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The Utilization of the Behavioral Sciences in Long Range Forecasting and Policy Planning

Semi-Annual Technical Report No. 2

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INTRODUCTION

The Advanced Research Projects Agency contract to The Project for Theoretical Politics began January 1, 1973. The semi-annual technical report is being submitted to cover the dates of July 1, 1973 - December 31, 1973.

The report will be divided into six major sections. The first will describe the analysis initiated and completed during the half year. Results of special significance will be highlighted. Methodological problems that have arisen during the analysis will be discussed in the second section and the computer programs that have been written or revised will be described. In this and the previous sections, technical terms and discussion will be avoided where possible.

The third section of this report will describe the data collection obtained during the period and their disposition in data archives. Current personnel on the project, personal commitments made and consultation will be noted in the fourth section. Project publications, research reports, monographs and preparation completed during the period will be listed in the fifth section. The sixth section will delineate changes necessitated in the budget, status of sub-contracts, and total versus expected expenditures to date.

1. Report on Simulation Status

The goals of the project have been the development of forecasting techniques to the point where alternative U.S. policies towards specific countries can be unambiguously ordered with respect to their utility in light of certain foreign policy objectives. As a way of achieving this goal, the project envisions the development of a complex mathematical system for forecasting the effects of U.S. policy in various nations. In doing this, assumptions about the relations between U.S. policies and country and region specific indicators of stability in foreign behavior are to be expressed in a mathematical language. Results from current ARPA supported basic research efforts would be used to provide a basis for defining and testing the relations between these indicators. Mathematical control theory and dynamic programming, integrated with the user stated objectives in each country would then be applied to identify optimal mixes of policies toward each country.

As a substantive target, U.S. relations with Middle-Eastern oil producing countries was chosen. Specifically, Iraq, Iran, Saudi Arabia, Libya, and Algeria are the nations to be analyzed. With this in mind, several module simulations are being developed to portray the dynamics 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 second 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.

In order to accomplish these goals, the modules are being developed in interaction with policy planners and in the Defense Department and the State Department.

1.1: Oil Production Module. A major part of the Project's work has been concerned with the study of crude oil production operations within the five countries. The objective of this analysis has been the development of a modular computer simulation of such operations. The oil simulation module is then to be used (along with agricultural and human resources simulation modules) as a causal stratum within our more general scheme.

The intended use of the simulation, however, calls for a different kind of model than is generally developed. We are not interested in constructing a simulation which (a) characterizes the operation of the world oil industry in any aggregate sense, or (b) is "valid" for crude oil production in all countries, or (c) provides point predictions of the operation of the crude oil industry within any of the countries under study. Instead, a central focus has been to represent those characteristics of the crude oil production operation that are considered (in part by United States policy planners and decision-makers) to be salient to government officials of the countries under study, subject to the further requirement that the simulation, when provided with realistic initial conditions and control inputs, behave plausibly in the view of knowledgeable observers.

Because very little of the vast literature on oil economics and the oil industry deals with that industry expressly from the point of view of a producing-country government official, there was relatively little guidance available on what factors should be included in our model. Many aspects of crude oil production in the Persian Gulf, in the Middle East, and in North Africa are not typical of production in other parts of the world; production in these areas (as opposed to contractual agreements) may be characterized as a relatively simple and stable mechanism. Thus, as a starting point, a relatively simple oil module has been constructed. As further interviews with U.S. planners enable us to better identify the actions of producing country decision-makers, we fully expect to find that the present oil module requires revision and further development.

As presently conceived, the oil module's central variables are proven reserves, production capacity, and capital investment. A determination is made, for the current month, of additions to production capacity from past capital investment. The same month's production is subtracted from proved reserves, while another amount (resulting from past capital investment) is added to proved reserves, and a decision is made on whether to allocate additional funds for capital investment. Revenue accruing to the government of the producing country is computed according to whatever contractual arrangement is provided by the user. Actions of producing country decision-makers are explicitly not modeled in the oil module, but are to be included

in the decision module currently under development. Posted price schedules and oil company-producer government contractual arrangements are exogenous variables provided by the simulation user.

Present work is concentrated upon completion of the overhead and interface programming general to the entire simulation, so that the oil module may be interfaced with a decision module. In addition, a key goal of the overhead programming is to facilitate, as much as possible, straightforward and easy modification, within limits, of any simulation module. Upon completion of the overhead programming, additional parameter estimates and initial conditions will be forthcoming. For a more detailed description of the oil module, see PTP Working Paper 15, "The Oil Module".

