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Automated Information Systems in
Public Policymaking

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ABSTRACT

Frequently, proposals for automated information systems to provide more accurate, timely, and relevant information to top-level policymakers in public agencies have tended to neglect the ways in which public policymakers are known to search for, select, and use information in their deliberations. This essay analyzes the likely use of automated information systems by policymakers. First it articulates patterns by which policymakers are known to select and use information. Then distinctive features of automated information systems are analyzed to understand the extent to which these common patterns may be altered. Such analyses show that public agencies are beset with several "information processing pathologies" such as filtering and suppressing data which automated information systems, in and of themselves, are unlikely to alter. An alternative proposal which couples selected organizational rearrangements with automated information systems ("technology-policy mixes") is presented as a more promising, but more difficult strategy for diminishing the information processing pathologies which are endemic to top-level policymaking. This analysis implies that people who build computer-based information systems such as simulations cannot claim that their artifacts will have some positive impact on policymaking simply because they contain some "policy-relevant" variables. Rather, they must also show that the organizational arrangements within which the data or analyses are utilized are ones in which staff analyses are not subject to the typical information processing pathologies found in public agencies.

Problems of Intelligence*

When we consider episodes like the Bay of Pigs fiasco, Ford's marketing of the Edsel, or our saturation bombing of North Vietnam, we think of intelligence failures. We presume that in these and many similar situations, appropriate policymakers would have acted quite differently had they been better informed about the substantive effectiveness of their actual choices. In each of these cases there is reason to believe that there was some evidence available before the key decisions were made: that the Cubans would not support a move to over-throw Castro; that owners of inexpensive Fords might not "move-up" to an Edsel; and that the industrial capacity of North Vietnam and morale of the populace might not be crippled by saturation bombing.

* I would especially like to thank James Danziger, Bill Dutton, Henry Fagin, Julian Feldman, and Martin Greenberger for their helpful comments on earlier drafts.

The reader is almost certain to know of other poor policies[1] formulated within public agencies or private enterorises. Many failures seem to rest on the inability of key policymakers to receive appropriate information about substantive effects of their actions in a timely manner-- even when such information is available within the appropriate organizations or to outside experts.

Over the last several decades, the problems faced by large organizations have become more complex, and the lead times from the emergence of important problems to the time appropriate actions are needed have become shorter. In addition, as the scope of action of public agencies has increased, the costs of misconceived policies have increased at least proportionately. The most extensive proposals for systematically reducing the frequency of intelligence failures have focused on revising organizational arrangements (Wilensky, 1967). However, actual reforms are rare and some technologists have suggested that some class of automated information systems might create a "technological fix" to help improve public policymaking[2] (Evans and Knisely, 1972; Sterling, 1974).

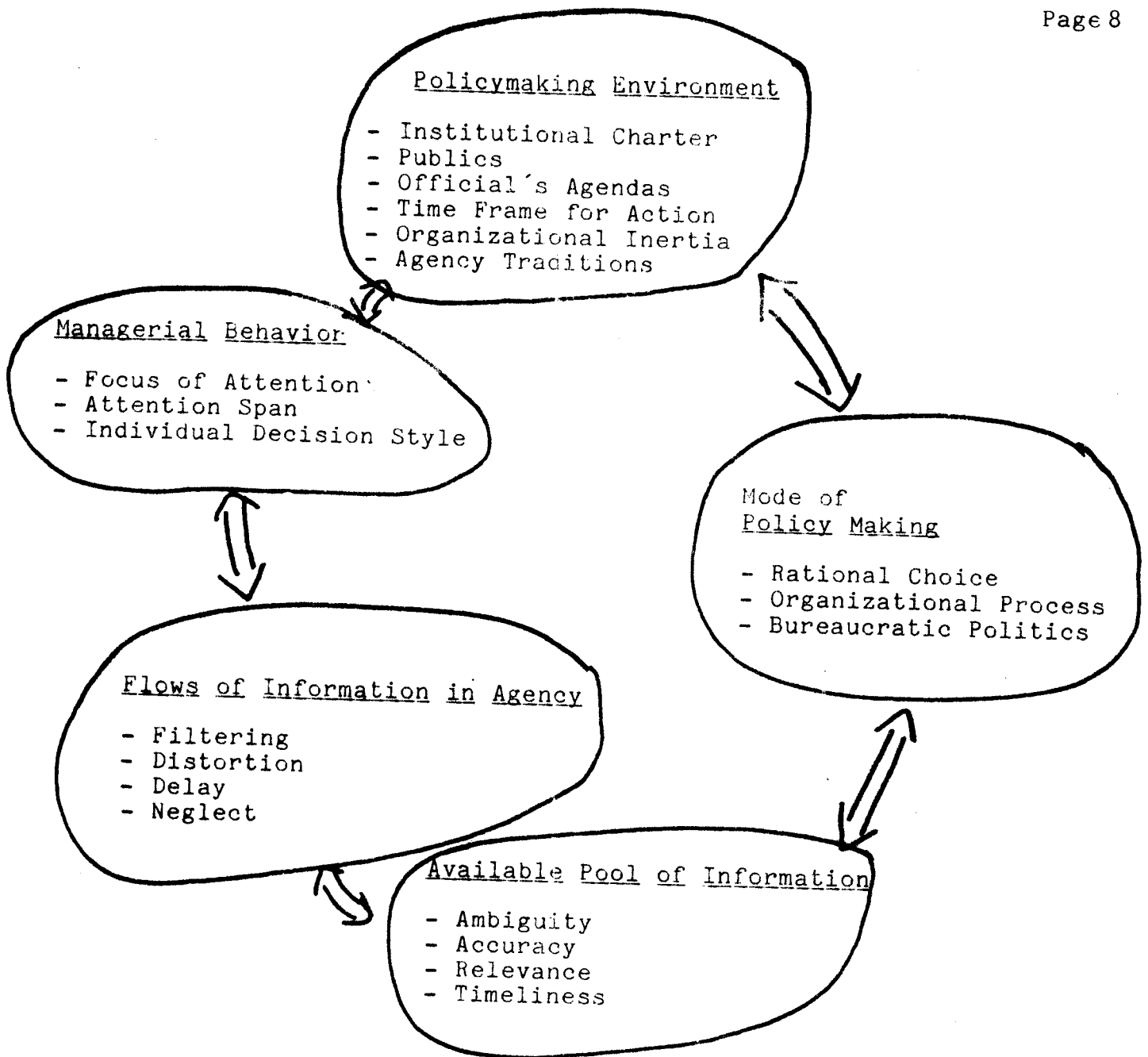
It's common knowledge that many policies developed by public agencies are not consistent with the best available information and that occasionally studies are altered or withheld for "expediency." Might the kind or quality of data provided by certain automated information systems be significantly less subject to such manipulation or neglect? This paper addresses the feasibility of such a technological fix.

