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Simulation for Policy Planning

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INTRODUCTION

An obvious objective of U.S. middle and long range
planning is the development of forecasting tech-
niques to the point where alternative policies
toward specific countries can be unambiguously
ranked with respect to their desirability in the
light of specified national policy goals. In this
paper we will describe a project which is invest-
igating the utility of computer simulation, social
science data, and the mental images of U.S. policy
planners in accomplishing this objective. The
project is in progress and this is a very prelim-
inary report.

As a substantive target, U.S. relations with sev-
eral Middle-Eastern oil producing countries was
chosen. Specifically Iraq, Iran, Saudi Arabia,
Libya and Algeria are the nations being analyzed.
Several country specific modules (oil production,
agriculture, human resources and national accounts,
and government) are being developed to portray the
dynamies within each country that might either
affect or be affected by U.S. policy actions. The
modules are being developed keeping in mind two
sets of criteria: The first is that we want to
specify those areas that policy planners feel are
significantly affected by U.S. actions. The sec-
ond goal is to insure that indicators are included
in the simulations changes in which are likely to
affect U.S. policy preferences in this region.

More specifically, we hope to:
1. Specify and inventory missions, options,
   desired outcomes and rationale for actions,
   as seen by forecasters and planners in the
   U.S. military.
2. Inventory and develop country level over-
   time relationships between key domestic
   characteristics such as indicators of
   economic development, political stability,
   and world political orientation.
3. Develop a computer simulation for project-
   ing the impact of alternative U.S. actions
   toward these countries.
4. Combine the rationale for acting and the
   desired outcomes of policy planners with
   the simulation model in order to develop
   performance measures to be used with the
   simulation.

These objectives obviously require the study of
U.S. foreign policy and, if this research is to
have any positive impact upon the policy planning
community, it is critical that our work be directly
and continually related to their missions. While
academics may possess a knowledge of analytical
methods and techniques, planners have an under-
standing of the practical and substantive expectat-
ions that U.S. planning must take into account.
Successful policy research requires both these
kinds of skills and thus our research design has
involved consultation with policy planners at all
phases. In this way we hope to avoid some of the
criticisms which have been made of applied behav-
ioral science research. For example, it recently
has been argued that a major difference between
behavioral science applied research and applied
research in the physical and engineering sciences
is that in contrast to his colleagues in the latter
areas, the behavioral scientist does most of his
research in the University and does not interact
in a continuous way with the potential consumers of
his research.

"The quest for solutions to social problems
should involve applied research in a sense that
has not usually been understood by the social
scientists--a continued and close interaction
between those who do the research and those who
must make the decisions and policies that result
in the application of research. The quest should
also include rapid and continuous exchange of
information and knowledge between those doing
the research and those who are doing the things
that research has indicated to be necessary for
the solution of the problems. To achieve these
interactions, it may be necessary to change...
the methodology of research....."[4]

DESCRIPTION OF TASKS

Task 1: Enumeration of missions, desired
outcomes, and rationale for using
specific actions.

Many tools might be used to organize and to make
sense of the complex environment in which U.S.
foreign policy is developed. One of these tools
is the model--a set of elements together with the

relations defined upon them. A model may be of many types, e.g., physical, mathematical, and mental. A mental model or image is simply an abstraction of various aspects of perpetual experience. For example, a decision maker might have a mental model of how agricultural decisions are made in Iran. He would then use this image in evaluating the potential impact of alternative U.S. policies toward that country. While mental models are frequently relied upon, there are major problems associated with this form of modeling. Decision makers often will have many different mental models, each dealing with a wide range of overlapping problems and each, frequently, inconsistant with the others. Planners are faced with difficulties in knowing which model is applicable to a specific case. Since the relationships in the mental model are generally not explicitly and clearly identified, the sources of contradiction are not immediately obvious. Policies made upon the basis of such images of the world are likely to have unintended and often undesired consequences. In addition, the lack of explicitness in mental images makes it difficult to communicate the assumptions upon which policy preferences are based. In these cases disputes about policy alternatives or outcomes may actually result from unidentified disagreement concerning the implications of actions. Perhaps more importantly from a long range planning perspective, it is difficult to manipulate the variables in mental models to assess the various impacts of U.S. strategic interactions. That is, the complexity of social phenomena makes it almost impossible to move from a vague set of assumptions about the world to the dynamic consequences these assumptions have for the impact of various policy alternatives.

