ABSTRACT

DESIGNING MODELS FOR POLICY PURPOSES: A VIEW FROM CAPITOL HILL*

by

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There is increasing dissatisfaction among many Executive Branch and Congressional policymakers about the contribution of modeling to public debate on critical issues. This dissatisfaction is apparent in President Reagan's budget cutting proposals. In calling for cuts in the Energy Information Administration's analysis budget, the President states:

> ...Much of this growth (in EIA's budget) has been to create new or more detailed data systems and refined analyses of limited practical value...The proposed change will reverse the trend toward ever more detailed statistics and assessments...Analytical efforts will be re-oriented to provide faster, more relevant analysis....

This lack of impact by modeling is due, in part, to a discrepancy between the knowledge requirements of policymakers and the conceptualization of models that policymakers are asked to rely on. Our paper, based on our research for the Congress, defines this discrepancy between modeling and Congressional requirements with illustrations from our respective fields of agriculture and energy. In developing criteria for assessing the policy usefulness of a model, the paper makes both structural and process oriented recommendations to assist modelers in improving the policy usefulness of their models.

*The authors are solely responsible for the contents of the paper. The views expressed are not necessarily those of the Congressional Research Service.

As noted by Rich (1979), researchers involved in knowledge development typically concentrate on one of three general areas: knowledge creation (generation), knowledge diffusion, or knowledge utilization. As a result, each of these areas have developed independently. However, each of these subprocesses influences the others; knowledge development is incomplete without understanding all of them. To focus on the entire research process requires the development of perspectives of that process based on the diverse types of questions researchers are asked to address. These questions range from narrow and specific research questions, (typical, for example, of operations research), to long-range planning questions which can be much more broad and ambiguous, (for example, in technology assessment.)

From the literature, Parker (1981) has synthesized three perspectives on the research process; Table 1 compares and contrasts these three perspectives across ten specific research questions.

From our research, we have observed that the legislative process requires a view of the research process from the right side or the "enlightenment" side of Table 1, while modelers have tended to view the process from an engineering perspective or the left side of Table 1. In capsule form, symptoms of this incorrect model-problem interface, from our perspective, include the following:

- o Tendency to equate enlightenment questions with technical complexity;
- o Tendency to equate disaggregation with sophistication;
- o Tendency to inadequately assimilate key variables into analysis;
- o Tendency to build general, "do it all" models rather than to tailor models to policy requirements.

Process and impact are interwoven. The process modelers choose in developing and using their model influences the impact they have on the policy

TABLE 1: COMPARISON OF RESEARCH PERSPECTIVES

Research Questions	Perspective on Research Process		
	Engineering	Intelligence	Enlightenment
Degree of difficulty and complexity in defining objectives	single objectives easily defined	multiple objectives difficult to define	defining objectives part of problem
Degree of explicitness of criteria for evaluating alternatives	single criteria mutually agreed upon	multiple criteria with a lack of general consensus	formulating criteria part of problem
Degree of difficulty in defining alternatives to the problem	several alternatives available	alternatives few and similar to each other	formulating alternatives part of the problem
Time frame of the problem	short-range	middle-range	long-range
Amount of uncertainty, real or stochastic, involved	uncertainty stochastic in nature	ranges of uncertainty describable	areas of uncertainty identifiable
Ability to arrive at an optimal solution to problem	single, optimal solution possible	comparison of alternatives possible	better understanding of problem possible
Number of different stakeholders whose interests are considered relevant	few stakeholders, interests similar to each other	groups of stakeholders, dissimilar interests	number of stakeholders unclear, interest not well defined
Degree of ability to restrict the system being studied	problem can be isolated from the rest of the system	some parameters can be put on the system	the system is an integral part of the problem
Extent to which dynamic features of the system and environment are considered	consideration of dynamic features unnecessary	selected dynamic features are considered	dynamic features are integral part of problem
Degree to which uncontrollable variables are considered	few uncontrollable variables to be considered	selected uncontrollable variables are considered	uncontrollable variables integral part of problem

process. Because process and impact are interwoven, our suggestions for improving models for policy purposes are both structural and process oriented.