1. The analysis begins with a brief sketch of patterns of information use in public policy development.
2. We then examine the relationships between policies and the substantive data upon which they might be based.
3. The ways that information is filtered and altered is studied as an ordinary aspect of complex organizations. In these first three sections, we will focus on the role of information in public policymaking without distinguishing between "data which comes out of a computer" and other sources of information[3]. These analyses deal with the variables in the four clusters uppermost in Figure 1. These analyses show that there is no necessary relationship between policies and substantive data upon which they might be based. Analyses of information systems which are sensitive to the organizational arrangements which guide their development and use show that "intelligence failures" seem to be more a function of these arrangements than of the quality of data in

the reporting systems (Adams, 1975). These points are supported by a variety of studies reported in the political science and organizational behavior literatures.

These observations are central to political analyses and are congruent with certain theories of organizational behavior. But they are rarely emphasized in the theories of most analysts who advocate automated information systems as a technology that will help promote rational policymaking [4].

4. We then examine the potential role of automated information systems, especially upward reporting systems and models, as a means of improving the quality of information that may be brought to bear in policymaking.
5. In the final section, we argue that whatever rationality is found in organizational information systems is a byproduct of both the kind of information system and the organizational arrangements used for handling the data and the analyses they produce. In particular, we will argue that the application of models to problems with a strong social component is highly experimental. Only in settings in which the analyses are shared with analysts with alternative commitments can one expect the results of model based analyses not to be distorted by the bureaucratic and political processes common to public agencies.



Some Key Relationships Between Information And Policymaking

Figure 1

A Brief Sketch of Policy Development

We will begin this inquiry by describing how issues which result in public policies emerge and come to the attention of top-level policymakers. Unfortunately, there are few systematic studies from which to generalize, but the best studies lead us to include at least the following influences:

1. The institutional charter of the agency and its scope of authority;
2. The publics-- agencies, politicians and interest groups important to the agency's success;
3. The personal agendas of the relevant officials. These include their "priorities" and proclivities, both explicit and covert.

The charter and scope of authority legislated for an agency provide a domain for enacting policy. They may shape and limit policies, but are usually too broad and ambiguous to generate specific policy concerns. For example, a school board may have a broad charter to direct the administration of a local school. That in itself doesn't mean that the school board will pay particular attention to the special educational needs of certain classes of children such as those with severe reading problems, the academically gifted, or the physically handicapped.

The concern to identify such special groups emerges from some problem focus much more specific than a broad goal such as providing basic education for children aged 4-16. Sometimes these concerns emerge from "outside" the agency. For example, a community group may draw special attention to the needs of handicapped or gifted kids. Or a state or federal agency may provide funding for new programs aimed at special groups of children.

Alternately, such concerns may emerge from "within" the agency. A school board member may be especially concerned with "doing something" for a special group of children. The agenda he brings with him to his position serves as a basis for a problem emerging for the relevant actors (school board members, school administrators, and teachers). Or a particular teacher may become concerned about some special group of children and bring his concern to the attention of higher officials. Some times there is a blend of sources when, for example, an elected official may search for a distinct issue to

develop in gaining support for re-election. I place substantial emphasis on policymakers' agendas since they provide a basis for focusing their actions and search for information. They enable the policymaker to control and make sense of his world. This emphasis underlies much of the following analysis[5].

Managerial Behavior

Empirical studies of managerial behavior show that many top managers live in a fragmented universe. They spend brief periods on a multitude of problems, are frequently interrupted, and are generally overloaded with information (Mintzberg, 1973). In an agency operating in a dynamic and complex environment, personal contact with other officials, advisors, subordinates, and members of their "publics" as well as routine and special staff reports can personally overload a middle level official. Careful studies of the behavior of industrial managers show that they may attend to several hundred transactions per day. Most of these transactions are initiated by others, and few of them last more than a few minutes. Occasional meetings may last an hour or two, but most industrial executives seem to spend little sustained time on any particular problem[6].

Doubtless, as one moves up the organizational hierarchy the number of information sources increases along with a consequent fragmentation of attention. Ironically, this means that those people charged with making the most sweeping and pervasive policy decisions are likely to be the least informed about the fine details of each component. While these observations are based on studies of industrial executives, there is little reason to believe that public officials live in a substantially different universe of information (Lindblom, 1959).

In such a universe, a priori value preferences and biases towards some specific instrumental goals (cutting cost, enacting policies favoring a particular interest group, maintaining good public relations) help an official select relatively few items for serious attention from the welter of data that might otherwise overwhelm him.

Modes of Policymaking

In the preceding discussion, I have implied that officials seek to maximize some agendas and select information that will best inform them of actions to take regarding their own agendas. If such search is limited by time and other resources, we have a "limited rationality" model of policy formulation by a single official. However, policies are often formed in an arena where several agencies, units within an agency, or individuals jointly participate. Such activities are rarely the sole concern of one official acting in a relative vacuum of competing interests.

This model of "limited rationality" can be extended to a complete agency. Generally, a rational model seems to be the preferred analytical model of management scientists and others who advocate "scientific" approaches to administration. It makes the most sense when there is substantial consensus on ends and acceptable means by the relevant actors. In addition, it best describes those settings in which authority for policymaking is centralized in one person (or harmonious body). Two compelling alternative models to the "limited rationality" model are presented by Allison(1969) in his careful analysis of the processes which lead to Kennedy's confrontation with Khrushchev over the placement of missiles in Cuba.

