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Beware the Pitfalls. A short guide to Avoiding Common Errors in Systems Analysis

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A Short Guide to Avoiding Common Errors in Systems Analysis

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Executive Reports bring together the findings of research done at IIASA and elsewhere and summarize them for a wide readership. The views or opinions expressed in these reports do not necessarily reflect those of the National Member Organizations supporting the Institute or of the Institute itself.

This report is largely based on *Pitfalls of Analysis*, edited by G. Majone and E.S. Quade, published by John Wiley & Sons, Chichester, England, 1980.

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LEARNING FROM MISTAKES

Systems analysis has become well established. Many governmental offices, industrial organizations, and international groups have built it into their research and decision-making processes. Others are experimenting with it, and still others are considering how it might help them.

The interest, which is now worldwide, is not hard to understand. Analyzing systems of various kinds has helped to solve some important social, economic, and environmental problems, and it has thrown light on others that must eventually be solved. As an aid to establishing policy, systems analysis has been particularly useful where matters are complex, where objectives conflict, and where future planning is difficult.

Yet despite its successes and the interest they have aroused throughout the world, systems analysis is far short of fulfilling its

‘The systems analyzed involve man, nature, and various products of man's society and his technology.’

potential. One reason is that decision makers who might want to try it sometimes have trouble determining what it is and how it might help them. Its form is always tailored to the problem at hand, so a decision maker may have difficulty seeing how the approach to another's problem can be adapted to his own (see box, page 3).

Another reason is that it sometimes goes wrong. Analysis techniques are never applied to easy problems, only hard ones, and in more than two decades of developing and refining methods, borrowing technology from other disciplines, and adapting to new applications, systems analysis has had some failures.

Profiting from mistakes, though, is at the heart of systems analysis. The analyst works necessarily with evidence, assumptions, models of systems, and concepts that may be partially tested. He must translate the languages of diverse fields into common terms.

He must also learn the decision maker's language and understand clearly his objectives and the obstacles to achieving them. There are ways such a process can go wrong.

Scientists at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, have a vantage point for observing the trial and error of systems analysis as a whole. They draw upon a wealth of real-world experience with it in many countries. As part of IIASA's efforts to advance the field, a small group of experienced analysts came to the Institute from several countries in 1977 to discuss the most common mistakes of systems analysis and ways to avoid them.

A guidebook for analysts and users emerged from their efforts: *Pitfalls of Analysis* (John Wiley & Sons, Chichester, 1980). Some of the main pitfalls discussed in the book are mentioned briefly on the following pages of this Executive Report. This presentation concentrates on common pitfalls that can be avoided by both analysts and users, thus aiding both to achieve effective results.

Adequacy and effectiveness

The book notes at the outset that broad standards of success must come before any determination of failure. Its authors identify two types of systems analysis standards:

- Internal standards that apply to the adequacy of the work on technical or scientific grounds.
- External standards that apply to the effectiveness of the work in contributing to sound policy decisions.

Internal standards are set by systems analysts, who want answers to such questions as these: Was uncertainty handled explicitly, or was it assumed away? How strong was the evidence? Were the conclusions tested for sensitivity to changes in the underlying assumptions? Were the models tested extensively for credibility?

External standards come from users and other interested parties, who ask these questions: Were the conclusions presented in a clear and convincing manner and in time to assist the decision maker? Was the study understood by those for whom it was done? Did it influence them? Have all legitimate interests been considered? Were the conclusions of the analysis acceptable to the implementing organization?

Analysts tend to evaluate their studies on technical adequacy; decision makers stress practical results. The editors of *Pitfalls of Analysis* saw both types of standards as important and related. They organized their material to present first some common pitfalls of technical adequacy and then some common pitfalls of

WHAT SYSTEMS ANALYSTS DO

Systems analysis is a process for organizing information to help make decisions. The choice of information and the means of organization depend on the nature of the decisions needed.