Regarding structural considerations there has been a tendency for modelers to focus on a models internal or technical validity. Although an important aspect of modeling, technical validity is only one way to assess a model's policy usefulness. We suggest four other considerations for assessing the validity of models for policy purposes: (1) the problem model interface, (2) clarity of model's dynamics, (3) external validity of model's results, and, (4) relationship with reality.

Utilization is a process, not just the use of the end product. Results are never self-explanatory. Therefore, modelers need to participate in the pol-

icy process. Applied research is only one input into the policy process--an input which is currently not well assimilated into the dynamics of that process. For integration to occur, interaction between modelers and policymakers is essential.

But what are the guideposts to such a research strategy? We recommend the following four guideposts for integrating utilization concerns into the research process:

1. Early Involvement of Users. Effective incorporation of users into the research process begins at the research design stage. This allows users to provide input into the process before the issue becomes set in concrete. This also lays the foundation for future discussions about the project's progress and results.

2. Continuing Relationships With Users. Discussions with users must be maintained throughout the research process. Besides providing the users with information on the project's status, such discussions help build the trust and credibility between researchers and users to transmit knowledge successfully.

3. Responsiveness to User's Needs. Effective interaction with users depends on the receptivity and responsiveness of modelers to users' comments, both on designing and executingthe project. Responsiveness keeps the research relevant and avoids factual errors.

4. Facilitating Communications with Users. Research products need to be written in concise and readily comprehensible forms. Although detailed reports are necessary to document findings, summaries which avoid jargon can provide users with useful insights and guidance into the research.

The policy process is dynamic and policy questions nebulous. Modelers can make valuable contributions to this process, by proving new understanding and insight into complex, dynamic policy issues. To do this requires modelers to build linkages to the policy community and to structure their models to respond to the intelligence and enlightenment questions policymakers ask. There are risks involved. There is no guarantee of success. However, if modelers wish to influence the policy process, they must assimilate their research into it. As indicated here, modelers can accomplish this. The question is whether they will.

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THE SITUATION

Many Congressional and Executive Branch policymakers are becoming discontent with the contribution of models to the policy process. One reason the modeling process and modeling results are being questioned is because of their perceived incomprehensiblity and limited utility. This discontent has intensified with the Administration's proposed reductions in domestic programs. This new mood of austerity is forcing researchers to justify modeling as useful to government policymaking.

Such justification will not be easy. Cynicism regarding models is widespread, particularly on Capitol Hill. For example, in informal hearings on the Department of Agriculture's (USDA) long-term modeling efforts[1] before the Agriculture Committees of the Congress, criticisms range from distortions

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in data collection and manipulation to deficiencies in communication between analysts and technicians over data results. Consequently, members of Congress are questioning the utility of prolonging the research. This increasing skepticism in the Congress combined with the administration's decision to designate this project as non-major casts doubts on the project's future contribution to National agricultural policy.

Executive Branch skepticism regarding models is apparent in President Reagan's budget proposals for energy analysis. In calling for reductions in the Energy Information Administration's (EIA) applied analysis budget, the President states:[2]

> ...Much of this growth (in EIA's budget) has been to create new or more detailed data systems and refined analyses of limited practical value ...The proposed change will reverse the trend toward ever more detailed statistics and assessments...Analytical efforts will be re-oriented to provide faster, more relevant analyses...

The suggested budget cuts in the Department of Energy (DOE) will affect the government's data base by eliminating certain data gathering forms. These reductions will also adversely affect EIA's analytical capacity, particularly its long-term modeling efforts.

These and other cuts in analytical capacity reflect the administration's view that modeling should not be relied on to direct policymaking.[3] For example, the administration has called for a redirection of federal research and development (R and D) efforts towards long-term, high-risk technologies. Although "high-risk" and "long-term" are the terms used by the administration in making its R and D recommendations, these terms have not been defined by the administration. Recommendations about energy technologies are apparently being made on the basis of the technologies' commercial viability and the administration's general economic philosophy rather than forecasting the potential

contribution of each technology and analyzing whether the costs are worth the benefits.