The first of these alternatives is an "organizational process" model. It assumes that the way in which an organization acts today is best predicted by what it did yesterday. Public policies are understood as the "outputs of large organizations functioning according to standard patterns of behavior(Allison, 1969)." It also accounts for delays in passing information, making decisions or granting approvals when many specialized actors follow the standard operating procedures of an agency. In such situations, one expects to find largely standard kinds of information flowing through the ordinary (formal and informal) paths in an organization. As policy issues move along such "decision paths," the information is normally processed by each organizational subunit. In addition, each organization (or organizational subunit) has a limited set of sources and a specific time frame in which to operate. An example which fits this model quite well is the approval of new courses or curricula within a university.

The second alternative that Allison illustrates in his case analysis emphasizes "bureaucratic politics." This model presumes that organizations or organizational subunits are preoccupied with maintaining their survival, maximizing their power, and "making out well" in the interplay of groups that influence a particular policy. The policies elected by officials in public agencies are understood as the "outcomes of intricate and subtle, simultaneous, overlapping games among players located in positions(Allison, 1969)." In such instances, we expect organizations (or organizational subunits) to present to their audience those pieces of information that best support their

cases, and to suppress information which weakens their cases. In addition, we expect information which supports some alternative point of view or proposal to be belittled. Situations which illustrate the "bureaucratic politics" model are commonplace. For example a recent New York Times article begins:

"Analyses saying that the city's municipal hospital system could be strengthened by closing some hospitals and dismissing hundreds of employees were deliberately withheld from the board of directors of the city's Health and Hospitals Corporation when it was deciding how to economize in the budget crisis. The reports were kept from board members by the corporation's president, who has steadfastly opposed the closing of any of the 19 municipal hospitals....the corporation's first vice president for finance who directed the studies said that after he presented the first study to (the corporation president) last January he was told not to talk about it. 'This is too hot, too controversial,' (he) quoted (the president) as having told him. 'You don't talk about it.' (The vice president) said he was told the same thing about his subsequent studies" (Bird, 1975).

Each of these models (i.e. limited rationality, organizational process and bureaucratic politics) provides a partial portrait of public policymaking. Of these three, the latter two seem by far to be the richest in explanatory power. They will provide the presumptions of this essay, although we will lean more heavily towards the "bureaucratic politics" model in the later sections.

The appropriateness of each of these models is signaled by distinctive treatments of information. If an agency or official eliminates a particular line of inquiry for lack of resources or time, one may focus upon the influence of "limited rationality." If information must be gathered within a particular time frame or come through certain legitimate sources, that triggers the "organizational process model." If information is suppressed, one is alerted to politicking within the bureaucracy. Of course, each of these idealized models describes only part of the way decisions and policies are made in public agencies. But each is associated with distinct information handling pathologies (Wilensky, 1967). Before looking at these information processing pathologies in detail, however, we will consider the relationship between data and policymaking a little more carefully.

Evaluating Data

Sometimes we assume that facts we find most compelling will influence others likewise. In short, the "facts should speak for themselves." In this essay I presume the contrary. The relationship between data[7] and policy is problematic.

In a recent study of the process by which the Federal Reserve Board sets monetary policy, Sanford Borins(1972) noted that the preconceptions of the various officials best predicted how they would interpret the available economic indicators. He studied the process by which the Federal Open Market Committee (FOMC) arrived at decisions to ease or tighten the money supply. The committee is composed of the Governors of the Federal Reserve Board, presidents of the regional Reserve Banks, and several other top officials and key staff members in the reserve system.

Borins identified three major ideological groups within the FOMC: "doves" who favor economic expansion to increase employment, "hawks" who favor tight money to control inflation, and "moderates" who favored both goals equally. One might expect such a group of expert economists with differing values to agree on the state of the economy, but to differ on what actions to take. That is, the facts should speak for themselves, but reasonable men with different values might strongly clash over the policy implications of the agreed upon state of affairs.

In his fascinating study, Borins argues that such a scenario doesn't describe the FOMC meetings very well at all. Instead, he says that minutes of the FOMC meetings reveal that doves were consistently pessimistic in their reading of the data and generally had low estimates of the strength of the economy. This led them to argue that an expansionary monetary policy would be necessary to avert a recession. The hawks were optimistic, seeing the strengths of the economy, and argued that a restrictive monetary policy was necessary to prevent runaway inflation.

Borins goes on to describe how, in practice, values seemed to shape everyone's views of the "facts." There is a vast amount of data available to the Federal Reserve Board staff. Data several months old in the form of "hard" statistics and more recent "soft" data (estimates subject to revision, as well as rumors unconfirmed by statistics) are often contradictory. Members seek what they think to be indicators of economic trends, and then they argue about which indicators are most important. The operational result is that differing rules are used for "admitting evidence" and for determining when an indicator is behaving satisfactorily.

Borins described a particular example in which one member : was worried about inflation and used "unorthodox" sources, such as newspapers, rather than official statistics in his search for evidence. Another member, less concerned about the perils of inflation spent considerably more time analyzing employment and national income data and less time analyzing price-level statistics(Borins, 1972).

Policymaking in the FOMC is rather stable compared to many other settings. Its policy tools (buying or selling Federal securities) are stable, and there are a relatively large number of agreed upon sources of information available for routine use. Yet, I believe that this case illustrates some themes common to most important policymaking:

1. When important policies focus on emerging problems, systematic data are often unavailable. The available data are often "soft," incomplete, contradictory, and ambiguous;
2. An official's agenda or preconceptions are often his best "subjective" guide to interpreting ambiguous data;

3. When data are ambiguous, officials will stick to their agendas and argue for the "admisibility" of that data which best supports their preferences.

I believe the FOMC example illustrates the behavior of policymakers who are unusually expert, well informed, and relatively well insulated from explicit political pressures. Thus there is reason to believe that the behavior of the FOMC typifies the best relationship between data and policymaking we might routinely expect from public agencies.

Information Processing Pathologies

Most accounts of managerial decion making emphasize the ways in which top managers have a broader range of information than their subordinates. Managers are described as "nerve centers" of their organizations (Mintzberg, 1973). March and Simon (1958) note that higher level officials deal with larger and more complex matters than their subordinates, but that they have similar personal limitations that hamper their abilities to deal with problems in fine detail. As a consequence, they deal with problems in "grosser and more aggregative form (March and Simon, 1958, p.150)."