FIGURE II-1

Simple Flowchart of Computer Program

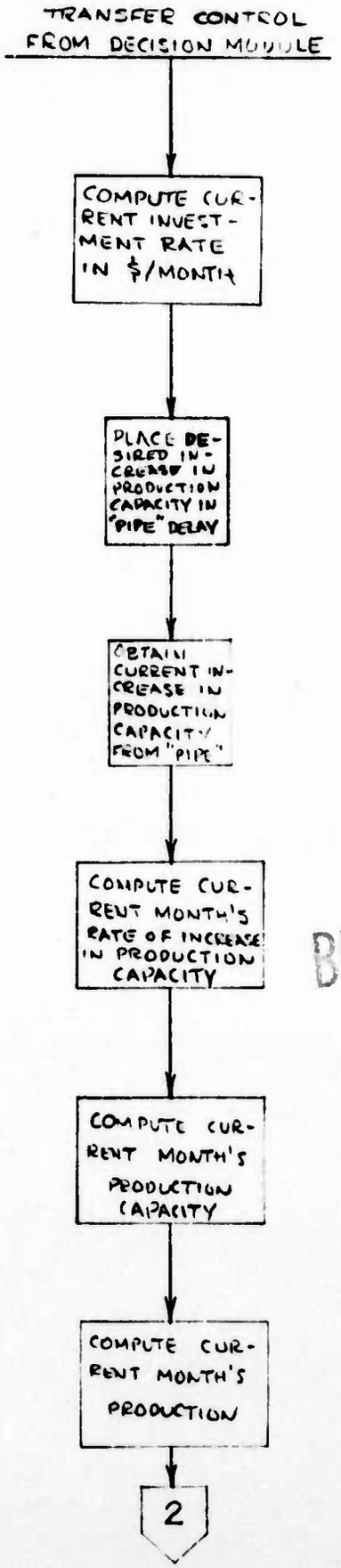


FIGURE II-1 (cont.)

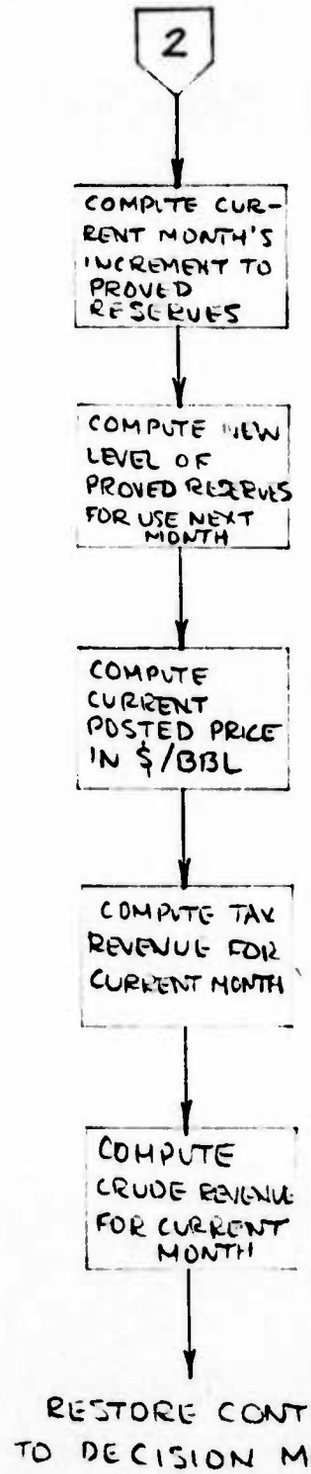
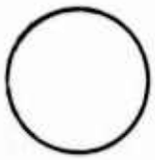
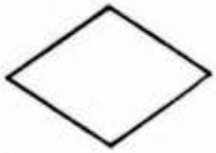


FIGURE II-3a

Legend for symbols used in Figure III-3b:



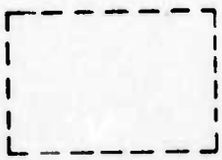
Process information variable



Control information from control stratum

Exogenous information provided by user

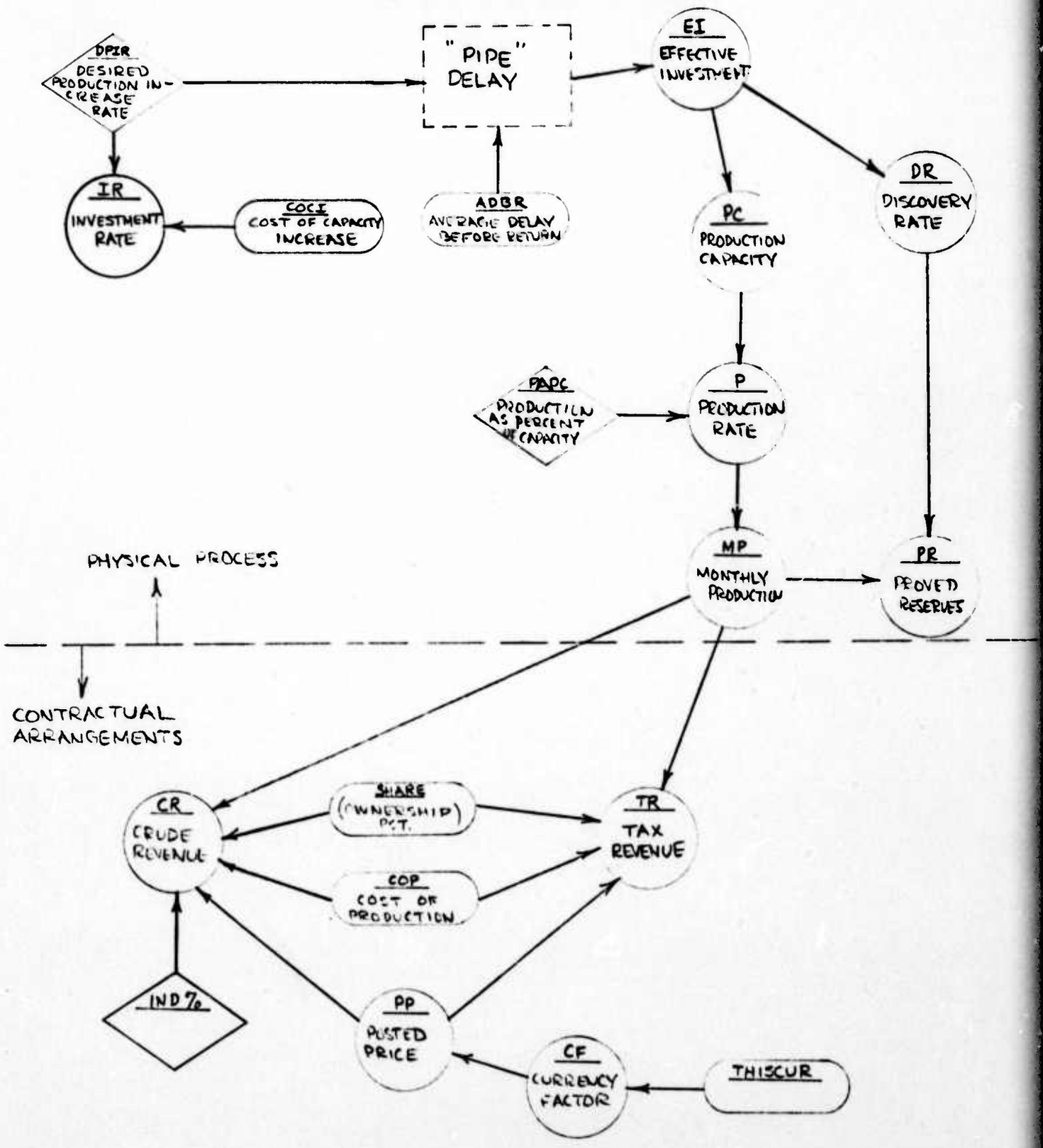
Indicates influence of one variable upon another



Specifies additional detail concerning a particular influence mechanism

FIGURE II-3b

Conceptual Flowchart of Module



1.2: Agriculture: Oil clearly has been a dominant factor in the economies of these Middle Eastern countries. However, to focus solely on the oil sector is to present an incomplete picture of Iran, Iraq, Saudi Arabia, Libya, and Algeria. While this sector constitutes the major source of revenue for each country, it remains only one of several important sectors "defining" the environment within which decision-makers in these countries operate. Another important sector in this setting is that of agriculture.

After oil production, agriculture provides the largest single contribution to the national accounts (i.e., the national income, the GNP, the balance-of-payments, etc.) of each of the five countries. The agricultural sector, moreover, is the principal source of employment in these oil-producing countries, with more than half of the population in each country (except Libya) deriving its livelihood from agriculture. Due to a number of constraints (e.g. limited water resources), however, the level of agricultural productivity in these countries is presently rather low. As a result, these countries are not able to produce enough on their own to meet the ever-increasing food needs of their respective populations. Further, with ever-growing populations and rising demands for better standards of living, they face the strong possibility of widespread famines breaking out in the not-too-distant future. To avert this situation, extensive efforts are being made in each country to modernize and develop, the agricultural sector.

It is in the context of these development efforts that we have attempted to construct a simulation of the agricultural sector in these five countries. Specifically, we have sought to formulate a structure which would enable us to (1) identify and trace the various information and material flows in the agricultural production process which influence the decision-makers' choices of developmental policies and programs, and (2) project the consequences that their choices might have for the output behavior of the agricultural sector. To this end, we have adopted a "building-block" approach to modelling this sector. The complex array of variables and interrelationships are conceptually grouped into several sequentially-linked "logical components", or building-blocks, to simulate various facets of the production process. Four such components are included in the present version of the agricultural simulations: resource allocation, modernization, production/marketing, and consumption/demand components. The output of a component is either an input to another component or a performance variable, or both. The final outputs of the model thus included not only physical outputs, but also a set of performance variables. It is this set of variables which the decision-makers evaluate and compare with policy goals when choosing their policies and programs for the next time period.

At present then, we have a model which is structured to simulate the production of field crops (specifically wheat, the principal crop and food staple) in these oil-producing countries. Parameter values are available for one country (Saudi Arabia) and will soon be ready for the other four.

For a more detailed description of the agriculture module, see PTP Working Paper 16, "Agricultural Sector Module: A Preliminary Sketch".