The systems analyzed involve man, nature, and various products of man's society and his technology. The forms of analysis that have been applied to these systems have been refined and broadened in recent years. It is impossible to capture the wide range and diversity of applied systems analysis in a short definition. But it is possible to describe briefly what systems analysts do. They perform some or all of these tasks:

- Observe and describe the behavior of complex systems.
- Build models to explain the observations and test their validity.
- Describe important segments of the systems involved, using models in combination with other knowledge.
- Devise programs and courses of action combining the evidence with the use of models and informed judgments.
- Compare the alternative courses of action available to decision makers.
- Communicate the results to decision makers in various ways useful to them and in readily understandable language.
- Help implement decisions based on the alternatives provided.
- Evaluate the results of the implemented programs.

effectiveness. Chapters 2 through 4 that follow deal with adequacy; chapters 5 and 6 discuss effectiveness. The order is not chronological, because pitfalls of both types occur throughout the systems analysis process.

2

ANALYZING FROM A TO Z

To avoid the pitfalls of systems analysis it is important to know where they are likely to occur. This chapter scans the process from the earliest formulations of the problem until after recommendations relating to the problem have been implemented.

It arranges the material into five phases of analysis: setting the problem, gathering and refining data, developing tools and methods, constructing the argument, and using the conclusions. The emphasis is on pitfalls relating to internal standards of adequacy (as noted on the preceding page). Chapter 5 arranges pitfalls relating to external standards of effectiveness into the same five phases of analysis.

Setting the problem

The problem-solving process starts before the problem has been identified. First comes an awareness that things are not as they should be. How that awareness gradually becomes translated into a description of the problem affects the outcome. The cultural, institutional, and professional backgrounds of the analysts and of the decision makers influence the way the problem becomes identified, which in turn limits the solutions possible. These pitfalls occur during the process of identifying the problem.

- The user considers only the alternatives falling within his own jurisdiction, and the analyst accepts the formulation uncritically. This can result in suboptimal solutions. For example, inquiries of the Delaware River Estuary Comprehensive Study in the US were confined to the outdoor recreational possibilities of the Delaware River Estuary (for which the user was responsible). The study did not consider other – and probably better – alternatives for outdoor recreaction in the area.
- The analyst's formulation of the problem is too limiting, and the user fails to question it. Again in the Delaware River study, sanitary engineers used dissolved oxygen in the water as the principal indicator of water quality. Economists responsible for a cost–benefit analysis accepted this formulation uncritically. This produced a choice of policy alternatives for raising dissolved oxygen levels in the area with the worst pollution (between Philadelphia and Wilmington). But none of the alternatives would have made the river more suitable for recreation.

- The problem is formulated only in terms of how it affects the user. This can produce solutions that cause worse problems. But the analysis can rarely consider more than a few of the system's interrelations. The possibility of poor results must be weighed carefully against the possibility of unacceptable increases in the costs of analysis.
- When the problem is being identified, it is particularly difficult to produce and interpret data. The way the problem is conceived influences questions asked on opinion polls and attitude surveys, and this in turn affects the information received. Also, facts may be deceptive. For instance, a drop of a percentage point or two in the growth rate of a country's gross national product is often seen as a cause for government action. In fact, national income figures are only accurate to within 10 to 15 percent, and foreign trade, unemployment, growth statistics, and other economic data are even less certain.

Gathering and refining data

Once the policy problem has been specified, new types of data come into play. Some are raw data (such as retail prices), and some are refined into specialized information (such as an index of consumer prices). Making use of data has such pitfalls as these:

- Since econometric model builders do not usually collect the primary data but rely on figures from a variety of sources, problems of interpretation can be serious. Social and economic statistics are often collected not by logical classification schemes but by expedience – the availability of data, the feasibility of making

“The *ad hoc* nature of much economic accounting is seldom publicized, and it can be overlooked by the data users.”

estimates, or the operating procedures of the data-gathering office. The *ad hoc* nature of much economic accounting is seldom publicized, and it can be overlooked by the data users. Problems of interpretation are compounded because the components are put together by statisticians who have not collected the data and because the information has gone through several manipulations by the time it reaches the analyst.

