dimensional sketches). The impact of E_4 varies in size (shaded regions) in the enumerated objects and in geographical effect in the demographic categories. For simplicity, the variation in impact on different psycho-social factors is omitted in this figure. Also omitted from the figure are the effects **on** the external actors, such as non-governmental organizations (NGOs), U.S. or Combined forces, neighboring countries, other interested countries, and the U.N. Interactions among objects are indicated with dotted lines. These interactions propagate over time and include reactions to past events.

The foregoing specification represents the operational environment and permits passive or semi-static analyses. The NationLab and SIAM models are examples of semi-static models. They are structured as complex influence diagrams. Different policies (including sets of actions) or differing assumptions about the state of the environment can be tested for relatively immediate impacts in this type model. For some uses, this type model is adequate and the simplicity inherent in the design aids in achieving transparency.

5.3 Representing Relevant Actions

However, some questions require dynamic analysis. Objects must move and perform actions; information channels, such as radio, television, leaflet-dropping, and word-of-mouth campaigns must be explicitly represented; and recursive relationships with positive and negative feedback, requiring the explicit representation of time, must be included. Analyses that address such questions require the structure provided by discrete event simulation. SENSE, CarePlan, GCAM, SimCity, DEXES, and Spectrum provide examples in this category. The situation shown in Figure 8 becomes more complex. Not only do the various objects react to events (and react to others' reactions), but they also post events (E_i) to the queue and move, whether cohesively, semi-cohesively (splitting and re-combining), or diffusively (e.g., refugee movements, religious/political conversions, and spread/contraction of epidemics). Situations in which things must get worse before they can get better require this type of modeling.

6 OPERATIONAL ISSUES

Past policies must be gamed in the system to test for first order effects and to calibrate the model. Questions of interest will include: What is the prompt impact of X? What is the delayed impact of X? Where are the likely "hot spots?" The variable X could be actions such as treaties, golf with prime minister, or military exercises. The results should be assessed cumulatively, because everything counts. At the national level and at the force provider level, the questions will address the adequacy of systems, doctrines and forces to produce desirable outcomes. At the Unified Command Commander in Chief (CINC) level, the questions will more likely be designed to support the CINC's consultation with an Ambassador. Only if there is an appropriate and current database for the area of responsibility of a prospective operation will it be possible for COA analysis to be performed in a timely manner.

The data requirement for impact analysis represents an additional major difficulty. The data requirements for OOTW analysis have already been realized as being a major difficulty and efforts are under way to gather the data. However, for an impact model to provide a more thorough exploration of possible impacts, a more thorough data collection effort is required.

The questionable validity of the underlying logic and equations of any impact simulation suggest the need for extra efforts to make these drivers visible to the users. Figure 9 shows the systems layers on the left side and embellishes the extended user interfaces in the cartoon on the right. Commercial computer games only provide a user interface at the control level, although to be successful, the games must have a very polished interface. Standard government combat models provide user interfaces for both control and for data, although the quality of the interface at the data level is often poor. The computer code level is rarely accessible to a user; however, in this application, the code level needs to be split into two levels, one labeled "code" and the other "equations". The new "code" level refers to the basic structure of the model, while "equations" means those relationships between modeled objects that are controversial. Impact modeling for OOTWs requires a user interface for the equations level as a deeper "data" layer that will need modification to fit observed reality as the model is used.

Also, because the **relationship among factors is poorly understood** and because the **impacts of events are inherently variable**, there is a second operational remedy: impact modeling for analysis must not produce single point solutions. **Impact modeling for analysis must be designed and used to produce distributions of possible outcomes.** The distributions allow for calculation of relative frequency of similar results, e.g., 45 times of 1000 (4.5% of the time) the result is riots. These frequencies must then be interpreted in light of the current state of the art. That is 4.5% means between 0% and 50% for early models or 4.5% means between 1% and 10% for mature models. In addition, because knowledge of the interactions of social, political, economic, and military factors is **not an exact science**, trial and error will be required.

The first two operational remedies for validity concerns are addressed in constructing a particular impact model; however, the third remedy is broader: build multiple models. Multiple competing models do not represent wasteful duplication, but needed replication to explore different possible approaches and to identify successful ones.