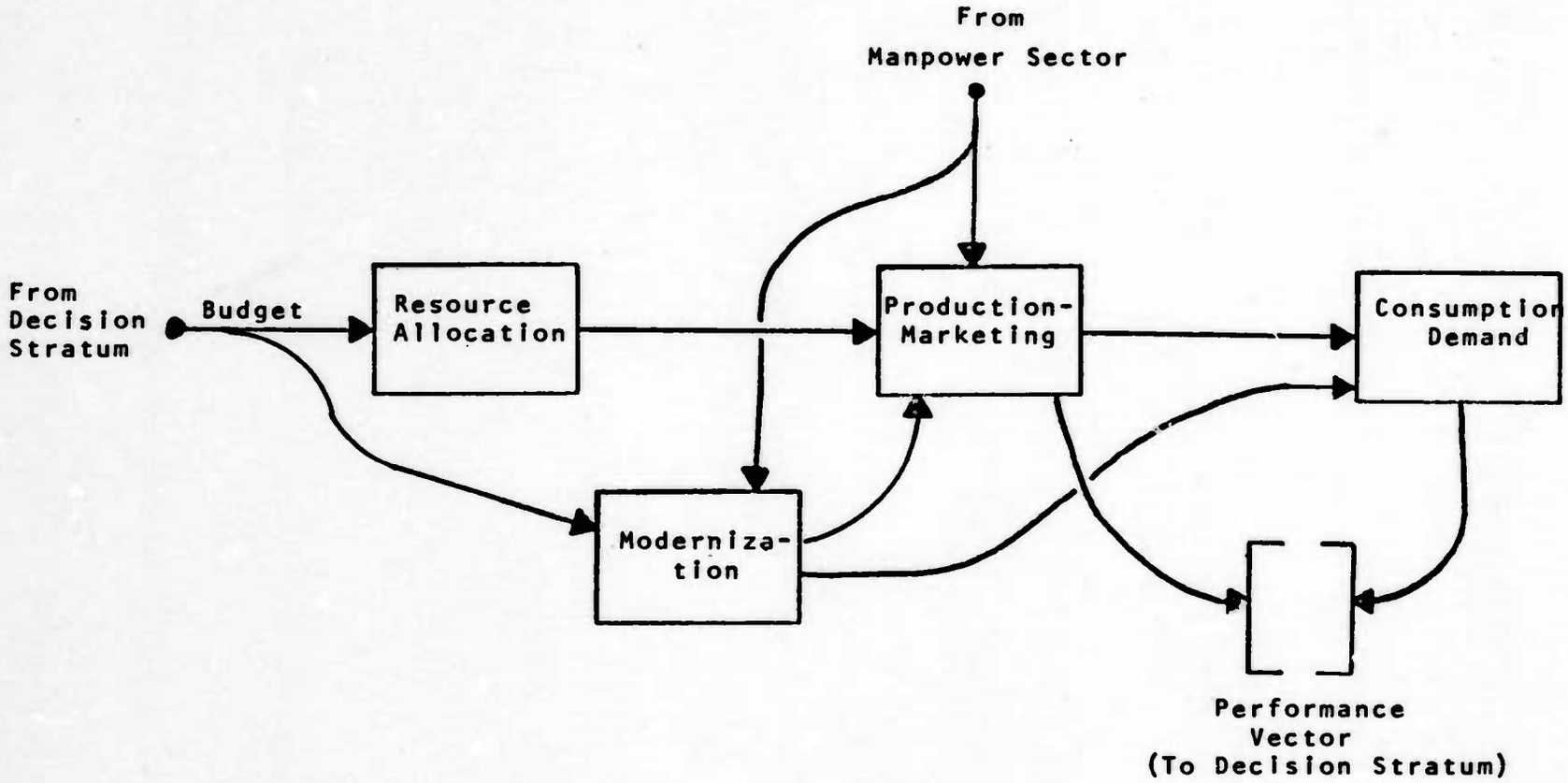


FIGURE 1. Major Component and Interacting of the Agricultural Sector Model

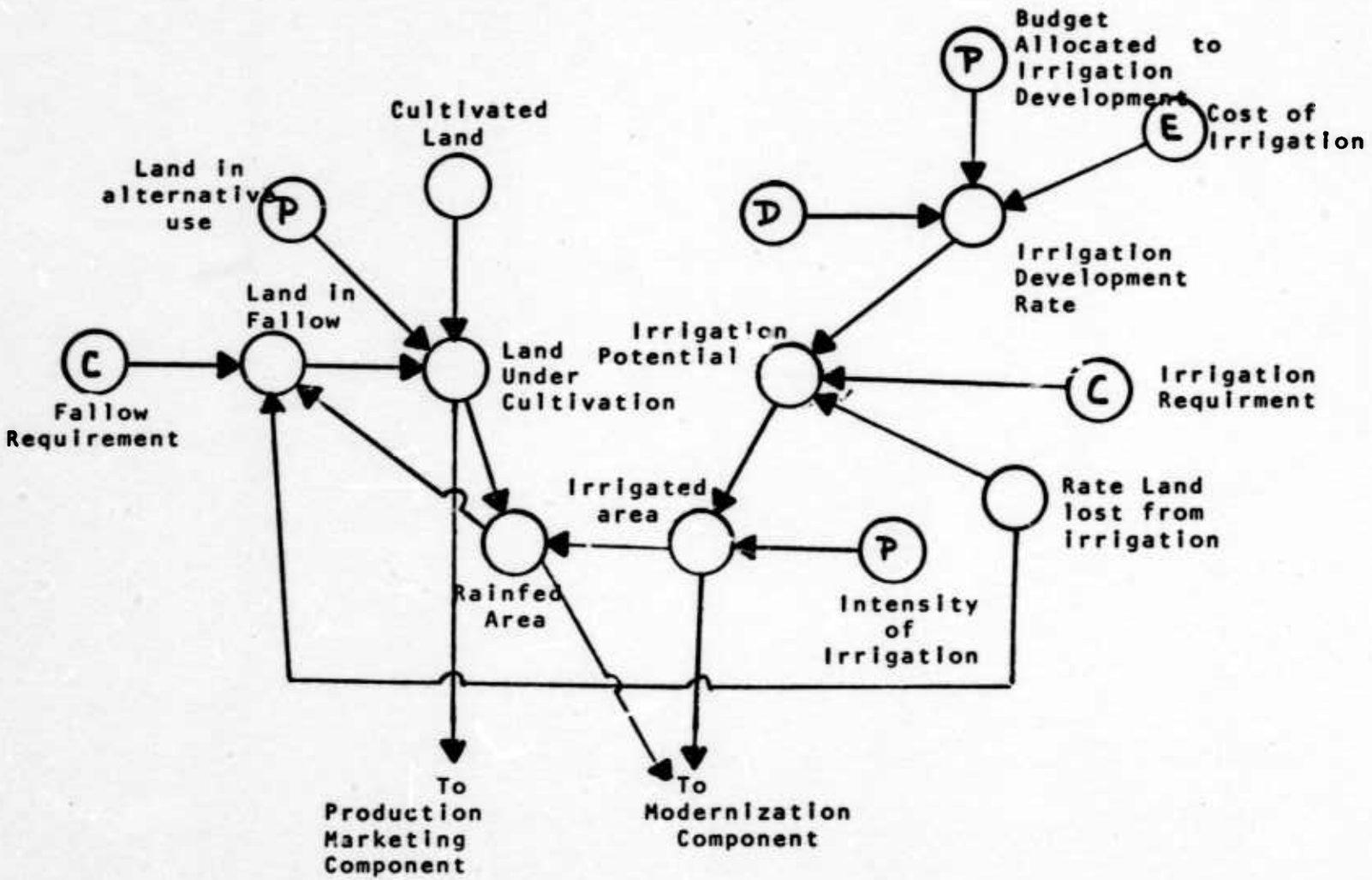