How are details removed from the attention of higher level staff? As we shall see, there are four common processes that limit the extent to which "all the relevant information may reach top-level policymakers in a timely manner." These are filtering[8], distortion, delay, and neglect. The first three of these seem to bias the kind of information that comes to the attention of higher level officials as well as the sheer quantity of data they receive.

One might simply assume that "irrelevant" details are primarily filtered. Thus a municipal official who is studying hospital costs may receive budgets and tables of the kinds of patients and services provided by city run hospitals. Data about the particular people who received particular bundles of services and the particular people who provided them are simply not provided since they are "irrelevant" to the level of decisions being made.

Such "filtering" may be acknowledged as helpful by both the official receiving the budget reports as well as by those staff who prepare them. Other forms of filtering inadvertently drop details which a higher level official would rather know. This often happens when stories of particular events are passed by word of mouth through a chain of people, each of whom subtly and unconsciously alters its content. Lastly, and most important, information may be withheld willfully. The earlier example of the municipal hospital corporation president who suppressed budget and cost analyses provides an excellent example of an official "filtering" important, policy relevant data. When officials are requested to pass on to a higher

level official or body information which may shape his career or cut his favorite programs, the pervasive pressures to filter information become obvious.

Several studies support this observation. In one study of 52 middle managers there was a moderate positive correlation between "upward work-life mobility" and withholding "problem information" from one's boss (Read, 1959). More recently, Ullman and Huber(1973) found that officials in federal job bank programs tended not to pass on complaints which they personally could not act on. They found that officials were inclined to accept facts and implications associated with positive findings and were not inclined to accept those associated with negative findings." Lastly, Adams(1975) has presented a compelling account of the barriers he faced in trying to convince higher level CIA officials that their estimates of Vietcong manpower were in error.

All of the systematic evidence seems to show common practices of distrusting or filtering "negative information" -- that which casts doubt on one's effectiveness or preferred course of action. While an official who filters a set of data or study acts like a cool poker player in keeping his hand to himself, the official who distorts a set of data is like the card shark with several aces up his sleeve.

Halberstam's (1972) careful chronicle of top-level policymaking during the Vietnam war includes an amazing account of American battlefield reports. He shows how difficulties in the field were rewritten in Saigon to provide an impression that the war was going well. Top level cabinet officials and presidential advisors are portrayed as truly basing their optimism on phony accounts of the war's development.

Are studies which involve computer-based models less subject to distortion? The following case study helps illustrate some of the issues that arise in model-based studies*.

A county supervisor in California sought to critique a set of policies that would restrict the rate of population growth in the county. This particular supervisor entered politics after a successful career as a business contractor. His sentiments in favor of vigorous development of the available open land were well known. He requested that the county's Social Forecast Agency (SFA) use its "growth model" to project the expected population in 1980, 1990, and 2000 according to the "new demography." That is, they were to take account of the declining birth rate and decreasing rate at which people were moving into the county during the previous few years. The

* I would like to thank Joel Carissimo for collecting the data which is abstracted into this case.

SFA had used a "population model" to make inferences about the distribution of the county's population in subsequent years in several widely distributed reports.

This model actually took a population figure and descriptions of the kind of housing available in each city and allocated the original population to the different localities. It didn't project populations, it used population projections to describe the spatial distribution of expected population totals. However, the key SFA administrator sold the population model as a "projection model" to the County Board of Supervisors. When the supervisor who was known to favor growth requested a new population growth study from SFA, the agency head ordered his staff to prepare data which he believed would conform to the supervisors expectations. While the staff members were demoralized at the prospect of developing a meaningless study, they did the best they could. In the words of one staff member,

"We sat around the terminal and generated population figures in a 'heuristic delphi' process. There are lots of heuristic parameters in the model. Unless we had the exact transcript of the parameters we used the day we ran the model, we couldn't duplicate its output today.

The staff developed a new set of population figures which were a few percentage points lower than the figures in a population growth study done several years earlier. The figures were then embedded in an ambiguous, and inconclusive report and dutifully passed on to the supervisor who requested it. Nevertheless, the phony data were

blessed with the credibility of a rational computer model.

One expects distortion when some information must be forthcoming and the agendas of some higher-level official influences what lower level staff think they must produce. In this respect, the case of the Federal Open Market Committee differs from the case of the Social Forecast Agency. In the former situation, staff analysts prepare data for a large body (60 members) who are well known to disagree on their preferred actions, but who will enter into "friendly" debates on the meaning of various kinds of data and usually reach a consensus on what action to take. In contrast, the SFA staff in the previous example were preparing a report for a single county supervisor with well known preferences who operates in a very divisive setting. County supervisors are elected and in that county, it was well known that developers were large contributors to the supervisors' campaign funds.

In "agenda driven" settings such as those described above, one expects bodies of information to be delayed or neglected. Reports that are "too hot" today may become more acceptable tomorrow. The existence of secret studies may become well known after months or years. Consider, for example, the career of the Pentagon Papers. Data are delayed through the same social processes that lead to filtering. Of course delays in moving information from its source at the organizational boundary into the attention of appropriate policymakers may also occur simply because it takes time for information to be passed from person to person in a large organization.

Searches driven by strong agendas emanating from top-officials often lead staff analysts to neglect information which "doesn't fit" or isn't likely to fit the range of currently acceptable policy choices. But organizational politics is not the only cause of neglect. Once an issue is (temporarily) resolved, agency staff may move to the next hot item. Reports which were pertinent to yesterday's problem but not to today's may simply be cast aside in the hectic environment of many large and busy agencies. For example, Greenberger and his colleagues(1976) report the comments of an official who observed that if a report doesn't cross his desk at the same time he is dealing with the problem it addresses, he is unlikely to read it. Thus overload and standard operating procedures may lead officials to neglect information that arrives today and which will be of real use in six months.