These decisions are, in part, the result of mounting skepticism regarding the role of modeling in aiding policymakers in grappling with critical issues. Modelers must now reassess their methodologies and perspectives on research to respond to the challenge: to provide policy relevant information in a form comprehensible to the policymaker.

In this paper we look at the cause of this discontent by examining the relationship between the research process and the Congressional decision-making process. From this assessment, we note a disparity between the nature of the decision-making process and the conceptualization of models on which policymakers are asked to rely. Specifically, the paper provides examples of how this disparity manifests itself in modeling efforts. We conclude by making recommendations for integrating utilization concerns into the research process, and by discussing the risks and benefits involved with such a linkage.

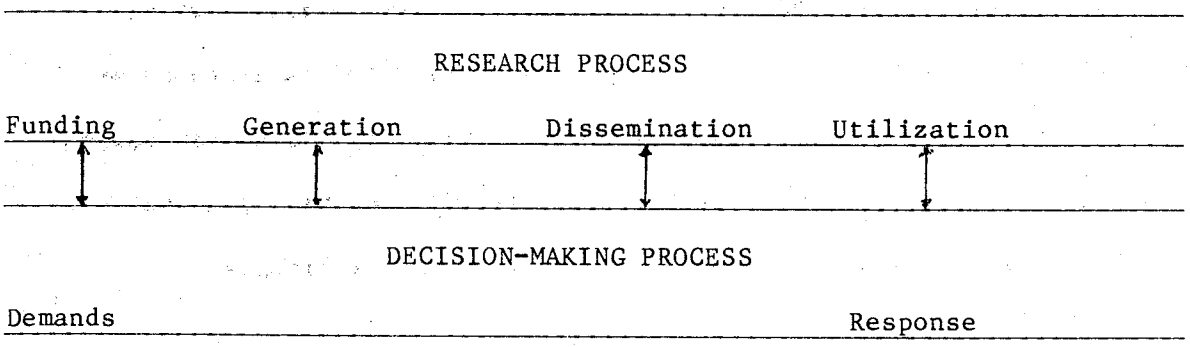
REASSESSING RESEARCH PERSPECTIVES

As noted by Rich (1979)[4] researchers involved in knowledge development typically concentrate on one of three general areas: knowledge creation (generation), knowledge diffusion, or knowledge utilization. As a result, these areas have developed independently. However, each of these subprocesses

influences the others; knowledge development is incomplete without understanding all of them. The study of knowledge utilization is insufficient without studying its creation and diffusion. Analysis is incomplete without understanding the channels used to disseminate information and the assumptions made in creating the knowledge.

The impact of the entire research process can be conceptualized as the overall impact various user-researcher interactions have on individual policy-makers throughout the entire research process (See Figure 1).

Figure 1: CONCEPTUALIZATION OF APPLIED RESEARCH PROCESS



From the literature,[5] Parker (1981),[6] has synthesized three perspectives of the research process: the engineering perspective, the intelligence perspective, and the enlightenment perspective. (Table 1 compares and contrasts these three models across ten specific research questions.) Research from all three perspectives can aid decision-making in the policy process.

The engineering perspective sees research as having a direct application to decision-making. This perspective requires research problems to

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be well-defined, and to have an optimal solution. The research process is seen as being straightforward. The researcher receives the problem from the client, does the research, finds the optimal answer, and transmits that answer back to the client. The client then applies the answer to the problem. Communication between the client and the researcher during the process is not necessary because the problem is well-defined and the solution produced is optimal as defined by this perspective.

Unfortunately, this view of the research process ignores the complexity of social problems, the decision-making process, and the policy process. Social problems are rarely well-defined to the degree required for the engineering perspective. They generally involve multiple and sometimes contradictory objectives, and do not have an optimal solution. Additionally, the decision-making process is highly diffuse, often vague and disjointed. The generation and dissemination of information, however, is continuous throughout the decisionmaking, varying in degree and intensity over the course of the process.