Even reflecting the dynamic (i.e., overtime) behavior of a system of nations is not, of course, enough. In addition, we need to anticipate the outcome of U.S. actions. Here once again people actually involved in long range planning have vital contributions to make. All planners and policy makers routinely make estimates which can be abstracted and become the basis of an explicit and hopefully, consistent theory of how various strategic options are related to changes in exogenous conditions.

Task 2: Identification of within country relationships for a specific set of variables.

The amount of data or information about the conditions in specified countries currently available to political scientists and students of international relations is truly staggering. It is relatively easy today to find economic measures such as Gross National Product of almost any nation in the world. We know the amount of trade, the number of ambassadors sent abroad, or the diplomatic protests exchanged between any two nations for selected years. We have the war experience of the system as far back as 500 B.C. While we have relatively few time series data, we certainly have information about the post World War II period covering much of the national behavior and characteristics.

The task at this stage is to comb through the data currently available and to identify a set of variables and the relationships between variables which are deemed important to policy planners and long range forecasters. Certainly measures of economic development, power capability, political stability, and international political orientation are obvious candidates for a simulation model. In addition such foreign policy outputs as economic and diplomatic indicators of agreement or disagreement with major world powers, and military conflict will also be included. The exact variables will be identified in discussion with policy planners and long range forecasters.

Task 3: The development of a computer simulation.

Mental images of foreign policy interactions are often misleading due to the complexity of the foreign policy environment. The human mind simply is not well adapted to dealing intuitively with large numbers of variables which interact in unfamiliar (e.g.,non-linear) fashion. In fact most attempts to generate explicit models of foreign policy behavior rely on linear relations among relatively few variables (e.g., linear regression models and factor analysis). These assumptions of linearity will generally provide fairly accurate short term (several years) projections since any curve, over a short enough interval, can be approximated by a straight line. However, the longer into the future the projections are made the greater will be the likely error. In designing long term planning systems, we must be prepared to work with non-linear systems. Thus computer simulation becomes a useful technique.

Task 4: Identify performance measures on the simulation.

Simulating the system is not enough, however. If data based simulation is to be useful in evaluating policy impacts, it must provide answers as to which alternative strategies are likely to avoid unwanted consequences. To this end there must be a set of performance measures defined upon the outcomes in such a way that alternative policies can be compared in terms of the desirability of their expected impacts. The performance measures of various strategies will be assessed against independent ratings of the importance of different objectives with regard to U.S. relations with other nations. The performance measures must be defined in such a way that they rank strategies according to their outcomes as anticipated in the simulation. The question then becomes; given a set of objectives with regard to a specific nation, say Brazil, what set of policy actions would best realize stated objectives given the assumed relationships between manipulable exogenous variables (that is, U.S. strategic options) for that country and the set of assumptions about both non-manipulable exogenous variables (such as the impact of Soviet or Chinese initiative toward that country) and non-manipulable endogenous variables (such as the impact of economic development).

Oftentimes, it is extremely difficult to quantify the elements in the performance index. For example, suppose the performance index include political stability, economic development, and attitudes toward the U.S. government. From a policy making perspective, the temptation here is to take the element most easily quantified (in this case probably economic development) and attempt to maximize (minimize) it with the hope the others will follow along. Oftentimes, however, yielding to this temptation can have disastrous long term consequences. In the case where, over some interval, increases in economic development lead to a decrease in stability which in turn encourages hostility toward the U.S., a policy maker who simply optimized on economic development might soon be confronted with a rapidly deteriorating situation.

It is easy to write that variables which are not easily quantified must not be excluded; it is much more difficult to recommend how to include them. Once again, working closely with policy planners and policy-makers will be helpful both in avoiding the trap of ignoring "soft" variables and in suggesting ways to index these variables.