FIGURE 2. A Causal Map of the Resource Allocation Component

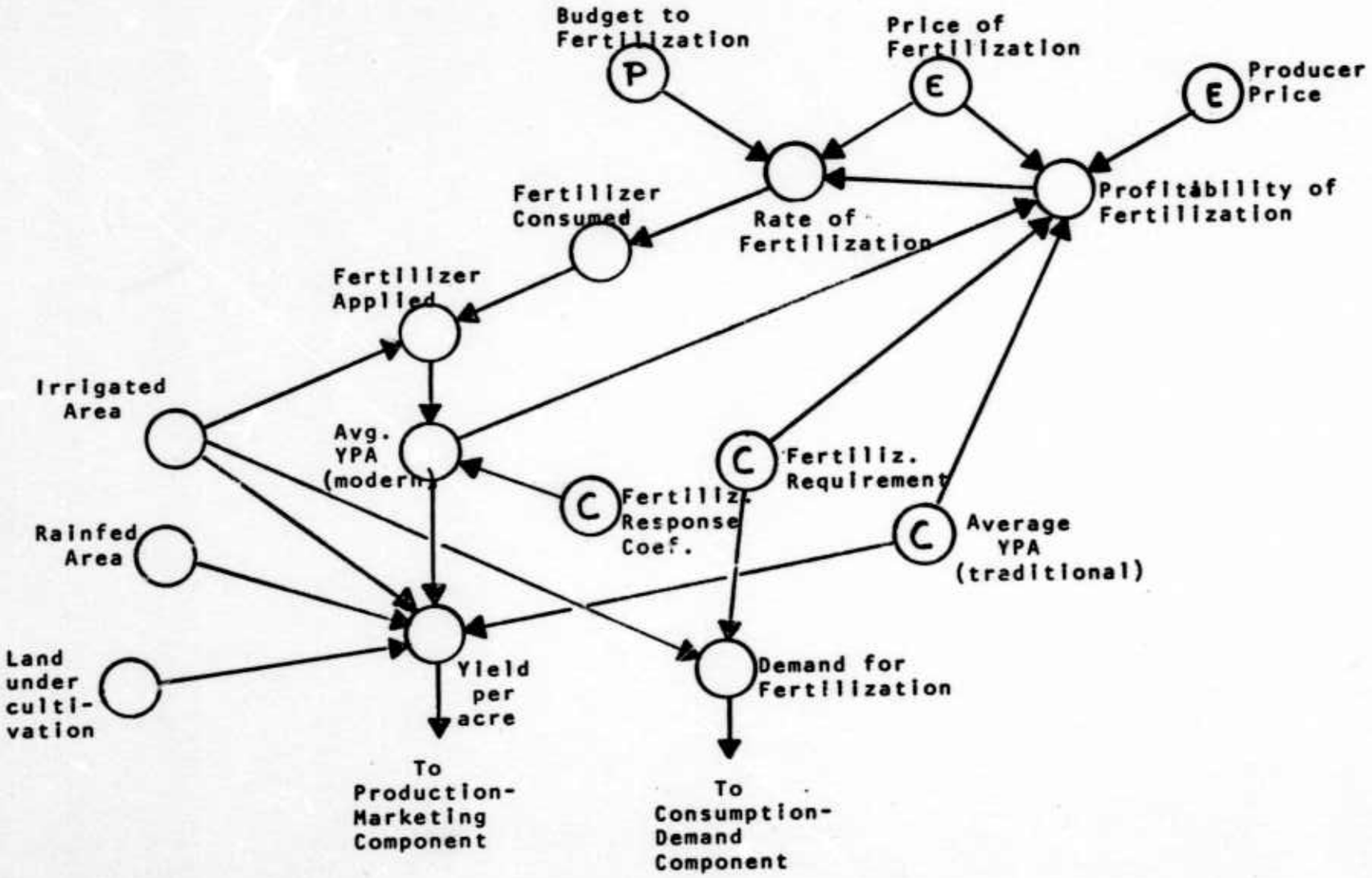


FIGURE. 3a. A Causal Map of the