This situation is reflected in Congressional decision-making. By nature, the institution's decision-making is instinctive, often responding to uncertainty with incremental solutions. Solutions are a combination of ideas and choices based on nebulous criteria, often designed to rationalize rather than explain the policy choice. Congressional decision-making is the result of selective legitimization of options, options which change even as decisions are implemented.

Policymaking is developed through this political process. Bargaining and compromise are continual, and to expect any one solution, or series of solutions to have an immediate and direct impact on the output of such a process is a mistake. Many factors, including interpersonal relationships, organizational interests, external events, urgency of the problem, and re-

searchers' efforts to increase utilization all affect the policymaking process.

The legislative process is illustrative of this dynamic process. Many factors, including interpersonal relationships, interest groups, and current events influence the direction and tone of Congressional policy. Weiss (1977)[7] has suggested that it may take ten years or more for decision-makers to respond to the accumulation of consistent evidence. The scientific, orderly, and well-disciplined rigor of the engineering perspective of research, with its emphasis on the optimum answer, cannot be easily assimilated into this dynamic process. Thus, researchers hoping to impact the legislative process need to recognize the limitations of this perspective.

The other two perspectives presented here are the intelligence and enlightenment perspectives of research. By emphasizing the uncertainty, lack of consensus, and the dynamic nature of decision-making and the policy-making processes, they illustrate the need to integrate utilization concerns into the research process. The intelligence view of research sees research as providing a knowledge base for decision-making by identifying and comparing alternatives across multiple criteria and discussing the tradeoffs involved in the decision-making and policy processes.[8] As summarized by Lasswell, the intelligence perspective sees modelers aiding policymakers by clarifying goals and alternatives, and providing needed information. From the intelligence perspective, research is introduced into the policymaking process as one of many inputs, and provides only one basis for decision-making.

From the enlightenment perspective, research provides increased insight and understanding about policy problems to the policymaker by defining issues and alternatives, and identifying areas of uncertainty. From this perspective, modelers aid the policymakers by providing insight on

on policy objectives, possible alternatives, areas of uncertainty, and, the dynamics of the particular policy area.

An enlightenment perspective of research will produce perspectives, orientations, and empirical generalizations about policy areas and priorities. To produce such perspectives, a consensus with decision-makers is not necessary.[9] As summarized by Weiss, this perspective:

> ...does not consider the value consensus a prerequisite for useful research. It sees a role for research as social criticism. It finds a place for research based on variant theoretical premises. It implies that research not necessarily be geared to the operating feasibilities of today, but that research provides the intellectual background of concepts, orientations, and empirical generalizations that inform policy. As new concepts and data emerge, their gradual cummulative effect can be to change the conventions policymakers abide by and to reorder the goals and priorities of the practical policy world.

The combination of these three perspectives--engineering, intelligence, and enlightenment--contribute to a view of the decision-making process that is more complete. These perspectives indicate that the conduct of research can determine its impact. Hence, modelers should view the research process from all three perspectives.

In viewing research, the federal govenment has begun recognizing the need to understand the broader issues involved in policymaking: the costs of uninformed decisions has become too great. As stated by Roger Glassey, former Assistant Administrator of the Energy Information Administration for applied analysis:[10]

> I believe we are much better served by focusing our attention on broader issues at higher levels of aggregation rather than continuing to pursue the will-o-the-wisp of ever finer detail in analytical questions.
>
> So how do we set our long-term goals? Well, simply by trying to understand better what are the long-term issues....An issue represents a long-term value conflict within the society, or within the body politic, that is not going to go away quickly just by a technological fix or a brilliant policy stroke.

Despite this, most modelers tend to view research from an engineering perspective. They seem intent on designing models which will calculate that "brilliant policy stroke" that will solve policy problems. In the case of systems dynamics, some practitioners have suggested that by adopting this approach, modelers can arrive at the optimum solution. As stated by one practitioner when introducing newcomers to a conference on systems dynamics:[11]

> The conference is designed to provide you with tools and a point of view that can help you develop relatively simple answers to complex problems, in whatever area of application that is professionally interesting to you.