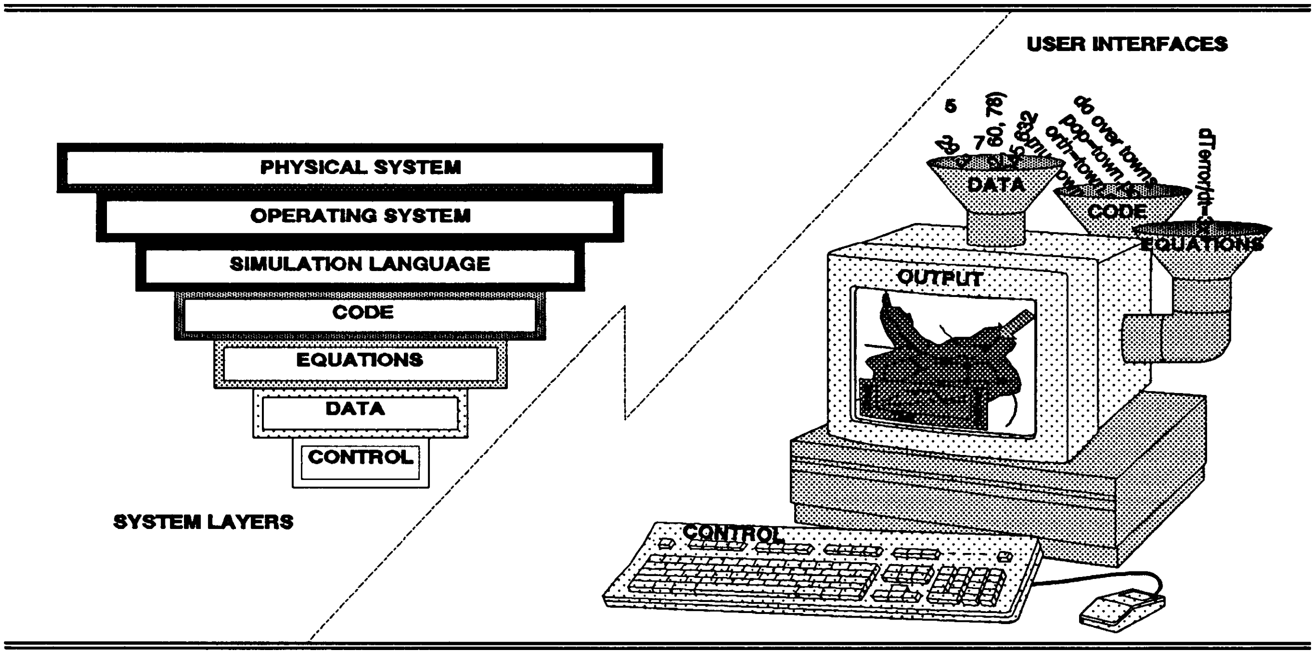

Figure 9: System Layers and User Interfaces.

7 IMPACT MODELING: TRAINING VERSUS ANALYSIS

Most of the currently available impact models were designed for or have been relegated to training and are not immediately suited for analysis.

The primary purpose of a training model (whether for combat or OOTW) is stimulation, while adjudication of results is a secondary purpose. In the biggest user of computer models for training, the command post exercise (CPX), the training audience never sees the computer. The model outputs are filtered by human controllers or through real-world Command, Control, Communications, Computers, and Intelligence (C4I) devices. The computer model is needed as a bookkeeper for the myriad activities being modeled. The model has to adjudicate results internally to produce the sequels that are the stimulants for the training audience; however, those results are not by themselves used to judge the training audience. This is not to say that the fidelity of the model is unimportant: poor models or data that result in unbelievable results can cause participants to break out of a training mode and fight the model and more subtle errors may cause negative training (at worst, inducing participants to learn something that is false).

On the other hand, the primary purpose of analytical models is the adjudication of results. The exact value of the results may not be significant in all cases; however, the relative values when compared to the values under alternative situations must be correct (within the tolerance of the particular use). All analysis depends on determining that one thing is better than another, or not. Even analysis "for insight" depends on a belief that the unfolding of the situation as exposed by the model has a fair chance of being correct.

The current models used to simulate OOTWs for training may not have the required fidelity for analysis or they may not have engendered sufficient confidence in their fidelity for prospective users to trust them. However, they do represent attempts to model elements that are required for analytic OOTW models. Attempts to improve existing models or improve the status of impact modeling for training are highly relevant to attempts to improve impact models for analysis. A recent publication [Loughran, et al., 1999] provides an excellent description of the state of training modeling for OOTWs, including good descriptions of many of the models being used. It also implies that work will be committed to improving the state of OOTW training models.

8 IMPACT MODELING MNS

This paper has discussed the uses for impact modeling and means of achieving it; however, the official Mission Needs Statement (MNS) is missing. Each of the elements covered in this paper provide initial elements of an MNS. Most of the remaining elements could be obtained from a workshop organized around an OOTW Impact Analysis MNS theme. This workshop would clarify the tasks to be performed and the results to be expected. It would also produce initial buy-in of prospective users for the MNS produced from the workshop results.

9 CONCLUSION

Because an impact analysis model is mechanical in nature, it can be consistent in always considering the effects of all known factors. It can be consistently time-binding by always considering the persistent impact of previous actions, as well as currently contemplated options. It can be consistently globally oriented by including the effects of other conscious players (such as other governments with their own agendas) and less conscious players (such as international corporations). It can consistently consider asymmetric warfare aspects in OOTWs, e.g., one or more factions may consider that they are conducting a war, despite our view of the operation as other than war. An impact analysis model **can** do these things, but only if its operators use it that way.

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