Automated Information Systems and Models

The preceding sections have sketched the roles of information in policymaking and the information processing pathologies which are endemic to large scale organizations, public and private. This prelude provides a necessary background for understanding the potential utility of automated information systems in altering the quality, accuracy, and timeliness of data which reaches policymakers in public organizations.

To some theorists, computer-based systems appear to be a potential aid in ameliorating the information processing pathologies outlined in the preceding sections (Simon, 1973; Ackoff, 1974; Michael, 1973). Automated data bases may be accessible to a variety of officials and once data are transferred from paper to machine processable format, it is harder for an official to distort its content or withhold it from officials in other organizational subunits (Downs, 1967; Michael, 1973; Kling 1974, 1975; Dettlinger, 1971). In addition, some analysts argue that analytical models can, in principle, focus an agency's attention on the most policy-relevant variables. In principle, a model might at least give its users some insight into the dynamics of their problems even if it doesn't provide specific guidelines.

I believe that these assumptions provide the best basis for understanding the following comments by Simon about the utility of modeling as a aid to policymaking:

"...the most important organizational requirement for handling energy policy in an intelligent way is the creation of one or more models--either of an optimizing or of a simulation type--to provide coherence to the simulation process...the mere existence of the models, wherever located, cannot but have a major impact on energy policy decisions" (Simon, 1973).

Taken literally, such proposals are hard to reconcile with the studies of actual information flows in public agencies described in the preceding sections. They apply with the least qualification and in the short run, under special circumstances: there is a strong consensus on organizational and policy goals and top-level policy makers are reflective and willing to weigh carefully whatever positive or negative information passes across their desks. In contrast, the studies of Mintzberg(1973,1975) Ullman and Huber(1973) portray administrators as preferring action to reflection and as relatively unwilling to give serious attention to negative information.

A second interpretation would presume that the development of a model by any of the many conflicting parties would, over time, lead the other parties to develop their own models or sophisticated analysis as well. In effect, such an "arms race" approach might lead all parties to increase their sophistication simply so that they could contend with their adversaries.

A third and more sanguine interpretation is suggested by Greenberger's(1976) study. He and his colleagues examined a wide variety of policy models and found that they had little direct influence on policy. However, they also found that many of these same models influenced the metaphors and ideas policymakers used in their own analyses. From this point of view, modeling may well provide an effective and interesting means for increasing the range and variety of concepts used by public officials. While this view of modeling as an educational activity may be the most accurate, it cannot be

accepted as a sufficient basis for understanding the use of models in political agencies. After all, staff and officials will use the findings of model based studies as well as their concepts when they are congruent with their own positions. modeling may be a stimulating educational tool for on-the-job training; but it is often a political tool as well.

Many analyses emphasize the more rational elements of modeling and neglect the strong psychological influence of the institutional mobilization behind certain policies (Mihram, 1972). For example, Halberstam's (1972) account of policymaking during the Vietnam war continually describes the "hawks" (who were a majority in top level policymaking circles) as demeaning "doves" and other critics who refused to "get on board" in supporting the war. The "institutional mobilization" required to begin implementing certain key policies is so great, that once set in motion, they are difficult to alter without their original advocates losing face. In such settings, evidence that a particular policy was based upon unsound assumptions may be unacceptable until the evidence of failure is overwhelming (Adams, 1975).

Tremendous resources are required to design and develop automated information systems [9]. They are costly in skilled staff time and often demand that the patterns of information flow in an agency be altered to feed them (Kling, 1974, 1975). Thus, automated information systems tend to be initiated, or at least developed with the consent of higher level officials who can mobilize the rather large resources required (Laudon, 1974). In turn, such officials seek information which will help support their own concerns. For example, the Social Forecast Agency described in a preceding section, was asked to provide data to support the land use policies preferred by a supportive county supervisor.

When models are used as tools of advocacy, the organization which supports the modeling group may well influence the outcomes. In principle, "an energy model" might relate consumption, supply costs, and the environmental impacts of various sources of energy. In the energy area, one can expect families of highly specialized models. Such models would include relatively few variables (such as cost and demand or sources of fuel and environmental impacts) and differ in their detail. One could select any of several models to relate air pollution control strategies to air pollution levels in a several hundred square mile region (Conn, 1976). A quite different model might relate the size and design of nuclear reactors to the temperature of lakes used to cool them. These examples should illustrate the ways in which dozens of different models could be developed to answer specific questions.

Which models are chosen depends upon the questions asked. For example, the models currently receiving the most attention within the Federal Energy Administration relate energy costs to expected consumption at a national level. These models omit the environmental impacts of developing various fuel sources such as strip mining, off-shore oil drilling, oil importing, and coal mining[10]. Clearly, officials who seek to expand the range of domestically available fuels would be more satisfied with such models than would officials who are especially concerned about the relative environmental impacts of obtaining, preparing, and utilizing different sources of energy. Different priorities are served by different models.

This does not mean that restricted models imply narrow-mindedness. For example, one recent analysis of the impacts of different transportation policies on national levels of fuel consumption skillfully blends the results of several different and limited models (Hirst, 1976). Nevertheless, the mere presence of some model in an agency says little about the extent to which agency officials are asking an appropriately broad range of questions in framing their policies[11]. Nor does the use of a "comprehensive model" become a guarantor of sufficiently broad analysis. While multiple models which are calibrated on different populations and at different times may suggest cautious evaluations, comprehensive models have their own problems as well. Comprehensive models which attempt to integrate some compatible theories may be both weak in theory and in data. Such was the case with urban housing models (Lee, 1973; Brewer, 1974) and may be true of any broad area of policy given

the primitive state of the appropriate social sciences.

A tempting tour-de-force entails cascading partial models so that the output of one may create input for another. Such techniques pose problems in so far as data from one model may have to be disaggregated to feed its successor. But more deeply, errors tend to compound severely in cascade models (Alonso, 1968). Even for crude policy analyses, errors of several per cent may be critical. For example, Daly (1976) suggests, that a difference of 3 per cent in a critical parameter alters one's estimate of whether or not breeder reactors are economically attractive. In the current state of the art in many important policy areas, such as housing, transportation, and energy, common combinations of data and theory often provide results which are accurate within a factor of 2.