To provide useful input into the policy process, modelers must recognize the complexity and lack of a single "truth" involved in their work. Such a recognition suggests a different conceptualization of the research process -- one that recognizes the dynamics of the policy process and the importance of the various user-researcher interactions during the entire research process. Such an approach stresses the need for user-researcher linkages. This view of the research process also requires modelers to reevaluate the appropriateness of their methodologies to the problem they are addressing.

SYMPTOMS OF THE PROBLEM

How does the attempt to impose an engineering perspective of research on intelligence and enlightenment research questions manifest itself in models? From our vantage point, we have observed the following characteristics of an incorrect model-problem interface. The list is not comprehensive, but representative.

- o A tendency to equate enlightenment questions with technical complexity;
- o A tendency to equate disaggregation with sophistication;
- o A tendency to inadquately assimilate key variables into analysis;
- o A tendency to build general, "do it all" models rather than to tailor models to policy requirements.

1. Tendency to equate enlightenment questions with technical complexity.

As noted earlier, enlightenment problems are nebulous, long range, and involve great uncertainty. In designing long-range models for addressing enlightenment questions, modelers have tended to increase the technical complexity of their models. An example of this is the SEAS model used by the Department of Energy for assessing environmental impacts of energy developments, which has over 100,000 variables.[12]

Additional examples include the Iowa State University Center for Agricultural and Rural Development (CARD) linear programming series models.[13] The models, attempt to provide a "family of models for the analysis of land and water use and agricultural structure."[14] Refined over time, the models impose various constraints to study relationships between agricultural production and land use and environmental conditions and policies. The number of constraints applied to structural variables ranges up to 4000. Such detail makes interpretation of results difficult. As stated by English and Heady, creators of one model, "these models are capable of generating a vast amount of detail...[in fact], so much information can be generated that it cannot be be readily interpreted and presented in a typical manuscript."[15]

Such complexity does not increase the understanding of enlightenment problems. In fact, it may mask important assumptions, internal logic, and

data limitations of the research under a facade of rigorous but superfluous methodology. Such extravagant methods may add an aura of precision to the analysis, but they add nothing to the understanding of the problem.

2. Tendency to equate disaggregation with sophistication.

A second approach to dealing with intelligence and enlightenment questions is to disaggregate the analysis. While some disaggregation can aid understanding of a policy issue, there is a point of diminishing returns. Excessive detail is unnecessary to understand the key variables and trends in enlightenment questions. Often, disaggregated analysis requires detailed data which doesn't exist. Hence, when modelers regionalize their analysis they disaggregate the existing data according to some formula or variable which may be inappropriate. When data do not support disaggregation, disaggregation can add uncertainty to the analysis while appearing to add precision.

The tendency to disaggregate unnecessarily is evident in Federal government efforts to assess supply and demand for natural resources. Agencies within the USDA and the U.S. Department of Interior have undertaken monumental projects to collect and analyze "useful" data on the Nation's natural resources. This effort involves the collection and categorization for example, of the number and species of trees, the acreage and uses of land, the number and species of fish and wildlife, etc., as well as verifying the data, assimilating the information, and, massaging the data into a usable form for analysis.

These efforts and the subsequent long-range projections have been characterized as "almost irresponsible...vague...contradictory...fragmen-

tary...and impossible to validate."[16] The data, in some cases, do not disaggregate well below the state level. Although data are disaggregated into arbitrary market, production, transportation, and resource production areas, the information and the restraints incorporated in the models are inadequate to accurately simulate responses to changes in resource use below the state level. This is because data collection procedures were not uniform, and the information supplied was, in some cases, based on analysts perceptions of the situation, not empirical observation.

Disaggregation is not a panacea for enlightenment questions. Disaggregation should be done when significant regional trends are suspected and when the data base is appropriate. Otherwise, modelers risk doing a lot of work to produce a lot of numbers which reveal nothing to the user.

3. Inadequate Assimilation of Key Variables into Analysis.

A third response to enlightenment questions is to postulate or ignore key variables which cannot be easily assimilated into a model. This is not to say that all exogenous inputs are bad, but that variables which have a major influence on model results should interact fully with the dynamics of the model.