Modernization Component (Fertilization)

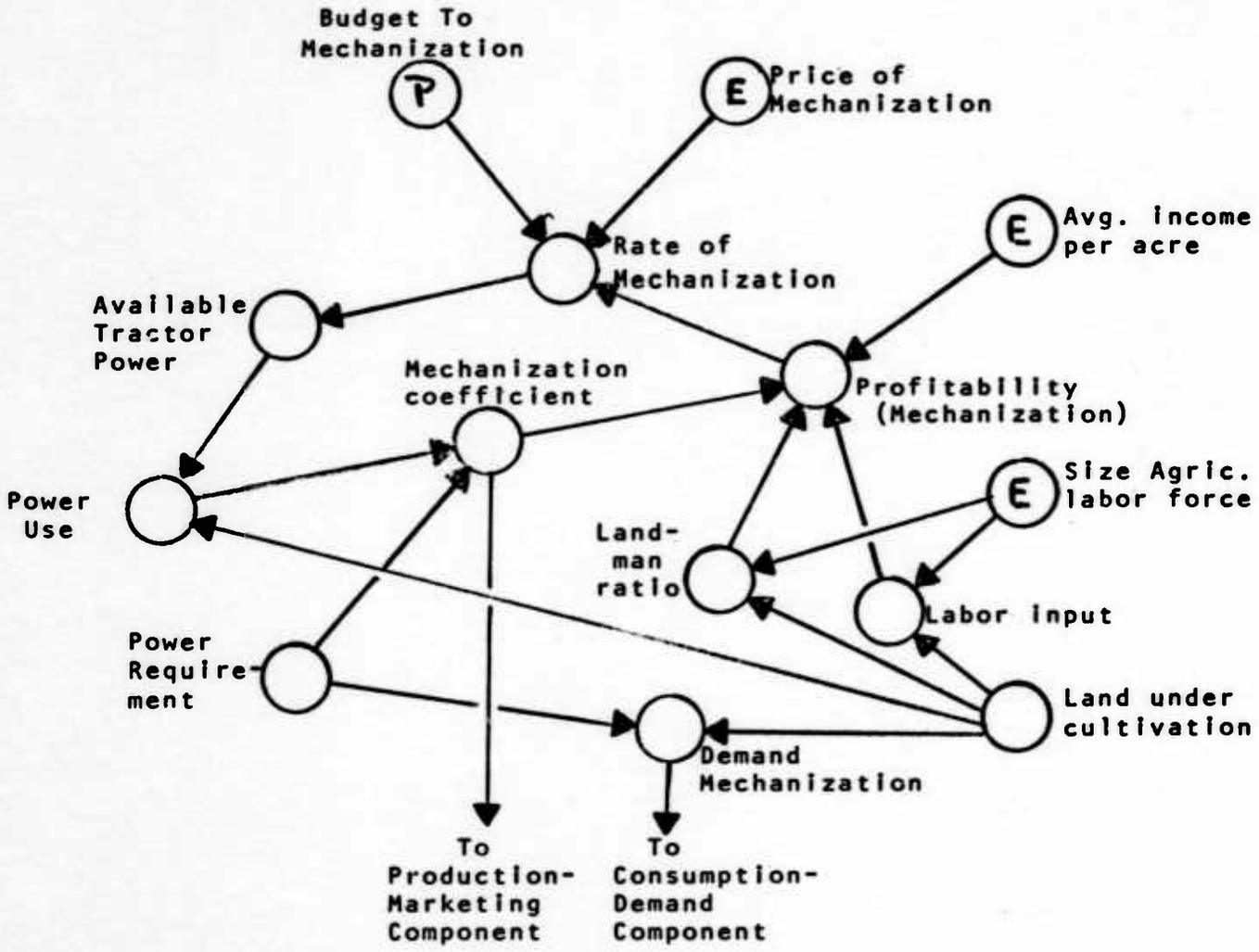


Figure 3b. A Causal Map of the Modernization Component (Mechanization)