Lastly, we should underscore the hope of modeling advocates that modeling should help provide insights to its users. Conventional wisdom amongst modelers, for example, suggests starting with a simple model for a particular audience first. The development of "comprehensive models" may often clash with this maxim. Top officials are often very mobile in public agencies. A model which is slowly expanded for one audience may well have to be "shrunk" for its successor. In addition, the weaknesses in a family of linked models may be difficult for the less sophisticated to discern. Conn(1976), for example, provides a rather pessimistic critique of several state of the art air quality models. He argues that the best models for linking air pollution to its sources in metropolitan size regions are

still too crude to be taken as a primary input for serious decisionmaking. They are simply still laboratory artifacts. He suggests that expert judgement still outperforms the analytical models on this task. However, if any one of the models he describes were embedded (as "the best available") into a larger regional "transportation and environment" model, its flaws may be still harder for the unsophisticated to discern.

All this means that while the search for broad theories may help our understanding in the long run, modeling is terribly experimental in many areas today. This places policy modellers in the situation of both engaging in research and attempting to apply their results to policymaking in the short run (Alonso, 1968). These two roles conflict, in so far as one is more subject to the norms of peer review and some attempts to minimize bias more than the other. One simply needs to recognize that models which represent superb advances in theory may still be too crude for reliable policy use.

A second class of information systems which might diminish the influence of filtering is "upward reporting systems" (Downs, 1967; Kraemer, 1969; Kling, 1974). Generally, such systems collect data on routine agency operations or clients at the lower levels of an organization and provide summary reports to higher level officials. They may be viewed in terms of Simon's helpful criteria for evaluating information processing components in complex organizations:

"In general, an additional component (man or machine) in an information processing system will improve the system's

same influences to diminish the negative and enhance the positive that we have noted above. In addition to boiling data down, we need some additional procedures to insure that many of the critical intellectual ingredients remain in the distillate.

2. The kind of data usually collected within an agency's routine reporting system is often insufficient or irrelevant for informing many policy issues. For example, if a school board wishes to consider new programs for a select group of students (such as handicapped or musically gifted children) it's unlikely that they'll have special enrollment statistics for such groups. Part of the reason that such programs become policy concerns is that they are designed to give special attention to previously unidentified subgroups. Generally, public agencies collect the minimal information to satisfy their operational and legislative requirements. Many policy analyses would entail data that the focal agency would be unlikely to collect on a routine basis (Simon, 1973).

3. Even that data collected on a routine basis that deals with the variables in a particular policy analysis may be inadequate. Data aggregated from many different organizational subunits may be incomplete and effectively useless for systematic time-series analyses (Kling, 1975). To the extent that a policy issue requires projecting trends, older data may be far less relevant than more up-to-date

information that comes from a variety of "softer" sources. These same arguments also apply to "social data banks," such as census files, which are often irrelevant for most major policy decisions faced by public agencies (Kraemer, 1969).

Models and computer-based information systems in general are often portrayed as rational instrumentalities (Mihram, 1972; Lee, 1973; Hayes and Nolan, 1974; Ackoff, 1974). They are thought to increase the range of policy options considered (Brady, 1967) and the range of information appropriate for evaluating them. Yet the behavioral studies of policymaking in public agencies all seem to concur that acceptable options are contingent upon the political environment of an agency. Formal data may help a high level official locate potential problems and to rationalize policies enacted to deal with them; but such policies are rarely suggested by formal data. In addition, there seem to be strong institutional pressures to select data for a policymaker which support his biases. Thus, there is tremendous divergence between the assumptions upon which one would expect the use of computer-based systems to provide an enlarged set of considerations for helping form public policy and the actual conditions under which policies are developed in public agencies.

Technical and Social Rationality

Most proposals for developing automated information systems to support policymaking in public agencies focus on technical change and take the current policymaking arrangements as "given." With that assumption, one then can ask whether a particular automated system will in fact help provide more timely, comprehensive, or accurate information to a particular set of officials. Presumably, technical improvements in the characteristics of information introduced in any office within a public agency should lead to some improvements in policymaking within the larger agency.

The arguments of the preceding section leave me pessimistic that automated information systems, by themselves, can provide a systematic "technological fix" to help better inform top-level policymakers of the substantive issues surrounding the policies that they choose. Proposals which only focus upon changing the kind or quality of data available to public policymakers presume that "rationality" is inherent in the data or techniques used to generate it. Yet, the evidence seems to indicate that whatever "rationality" may be found in policymaking[12] is as much a feature of the policymaking process as it is of the data that informs it[13]. Thus it is impossible for an analyst who is building a simulation model to claim that his work is helping improve the quality of policymaking simply because it includes "policy-relevant" variables.

Many of the common beliefs surrounding the use of simulation or optimizing models presume that "rationality" is embedded in the models. Simulations were originally developed to model the behavior of relatively precise physical systems. Since they provided scientists and engineers an effective tool for studying complex, but well defined systems whose behavior was difficult to analyze mathematically, they offer tremendous potential in studying the behavior of other complex systems such as social and economic systems when they can be naturally extended. But one should understand that models used by scientists have played a constructive role in scientific inquiry conducted by communities of scientists.

In such a working community assumptions, methods, and data are all relatively open to scrutiny by peers. For example, one of the most publicized social system models, Forrester's (1969) Urban Dynamics model, has been advocated, analyzed, criticized, reviewed and modified in dozens of articles and several books devoted to its behavior. The impact of that model is less in the particular policy conclusions originally derived by Forrester than in the analysis of urban systems developed in the debates over the model.

The controversy over Forrester's Urban Dynamics is more typical of the process of scientific understanding than is communicated in the idealized accounts of science as a systematic, "rational," dispassionate enterprise. In a recent study of geologists who were studying the origins of the moon by analyzing rocks returned by the Apollo missions, Mitroff(1974) found tremendous controversy and partisan bias among practicing scientists. Scientists were well known for their predisposition to particular theories. Partisans of particular theories tended to emphasize the evidence that supported their position and to diminish the importance of evidence that conflicted with their preferences.