An example of this phenomenon is the CARD-RCA model[17] designed by Iowa State University to aid USDA evaluate policy options to avert excessive soil loss. Although supply factors are fairly well integrated into the model, important demand factors are exogenous or omitted. For example, because livestock and livestock feed demands are exogenous, the model cannot properly integrate export demand for these products. These products currently account for one-fourth of U.S. agricultural exports, and are expected to increase in importance in the future. U.S. export promotion policies, increases in centrally planned and developing countries imports of U.S. agricultural products, and

increases in developed nations demand for these products all contribute to future export demand. In addition, domestic agricultural policies, growth in commodity markets, and state programs to promote agricultural products contribute further to variances in demand. However, none of these dynamics are integrated into the model.

By exogenously introducing key variables into a model, the dynamics of the model do not interact with all the key variables. Relationships which have a major influence on model output are not developed. An opportunity to provide enlightenment into the system's dynamics is lost. The user receives incomplete results based on incomplete analysis.

4. Tendency to build "do it all" models rather than to tailor model to policy requirements.

The desire for detail noted here has given rise to modelers building rather large, detailed models. Such detail is often inappropriate in dealing with long-range enlightenment types of questions for several reasons: (1) it is almost impossible to provide accurate projections at detailed levels because the data are poor, (2) a bad result in a minor subsection of an analysis casts doubt on the entire analysis, and, (3) responsiveness to user needs is reduced because of the time necessary to both calibrate the model to specific questions and to run it.

Perhaps the most ambitious attempt to develop an all emcompassing model is the Department of Energy's Mid Range Forecasting System effort (formerly known as PIES). Began in 1974 with the Arab oil embargo, the effort has resulted in the most complex, detailed, and evaluated U.S. energy models in existence. The models, which are used by the EIA in making projections for its Annual Report to Congress, take months to make the necessary runs using two IBM 370 computers. As suggested by

E. A. Hudson at the 1979 symposium to review the 1978 Annual Report to Congress, "When two IBM 370-168 can't give you the turnaround, it suggests the model is somewhat large. And it is possibly somewhat unwielding."[18]

The PIES effort raises several questions about the feasibility of such large, integrating models. As summarized in the Texas National Energy Modeling Project evaluation of PIES:[19]

> ...The continuing pressure for analyses and for related updates and further development have left the modeling system seriously lacking in areas of verification and documentation. This current state of affairs ... raises important questions about the appropriate institutional arrangement for development and use of such modeling systems.

Such large and unwieldy models encourage a "black box" approach to modeling results by users. Consequently, recipients of model data do not understand the assumptions or the dynamics on which the results are based. Therefore, policymakers rely on other factors such as experience and political expediency to assess the model's validity. Under such circumstances, the rejection of model results is commonplace.

DESIGNING MODELS FOR POLICY PURPOSES

Process and impact are interwoven. The process modelers choose in developing and using their model influences the impact they have on the policy process. Because process and impact are interwoven, our suggestions for improving models for policy purposes are both structural and process oriented.

1. Structural Considerations

In developing a criteria for assessing the policy usefulness of a model, most commentators have focused on the model's internal or technical validity. Although an important aspect of modeling, technical validity is only one way to assess a model's policy usefulness. We suggest four other considerations for assessing the validity of models for policy purposes: (1) the problem-model interface, (2) clarity of model's dynamics, (3) external validity of the model's results, and, (4) relationship with reality.

a. Problem-model Interface

It seems only reasonable that modelers should employ methodologies of sufficient rigor to analyze an issue without obscuring the underlying insight. Unfortunately, as illustrated earlier, some modelers appear more interested in increasing the complexity of their methodologies than in providing insight into policy problems. Such a perspective serves to confuse users and make rejection of models easier.

In assessing the appropriateness of methodologies, we suggest modelers assess the relative importance of variables before they develop their final modeling methodology. Little is gained by adding 20 variables to an analysis which refines results by only a couple of percent. Such "refinement" is easily wiped out by the data uncertainties added by the variables and the real uncertainty the model can not formally incorporate. By the same token, adding exogenous variables which have a major influence on the results but which do not interact with other key variables does not provide complete analysis.