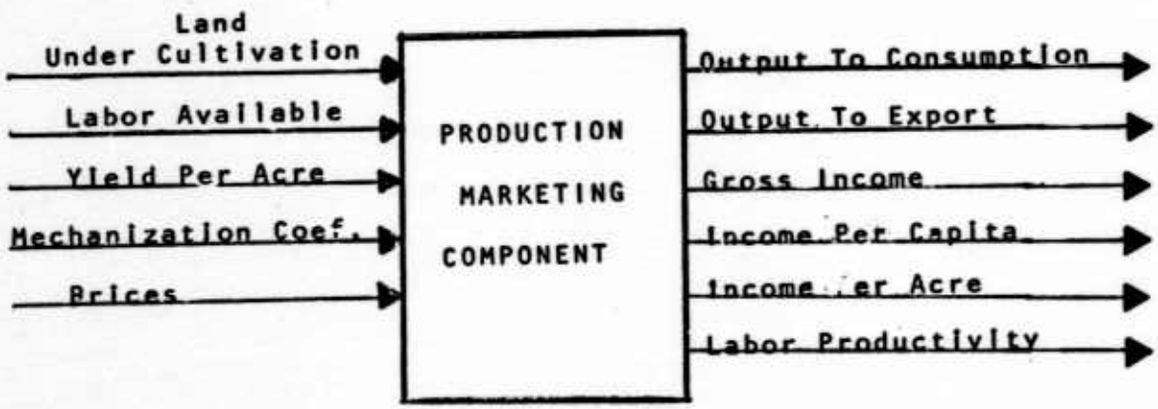


FIGURE 4. . Major Inputs and Outputs of the Production / Marketing Component

1.3: Country Specific Decision Module. The initial choice for an analytic representation for the decision process developed out of work done at the University of Michigan by Nelson, Winter and Schutte on evolutionary theories of economic growth. Briefly, their work was based upon a spatial representation of the various policy options open to a firm and incorporated a satisficing or bounded rationality approach to the identification of alternatives to the current policy. From the analysis of their basic assumptions and a comparison of those assumptions with preliminary work done on specifying the goals and values of the countries under study, it was determined that while the countries maintained many goals and that at one level those goals changed over time, the Nelson et. al. model and the variant of it that was being proposed for the decision module could not handle the complex procedure of goal specification and change.

Work done at Case - Western Reserve by Bossel and Hughes in connection with the Mesarovic - Pestel World Model, did incorporate a workable solution to the goals specification and change problem with which the Nelson et. al. formulation was unable to cope. Upon further analysis it was determined that the two approaches were not incompatable -- so another version of the decision module was developed. The newer version took goal changes to be a function of the decision makers' value structure and perceptions of the environment -- both national and international.

Current work is proceeding along two levels: 1) Specification of the value-goal structure and the relationship between perceptions and goal change; and 2) Further specification of the consideration and adoption of alternative policies vis-a-vis the goals of the national decision-makers. In addition, considerable effort was expended identifying goals and preference orders over alternatives for the five countries. The results of this analysis is reported on in PTP Working Paper 14, "An Analysis of the Goals of Five Oil Producing Nations". The decision module itself is described in more detail in PTP Working Paper 13, "The Decision Module".

2. METHODOLOGY AND PROGRAMS

2.1: Computer Terminals. The Ohio State University's simulation capabilities are strongly facilitated by TSO (Time Sharing Option) terminal capability. In order to make the most use out of this capability the Project has rented 3 computer terminals. One Execuport produces a standard 80 column hard copy and can be easily transported to and from Washington in demonstrating the modular simulations being produced on the project. Two other terminals are CRT's. These are excellent for debugging simulation programs and running the simulations when volumes of hard copy are not essential. Of course, separate commands for producing hard copy at the computer terminal for any run on the CRTs is available. Primary responsibility for developing and maintaining our computer system is provided by Polimetrics Laboratory at Ohio State University.

2.2: Simulation Programs. Of primary importance to the project is the ability to write simulation programs such that each of the modules developed in analysis can be packaged into a major simulation. The language most suitable for writing these programs is PLI. The work in constructing the simulation modules is being carried out by Robert Crain, a graduate assistant on the project, and James Ludwig, a systems programmer for the Department of Political Science.

2.3: Interaction with Policy Planners. Professors Stuart Thorson and Warren Phillips have been interviewing representatives of the Defense Department and State Department in an attempt to derive information from these planners on their perceptions of the operations of the U.S. activities in each of the countries being studied. Professors Phillips and Thorson are continuing to develop questionnaires to illicit more systematic information from both branches of the government.

3. DATA

3.1: Data Acquisition. In an attempt to have on hand a complete file on national attributes the project has acquired and implemented the Minnesota Data Set and Retrieval Program. These data were collected under the auspices of MUCIA.