ASSESSMENT OF MENTAL IMAGES

Since one of our objectives is to delineate the mental images of policy-makers and then to employ these images in identifying decision algorithms for foreign policy planning, we are lead to a difficult set of practical questions on how to generate responses from policy-makers which will permit us to formalize their assumptions. Not surprisingly we rapidly found that getting useful responses would not come from a straightforward question and answer routine. Those we interviewed initially were worried, for example, that we were products of the "quantitative international politics syndrome". They seemed to fear this "syndrome" as it means, from their standpoint, attempting to quantify the unquantifiable or to collect data on almost anything regardless of it's relevancy to their needs. We quickly had to make distinctions between quantitative data and the careful (e.g., mathematical) specifications of relationships.

The quantification of information about subjects of interest has long been seen as a desired goal in the study of international relations. Unfortunately, it has frequently been the case that this measurement problem has been confused with the problem of explicitly relating variables - i.e., theory development. In general, the adequate specification of a relationship cannot be done by purely empirical means. For example, Brunner[1] has demonstrated very convincingly that the data analysis strategies presently employed by political scientists (such as correlation and regression analysis) will usually not reveal the underlying structure of a system being theorized about. This will be the case regardless of whether the system behavior is analyzed cross-nationally at a point in time or individually in a time series. Thus, there are several important problems facing political scientists in the explanation of foreign

policy exchanges. First, there is a very broad data analysis problem. To what extent can data-- even time series data-- be used to identify the basic structure of the model for a theory of international behavior. Since most analysis strategies cannot be used to distinguish between structure and parameters, it is the responsibility of the theorist to impose a basic structure on his observations prior to statistical manipulation.[?] Cain and Watts[2] point out, "without a theoretical framework to provide order and rationale for the larger numbers of variables, we have no way of interpreting statistical results. Regression analysis is properly used to estimate parameters for a model only when the structure of that model and the elements which make up the theory are already well specifed. This specification of the structure must precede the application of the statistical techniques."

In a somewhat novel attempt to get around this difficulty we have chosen to use policy analysts' mental images as the initial theoretical groundwork for structuring a theory. Thus we had to explain to the analysts that we were not particularly interested in collecting data and using computers to search through the numerous possible relationships between all of the variables in hopes of scoring a success in "theory hunting." Rather, we were interested in using their images to suggest particular structures and then to analyze the implications of that structure for policy decisions.

The initial interviews were primarily to introduce ourselves and our goals to policy planners and to elicit from them key concepts and some idea of the relationships between these concepts that we should be sensitive to in the development of our models. The overall intent of the interviews is to identify images in the areas of system identification, controls, and outputs. Interviews were performed in the Department of Defense's International Security Affairs and the State Department's Intelligence and Research Groups. Subsequently, interviews have been held in the Defense Department's Policy Analysis and Evaluation Agency.

Initial interviews coupled with a good deal of reading in the areas of oil production, agricultural economics and human resource economics produced initial flow diagrams such as that shown in Figure 1 for oil. These flow diagrams were used to generate responses, in terms of agreement or disagreement with the relationships demarcated, from the interviewees.

Several of those interviewed responded with helpful suggestions. Unfortunately most of those interviewed (not surprisingly) found the flow diagram difficult to work with or were reluctant to comment until they could assess what the relationships led to in terms of specific output. This has led to the interesting problem of having more difficulty identifying the system in talking with analysts than in identifying the controls they would apply or some assessment of the quality of the output of the simulation itself. Our next effort was the production of operating models in all three areas.

The operating models for the agricu.. are sector and the oil production cycles are now programmed. These are being used in discussions with policy planners in the State Department and Defense Department to check the plausibility of the output of the model under various parameter configurations, to elicit responses in terms of the boundaries of acceptable behavior on the part of each decision-maker, and to encourage discussion of the interaction between outputs in these areas and U.S. goals vis-a-vis each of the countries we are dealing with. There are obvious problems in relying too heavily upon a criterion. As Newell and Simon observe:[8]

> The plausibility of a fundamental hypothesis about the world is almost always time dependent. Hypotheses are seldom thought plausible when they are new and have not been widely accepted. Empirical evidence supports our hypothesis increasingly, and if the hypothesis succeeds in providing explanation for a sufficient range of phenomena it becomes more and more plausible.