By concentrating on the key variables and avoiding excessive detail, modelers avoid projecting a false sense of precision to the user. This

can only help the researcher in presenting results and influencing individual decisionmakers.

b. Clarity of Model's Dynamics

As stressed here, increasing user's understanding of a policy system's dynamics is an important perspective to take on the research process. To do this, the logic of the model must be explicit and clear. A diagram of endless arrows and feedback loops sheds little light on a subject. Rather, modelers should attempt to describe the insight they have received through the modeling process in clear, concise language, avoiding jargon.

We are not talking about merely documenting the model, although documentation is important to explain methodology and variables. Rather, we are suggesting modelers attempt to synthesize the insight they have gained about the dynamics of the policy system during the modeling process. Such a synthesis would be an attempt to step back from the details of the model, and examine underlying trends and structures. This product could make a substantive contribution to a policy area while at the same time making the model and its results more understandable to users.

c. External Validity of Model

There is an unfortunate tendency among modelers to equate external validity with reality. External validity means that research results are generalizable to different situations. A model can simulate reality reasonably well and the model's results not be very generalizable. This is because external validity is influenced by several factors including: (1) the comprehensiveness of the data, (2) the scope of the model, (3) the strength of the results, and, (4) the policy problem being analyzed.

In generalizing their results, modelers have tended to concentrate on their methodology and strength of results. Using results in one situation to indicate results in another situation is dangerous. This is particularly true if there is a serious deficiency in one of the other factors mentioned above. Modelers need to temper their conclusions with their substantive knowledge of the policy area being examined. They should not rely only on their methodology or model results to make generalizations about policy issues.

d. Relationship with Reality

Many modelers have a dream--a model which simulates reality perfectly. Although this may be the ultimate goal for some modelers, it misrepresents the purpose of models. Models are abstractions, intended to simplify reality, and to help decision-makers understand the complexities of policy issues. Specifically, modelers should concentrate on providing users with the following insights:

1. A comprehensive view of complicated systems and relationships presented in a systematic and explicit manner.
2. An understanding of the dynamics of the policy system being modeled and the role of the key factors.
3. Sensitivity of variables to changes by providing comparisons of different scenarios.

Modelers cannot provide these insights if their models are as complex as the system they are examining. Models are being continuously refined as more complex methodologies are demonstrated to respond more accurately to historical trends. To assess these refinements, modelers need to determine to what extent these methodological improvements contribute to the purposes of modeling.

2. Utilization (Process) Considerations

Utilization is a process, not just the use of the end product. Results are never self-explanatory. Therefore modelers need to participate in the policy process. Applied research is only one input into the policy process--an input which is currently not well assimilated into the dynamics of that process. For integration to occur, interaction between modelers and policymakers is essential.

But what are the guideposts to such a research strategy? From our experience with research projects and the utilization literature,[20] the following four guideposts emerge for integrating utilization concerns into the research process:

1. Early Involvement of Users. Effective incorporation of users into the research process begins at the research design stage. This allows users to provide input into the process before the issue becomes set in concrete. This also lays the foundation for future discussions about the project's progress and results.

2. Continuing Relationships with Users. Discussions with users must be maintained throughout the research process. Besides providing users with information on the project's status, such discussions help build the trust and credibility between researchers and users necessary to transmit knowledge sucessfully.

3. Responsiveness to Users' Needs. Effective interaction with users depends on the receptivity and responsiveness of modelers to users' comments, both on designing and executing the project. Responsiveness keeps the research relevant and avoids factual errors.

4. Facilitating Communications with Users. Research products need to be written in concise and readily comprehensible forms. Although detailed reports are necessary to document findings, summaries which avoid jargon can provide users with useful insights and guidance into the research.

All of the guideposts identified above -- early involvement, continuing relationships, responsiveness, and facilitating communications -- require an active role by modelers in the course of their research. To accept such an active orientation to one's research is not without risks. While there are

probably no definitive "answers" to the risks involved, they should be made explicit.