4. PERSONNEL

4.1: Principal investigators. Professor Phillips has been coordinating the development of the country model of agriculture and oil production. He represented the project at the Military Operations Research Society in Monterey. He also presented the current findings of the project to the Foreign Policy Seminars at the Maxwell School (of Kentucky), Lake Cumberland retreat. In December he moved to Washington D.C. to manage the Policy Services Division of CACI Inc. He will be under subcontract to the project and responsible for user interaction tasks in the contract.

Professor Thorson has been overseeing the development of the oil and agriculture modules and has been centrally involved in the development of ways of constructing the decision modules. He served as a discussant on the Forecasting for the Nineties panel of the Military Operations Research Society's meeting's in Monterey. In addition he represented the Project at the American Political Science Association meetings. There he met with several scholars concerned with problems in bureaucratic decision analysis. He has also continued to consult with Robert Holt of Minnesota on the development of a related project.

5. PUBLICATIONS AND WORKING PAPERS (Papers 12 through 19 were completed during the past six months)

5.1: Working Papers

No. 1. Phillips, W.R., "Theoretical Underpinnings of the Event Data Movement"
No. 2. Phillips, W.R., "Forecasting for Planning"
No. 3. Phillips, W.R., "Dynamic Foreign Policy Interactions"
No. 4. Phillips, W.R. and P. Callahan, "Dynamic Foreign Policy Interactions: Some Implications for a Non-Dyadic World"
No. 5. Phillips, W.R. and M. Hainlain, "Major Power Conflict Exchanges in the Sixties: A Triadic Analysis of the U.S., Soviet, and Chinese Sub-System Froma a Comparative Foreign Policy View"
No. 6. Thorson, S. and R.E. Wendell, "Location Theory and the Social Sciences"
No. 7. Thorson, S. and J. Stever, "Classes of Models for Selected Axiomatic Theories of Choice"
No. 8. Thorson, S. and R.E. Wendell, "Some Generalizations of Social Decisions Under Majority Rule"
No. 9. Thorson, S. and R.E. Wendell, "A Mathematical Study of Decisions in a Dictatorship"
No. 10. Thorson, S. "National Political Adaptation in a World Environment"
No. 11. Thorson, S. "Comments on Some Problems in Constructing Descriptive, Policy and Design Theories of Foreign Policy"
No. 12. Phillips, W.R., Patrick T. Callahan and Robert C. Crain, "Simulated Foreign Policy Exchanges, The Rationale Underlying a Theory of Foreign Policy Interaction"
No. 13. Anderson, Paul, "The Decision Module"
No. 14. Callahan, P.T., "An Analysis of the Goals of Five Oil Producing Nations"
No. 15. Crain, R.C., "Oil Module"
No. 16. Hainline, M.K., "Agricultural Sector Module: A Preliminary Sketch"
No. 17. Hermann, C.F., W.R. Phillips, and S.J. Thorson "Theories and Forecasting in International Relations: The Role of Validation Efforts"
No. 18. Thorson, S.J., "Adaptation and Foreign Policy Theory"
No. 19. Gonzales, C.C., "Military Security Assistance to the Persian Gulf States"

5.2: Publications

No. 1. Phillips, W.R. and T. Lorimor, "The Effect of Crisis Upon the Stability of the International System", to appear in Multivariate Behavioral Research.

No. 2. Phillips, W.R. and R.C. Crain, "Dynamic Foreign Policy Interactions: Reciprocity and Uncertainty in Foreign Policy," to appear in McGowan (Ed.) The Sage International Yearbook of Foreign Policy Studies, Volume II.

No. 3. Phillips, W.R., "where Have All the Theories Gone?" to appear in World Politics.

No. 4. Phillips, W.R. "Theoretical Approaches in the Events Data Movement" to appear in C. Kegley, G. Raymond, R.M. Rood and R. Skinner's (Eds.) International Events and the Comparative Analysis of Foreign Policy.

No. 5. Phillips, W.R., "Forecasting for Planning," to appear in Hilliker (Ed.) Knowledge and Diplomacy: The Interaction of Research and Foreign Policy.

No. 6. Thorson, S. and J. Stever, "Classes of Models for Selected Axiomatic Theories of Choice," forthcoming, Journal of Mathematical Psychology.

No. 7. Thorson, S. "National Political Adaptation in a World Environment," forthcoming in J. Rosenau (Ed.) Comparing Foreign Policies (Sage).

No. 8. Thorson, S. "Adaptation and Foreign Policy Theory; in McGowan (Ed.) The Sage International Yearbook of Foreign Policy Studies, Vol. II (Sage, forthcoming)

No. 9. Wendell, R. and S. Thorson "Some Generalizations of Social Decisions Under Majority Rule," Econometrica, forthcoming.

No. 10. Thorson, S. "Problems in Constructing Descriptive, Policy and Design Theories of Foreign Policy Behavior," in J. Rosenau (Ed.) In Search of Global Patterns (Free Press, forthcoming).

(Note: Paper Numbers 8 through 10 were accepted for publication during the past six months)

6. BUDGET

6.1	Amount currently provided for contract	$ 65,914
6.2	Expenditures and commitments to date	$ 67,755.96
6.3	Estimated funds required to complete the work	$292,497
6.4	Estimated date of completion of work	Dec. 30 1975

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11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
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13. ABSTRACT

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