Their behavior was similar to that of the members of the Federal Open Market Committee described in a previous section. While their individual behavior was markedly partisan, the behavior of the scientific community was more balanced. As a group, the community of geologists watched the debate among different lunar specialists and sifted through the alternative explanations presented by more partisan specialists. Rationality was more a property of the scientific community than of the data, methods, or interpretations of any individual member.

From Mitroff's analysis, we can draw some straightforward conclusions about the role of computer-based analyses in policymaking. Information alone is not a source of "rationality." If one seeks to reduce the sources of "intelligence failures" in public agencies, one must do more than simply place appropriate information or analytical methods to some single office in a particular agency. Even defining what data is considered "appropriate" is a partisan act. Viable strategies need to exploit the dynamics of "bureaucratic politics" to lead to more effective policymaking rather than to simply ignore such pervasive patterns of activity or simply denigrate it as "political." After all, differences of values, goals, and analyses are endemic to any robust social system short of autocracy. Rather than simply providing new information or analyses "somewhere," one needs to insure that the new sources of information are available to a variety of conflicting groups which will offer alternate analyses and interpretations of the data. Most people would agree that plural analyses are sometimes helpful. We are saying something stronger. On many important policy issues, the absence of plural analyses of similar quality is often hurtful. "Pluralist" strategies could be supported by information technologies which allow dispersed and conflicting groups access to common sources of data and analytical tools.

Most organizational analysts who have studied the conditions that promote the sharing of information between organizations and between organizational subunits find that such conditions are rarely found in traditional, hierarchical organizations (Michael, 1973). Strategies for improving the quality of organizational intelligence by increasing the variety of analyses brought to bear on an issue are hardly new. For example, Wilensky(1967) advocates decentralizing staff analysts as an antidote to filtering.

Unfortunately, strategies that focus purely upon changing organizational arrangements or individual behavior are rarely implemented on a large scale. Schooler(1970) argues that Federal officials view such strategies as essentially redistributing the current patterns of influence and status. Those officials who believe they'll lose in a new shuffle vigorously oppose such procedures and often win. In contrast, these officials tend to view physical technologies as "distributive"--they often provide new resources without significantly altering the current arrangements of power, influence, and prestige. Consequently, they tend to support such technological developments since they don't view themselves simply as "losers."

In such settings, it is possible that selected computer-based technologies provide a means for supporting strategies that increase the variety of analysis and data brought to particular issues without incurring the strong opposition associated with organizational rearrangements. In particular, computer-based systems facilitate the sharing of data, models, and analysis packages relatively cheaply after data is collected and analytic routines are developed. Whether such sharing is supported by timesharing or by simply the sharing of data files and programs is incidental. Such schemes may well increase the competition among partisan analysts. They foster situations closer to the operation of the Federal Open Market Committee where major economic data were in the "public domain" of policymakers than situations such as those at the Social Forecast Agency or the military reporting system in Vietnam. In the latter, one bottleneck was sufficient to impede accurate data and alternative analysis from moving into the appropriate policy circles.

It should now be clear that proposals for simply providing new information systems through only one set of analysts to a particular policymaker (or body) offer little hope of seriously diminishing intelligence weaknesses in the target agency. The proposal suggested here of mixing computer based technologies with clear policies of allowing broad access to data and analytic routines is theoretically enticing, and may help decrease the likelihood of intelligence failures in public agencies. Let's examine some of the strengths of this approach and then some of the problems it faces.

1. It makes the explicit sharing of data and methods on which alternative analyses are based available to all parties for their own examination. Data files may be easily duplicated and programs may be cheaply shared.

2. It does not presume that there is a consensus on values or goals or that some particular group holds a monopoly on good analyses. This is one of the major weaknesses of many proposals for utilizing automated information systems and the tools of management science, systems analysis, or operations research in public agencies (Brooks, 1972).

3. It is sensitive to the actual uses and distortions of information in complex, hierarchically organized agencies. Unlike the analysts who believe that technologies have independent and necessary impacts (Downs, 1967), this proposal assumes that such impacts are influenced by the interplay of both particular technologies and the policies that influence their use. Novel "technology-policy mixes" rather than novel technologies, become the tools of institutional reform.

4. Since the alteration of organizational arrangements is accompanied by the introduction of new physical technologies, it is possible, but not guaranteed, that sharing arrangements may be easier to promote as a precondition for introducing the new technology.

Despite these unique attractions, this proposal faces some problems in implementation:

1. The lead time for decisions may increase since this proposal increases controversy rather than consensus in the short run.
2. The costs of analyses will increase since expertise is decentralized and analysis groups are placed in a more defensive posture when competitive groups now have access to their data and programs. In addition, a group which spends time aggregating data and building analytical tools will have to spend time (and money) training other people to use their creations.

3. Professional analysts take on roles which are atypical for them. On one hand, they must argue for new organizational arrangements rather than simply for new technologies. Secondly, in agencies which have one centralized analysis unit, the analysts may find their accepted expertise questioned by members of other organizations who are inspecting the details of their work rather closely.

4. Special demands are made of the policymaking body that commissions studies using computer-based analyses. The policymaking body should not be composed of "bottom-liners" who prefer to see the conclusions of staff reports rather than investigate the analyses upon which they are based. Rather they should be tolerant of debate, and be willing to attend to alternative viewpoints and their underlying rationale. Lastly, they should have the sophistication to learn from staged debates between experts.

Reading the Bottom Line

In the preceding sections we have viewed the potential contribution of computer-based information systems in helping better inform public policymaking. First, we looked at the typical ways in which information is passed to higher level officials and handled by them. We have argued that the sources of intelligence failures stem from features of complex organizations. These are relatively uninfluenced by some new increment of information processing capacity placed "anywhere" in a public agency. Rather, new information-processing capabilities which are coupled with organizational arrangements for sharing data and analytical methods between competitive groups seems to offer the most promise.

It is hard to predict how acceptable such a proposal would be to a wide variety of public officials. The relevant literature, while scanty, tends to report cases in which automated information systems, especially simulations, are used as tools of advocacy while being advanced as instruments of rational inquiry[14]. Several years ago, Mason(1969) reported a successful field study in which he staged a debate between two opposing managerial groups in an abrasives manufacturing firm. He described a debate in which the assumptions made by each group and their data were made public and had an enlightening influence on higher level managers. His success suggests that proposals of the sort suggested here are not in vain. Technologies which are co-opted and institutional reforms which are unaccepted may be overcome by strategies which carefully mix both new information technologies and organizational arrangements.