1. Using users to legitimize research. There is a temptation to appoint prominent persons as advisors or reviewers of a research product to increase credibility.

2. Susceptibility to Organizational Pressures. Building trust between users and modelers early in the research process may provide users with leverage later to press for changes in the results.

3. Selective Listening. Over time, the personalities of some users may clash with modelers, precluding the objective assessment of the users' comments.

4. Control of Research. Being responsive to user needs for information involves losing some control over the research agenda.

5. Control Over Conduct of Research. Being too responsive to user comments can imperil modelers' control over the conduct of their research and its conclusions.

6. Time Constraints. Presentations, trips, and designing summaries require considerable amounts of time; time which could be spent on research. Modelers must balance these demands on their time.

7. Rigor Versus Conciseness. In writing summaries, less precise language and detail must be used to avoid the use of jargon or excessive length. The need for brevity must be balanced with that for accuracy.

Although some of these questions can be properly characterized as "risks", others, such as control over the research agenda, are value judgments modelers make before they engage in policy research. Finally, some questions, such as time spent on utilization activities, are judgmental in nature, reflecting the philosophy of the modeling group.

INTEGRATING RESEARCH INTO THE POLICY MAKING PROCESS: THE MULTIPLE USES OF RESEARCH

The underuse of modeling for policy purposes is recognized by both the modeling community and policymakers. Each accuses the other for this situation. Modelers claim policymakers either ignore or do not know how to use their research. Policymakers claim modeling is incomprehensible, not relevant, or not useful for decision-making. Our experience suggests that neither case is accurate. The underuse is the result of a discrepancy between a dynamic policy process and the isolated research process. This discrepancy manifests itself both in the products modelers produce and the manner in which they produce them. Modelers have tended to divorce themselves from the policy process, and in so doing, produce research not well suited to that process.

Generally, modelers have tended to perceive the research process from an engineering perspective, one which requires well-defined problems and for which they can provide an optimum answer. Problems arise because this view of the research process ignores the complexities of the issues modelers seek to address. Such a perspective also precludes incorporation of the dynamic decision-making and policymaking processes with the research process; it totally ignores the reality of the policy process. Policy is dynamic, and policy questions nebulous. The scientific, orderly, or well-disciplined rigor of the engineering perspective of research, with its emphasis on providing the optimum answer, cannot be easily assimilated into this dynamic process.

Modelers must recognize the dynamics of the political process and the multiple ways in which research may be used. Specifically, this

paper suggests two other views of research which more accurately reflect the nature of the policy process: the intelligence and the enlightenment perspectives of the research process. The intelligence perspective sees modelers aiding policymakers in clarifying goals and alternatives, and providing needed information as one input into the decision-making process. The enlightenment perspective sees modelers providing insight and understanding about problems to the policymaker, rather than providing optimum solutions.

Modelers can make valuable contributions by combining these perspectives to build new understanding and insight into complex, dynamic policy issues. To do this requires modelers to build linkages to the policy community and to structure their models to respond to the intelligence and enlightenment questions policymakers ask. We recommend that modelers develop these linkages early in the research effort and maintain them throughout the entire research process. In so doing, modelers should be responsive to user comments and present their work in an easily understandable manner. In structuring their models towards the enlightenment types of questions policymakers ask, modelers should concern themselves not only with internal validity, but also with the problem model interface, the clarity of the models dynamics, the external validity of the model, and the model's congruence with reality.

There are risks involved. There is no guarantee of success. However, with the technological society in which we live, the cost of uninformed decision-making is very high--economically, environmentally and socially. Applied research, including modeling, provides a way for policymakers to evaluate policy impacts before and while policy is being implemented. To make

this contribution to the policy process, modelers must do two things. First, they must do research which is appropriate for policy issues and decision-making. Second, they must assimilate that research into the decision-making process. To continue receiving government support for modeling efforts, modelers must justify their activities by contributing to the policy process. As indicted here, modelers can make that contribution. The question is whether they will.

NOTES

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14. idem.

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17. See English, Burton C. and Earl O. Heady, op. cit.

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