While these sorts of difficulties might mitigate against using plausibility as a criterion for certain theoretical objectives, we may not want to make important policy changes until the predicted effects are, in some sense plausible.

How do we know whether policy theory is plausible? Again, one way is to ask people involved with the process. As we stated earlier, policy planners and long range forecastors have some mental images of the phenomenon which they operate and routinely make predictions regarding the consequences of actions. These should be of assistance in evaluating the plausibility of the structural relationships defined.

Several conclusions seem justified based upon our work thus far. To begin with, operating simulations do encourage policy-makers and planners to try ideas out on the simulations in terms of their impressions of plausible scenarios for each of the countries being studied. At one point in presenting an operating simulation to policy analysts in the Defense Department the simulation came to a question and answering routine which required that the operator respond with a yes or no statement. The operator was gently pushed out of the way by a General who was anxious to continue the simulation. The General remained at the controls of the terminal for approximately forty-five minutes generating scenarios which he thought were plausible and explaining what he would do were that particular configuration of outputs to occur. This strategy permits ascertaining the player's perception of critical values from the United State's position vis-a-vis the production of oil in each of these countries, the prices charged for oil, and the host country's future intentions. The simulations also let us see how the policy planner connects assistance in the human resource and agricultural area with oil production.

Another aspect of our model development has been the identification of host country decision-making.

We began work in this area by requesting from the State Department country papers on each of the five countries under analysis. We also requested "five year" plans and major speeches from the embassies of each of the five countries. The response was good in each case and we had more than enough material to begin analyzing the particular goals on a country-by-country basis.[3] The speeches of major decision-makers in each of the countries were examined. The primary source of goal statements are the reports in the Foreign Broadcast Information Service Daily Report (FBIS).[9] This source has been augmented by some other primary documents and in conjunction with the five year plan financial statements, allowed us to estimate the particular directions which each country was likely to attempt to take. Country decision-making models are being developed from this material. Once they are operating we will use the systems to interact again with policy-makers in Washington. In this way we hope to make sure that the model's estimate of the likely responses of host countries is similar to the estimates that would be made by U.S. policy analysts.

The major thrust of future research will be aimed at delineating the relationship between output on a country-by-country basis in the Middle East and the operating rules the United States is likely to employ in attempt to influence the process. In this area we are taking advantage of previous government work in The Department of State.[6]

A joint EUR/INR Net Assessment Group paper attempting to assess the impact of an enlarged EC on NATO, and the implications of this impact on the effectiveness of current U.S. European defense policies projected into the period 1974-75. They introduced a new methodology of eliciting estimates of the impact of European Nations' actions upon the objectives of the U.S. The research groups also elicited statements about the likelihood of a particular objective being reached given a specified U.S. goal. The procedure was to provide matrices in which respondents were asked to identify cells in which the interception of action with an objective was thought to produce a positive, negative or no effect. They had a good deal of success identifying estimates in both cases. Matrices like the two developed in the Europolicy exercise should provide information which can structure contingency models from which to develop decision moduals.

In addition, we have a graduate student developing decision trees on Foreign Military Assistance programs from both the State and Defense Departments' perspective. He is working on published hearings before Congress and has found it possible to distinguish between State's role in deciding the desirability of assistance or sales and defense's logistics perspective on delivery and support. The bifurcation of responsibilities has lead to some very interesting scenarios.[5]

CONCLUSION

The preliminary work we have done thus far supports the position that policy planners and policy-makers

can be extremely helpful in developing simulation based forecasting systems. This helpfulness extends through all stages including identification of the system, specification of alternative policies (controls) and evaluation of the plausibility of the system response. Such helpfulness does, however, seem to depend upon fairly frequent interaction between the policy people and the researchers. Needless to say, crucial work in external validation remains.

ACKNOWLEDGMENT

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FIGURE I. CONCEPTUAL FLOWCHART OF OIL MODULE