NOTES

1. Policy analysts seem to be unable to make a clear theoretical distinction between "policymaking" and "decision-making" (Lowi, 1970). Developing such a distinction is well beyond the scope of this analysis. Nevertheless, we treat policies as providing a pattern of action, sets of priorities and constraints within which other, more particular, decisions are made. Thus, an agency that adopts a policy of seeking minority employees creates a context in which other instrumental actions (e.g., how and where to advertise) are embedded and provides criteria upon which decisions to hire a particular person may be based. Of course, arriving at a policy entails a set of decisions such as its scope, relationship to other policies, resources to be committed in its pursuit, etc.

2. This paper focuses upon the role of information in policy development. To be substantively (rather than just symbolically) effective, a policy must be carefully implemented. This obvious observation merely hints at the practical difficulties that often hinder successful implementation (Presser and Wildavsky, 1974).

3. Occasionally public officials attribute special credibility to computer-massaged data (Kling, 1975; Danziger, 1975), but the influences of data on policymaking seems to have little relationship to the source (computers, friends, routine reports, etc.) aside from their formal characteristics such as (perceived) accuracy, scope, credibility, and timeliness.

4. Currently the literature on policy-oriented simulations is fragmented between political scientists who tend to study the ways in which models are used and management scientists, computer scientists, and engineers who emphasize modeling techniques. See [14].

5. The following analysis of managers and policymakers focuses upon appointed officials in bureaucratic agencies and upon elected legislators operating within their areas of expertise and interest. In particular, legislators are called to vote upon a large number of bills which they have little time to investigate, even if they were interested. Thus, empirical studies of legislative behavior show that legislators take cues from political allies in deciding how to vote on issues which they have neither the time nor inclination to study on their own (Mathews and Stimson, 1975). Such uses of cues as a basis for supporting public policies are outside the scope of this essay.

6. One may argue that even though many officials spend brief periods on particular problems, over a period of months or years, they may become quite familiar with continuing problems. Nevertheless, the kind of information that reaches officials on such occasions is highly filtered. For example, one public official made the following argument for consolidating several subunits which reported to him and placing an intermediary between them and him:

"I need processed information on which to make decisions. I can't bother with raw data all the time."

7. Technically, "data" refers to uninterpreted quantities and relationships. In contrast, "information" refers to "data" which is interpreted in such a way as to decrease a person's uncertainty about some state of affairs. In common parlance, "data" usually describes quantitative relationships, facts, and episodes. To be useful to policymakers, "data" must either be interpreted by organizational actors or be easily interpreted. Thus, policymakers focus upon information--data which makes sense to them and to others.

8. Filtering occurs when data (or information) is suppressed by an official. When data is distorted, some altered facsimile is passed on or it is embedded in a bogus interpretation. See March and Simon(1958) for an account of filtering as a normal aspect of information handling in complex organizations.

9. Software alone for medium size automated information systems costs tens or hundreds of thousands of dollars. In addition, staff training, forms, and staff time spent in using the system may cost several times as much as the original development.

10. There are some abstract models that relate consumption and the pollution it produces (Fleming and Pantell, 1974). Even these models treat only a few variables.

11. A recent analysis by Kadanoff and Weinblatt(1972) forcefully demonstrates that the variables selected for a model and its degree of detail can strongly influence the policy conclusions derived from it. They studied the relative influence of training unskilled workers, providing new jobs and clearing slums for industrial development on urban poverty. They explored the role of each policy in three different models that included increasingly larger chunks of the urban setting. At the extremes, the simplest model included only a single city and the most complex model included a network of cities, surrounding suburbs, and a national economy. Each model led to very different policy mixes for helping diminish urban poverty. "Any model" can suggest misleading policy conclusions. These results also cast some doubt on the "pluralist strategy" proposed by Chen and Garrison(1972). They suggest that one way of expanding the utility of Forrester's(1969) Urban Dynamics to include the preferences of social groups with markedly different values is simply to generate different models for each group, "one at a time." If the models don't include a sufficiently broad range of variables, a "restricted model" might

suggest misleading dynamic patterns regardless of what preference ordering different groups place on the trade-offs they include.

12. It is ironic that despite the quantity of literature on policymaking, political scientists seem to have avoided developing a theoretical concept of "rational" policies in a political setting. Most of the prevailing theories of rational action consider actions (or decisions or policies) rational in so far as they are an effective means (of those feasible) for achieving some desired state of affairs. Most analytical treatments of rational decision-making assume that goals are clear. See, for example, Mihram's (1972) idealized account of the modeling process. In contrast, in most "political" settings, goals are relatively ambiguous and legitimate parties have conflicting goals. In addition, there may even be conflicts within the set of goals held by particular interest groups as Rein (1970) has argued in the context of welfare programs. Theories that presume clarity, consensus and consistency seem to make poor predictions in those settings fraught with ambiguity, conflict, and "trade-offs."

13. In a fairly elaborate analysis of "inquiring systems," Churchman (1971) links the reliability of knowledge available to a system with both the sources of data it admits and upon the strategies it utilizes for processing and cross-checking information. For Churchman, an "inquiring system" describes any person, organization, or intelligent artifact that seeks to know the world it lives in. He concludes that strategies which rely solely upon single sources of uncontested data, whether they are guided by theory or fact gathering,

are especially sensitive to intrinsic "errors of intelligence." He argues that "inquiring systems" which are driven by multiple theories and "fact" gathering and which continually cross-check the validity of relevant data through internal contest and conflict are most likely to "converge" on a clearer portrait of the world they live in. While his analysis is cast in a philosophical framework, its translation into the search for good organizational intelligence is congruent with the analyses of the preceding sections.

14. See chapter 12 of Rites of Way for a typical study of the politics of modeling (Lupo, et. al, 1971). Unfortunately, much of the scholarly literature that reports on the development of policy-oriented information systems emphasizes the techniques used in their construction and neglects the extent to which they are used and how their use influences the deliberation over various policies.

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