- After the analyst has obtained the necessary data, either directly or from secondary sources, transforming them into informa-

> **BEWARE OF THE TOOLS . . .**
>
> Systems analysis is still developing, and as yet it has no generally accepted criteria of adequacy. Its composite nature – with descriptive, prescriptive, evaluative, and advocacy elements linked inseparably – makes such criteria particularly elusive.
>
> During this formative period, there has been a tendency to expect too much of mathematical programming, queuing theory, control theory, and other tools that have been successful in other disciplines and contexts.
>
> The tools of analysis are invaluable, but they cannot eliminate uncertainty and replace hard thinking. Deep pitfalls lie ahead for analysts and for decision makers who depend too much on the answers to questions provided just by the tools.

tion usable in a model or in an analytic argument is a crucial step. Such refining requires skills different from those of setting the problem and collecting the data. Pitfalls lurk in deciding which of many possibilities are the significant data to transform for use in a model or equation and in adjusting the model to make it fit the data. Standard statistical tests help in judging the quality of the fit, but a purely statistical evaluation cannot guarantee that the right data are chosen.

Developing tools and methods

A number of common pitfalls lie in choosing and applying the right tools and methods from the wide assortment now available to analysts. The risks are increased by the heavy dependence of systems analysis on other disciplines (see box above). Large-scale model building draws on mathematics, statistics, and economics. The problem under consideration usually brings in still other disciplines, which may range as widely as, for example, biology and architecture. The broadly interdisciplinary aspect of the work requires a constant effort to avoid misunderstandings. Most of the pitfalls relating to the tools and methods of systems analysis are failures of communication.

- Compromises sometimes establish common language between scientists without producing true understanding. The result can be

. . . AND BEWARE OF THE TERMS

Scientists sometimes use common words and terms in a technical sense that can mislead nonscientists. The terms (as well as the tools) of systems analysis can interfere with communications between analysts and decision makers.

It is widely recognized that subjective judgment plays a key role in successful analysis. But some of its advocates suggest a scientific precision their craft cannot provide by overusing such terms as "quantification," "optimization," and "formalization."

Written descriptions of analytic methods that rely too heavily on technical terms and formulas also cause misconceptions. Scientific theories and formulas cannot guide critical choices among alternative assumptions, data, and methods of analysis.

a composite jargon that lacks depth and tends to mask ambiguities and subtle differences in meanings. When concepts and techniques are removed from their disciplinary context, they can become stereotypes – with limitations not easily seen by people who want immediate applicability.

- The scientific worth of a field is sometimes assumed to be proportional to its mathematical or statistical content. Too much may be expected of the numbers. Under such assumptions, quantification and algorithmic elegance can become ends in themselves, at the expense of whatever cannot easily be quantified. This can prevent a deeper understanding of the substance of the problem.

Constructing the argument

The argument links information with conclusions. It is typically a complex blend of methodological considerations, factual statements, interpretations, evaluations, and recommendations. A wrong assessment of the strength and fit of the evidence before it is included in the argument can lead to pitfalls in drawing conclusions.

- In presenting the argument, information is not the same as evidence. Information becomes evidence when it is introduced at a specific point of the argument as an aid in persuading people. An inappropriate selection of data or models, their placement at the wrong point in the argument, or a presentation inappropriate to the audience can destroy the effectiveness of the information as evidence.

- In judging the acceptable level of accuracy for data used as evidence, different standards should be applied to different kinds of data. For example, in the natural sciences, an error of a billion years is acceptable for estimates of the age of the earth, while the value of a physical constant may be known with highly exact accuracy.
- The contemporary fashion of using mathematical arguments on every possible occasion produces a tendency to accept numerical results as facts rather than as evidence. The sensitivity of these results to changes in data, the model, or in the estimation procedures is easily forgotten. It may not be possible to determine with any reliable accuracy which of these types of changes might have the greatest effects on the numerical results.
- The value of large-scale models as evidence is often doubtful. Poor documentation can make it almost impossible for anyone but the modelers themselves to reproduce the results. On the other hand, complete documentation would be too voluminous to be digested – even by an expert evaluator.

Using the conclusions

The conclusions of an analytic study may be presented as a forecast, the clarification of an issue, a recommendation, an assessment of ongoing policies, a new idea, or a different perspective on an old policy problem. Whatever the nature of the presentation, it deals in abstract terms – poverty, health, unemployment, education, or others. This can lead to pitfalls in the communication and implementation of the conclusions, particularly when an abstract term has been used in a special sense.

- The analyst may fail to see that rational arguments alone do not determine attitudes. Persuasion is involved in any attempt to suggest a new view, judgment, or course of action. To be effective, the analyst must be an advocate, but he is also a believer in the virtues of the scientific method, and this belief is generally associated with a distaste for the problems and the requirements of communication and persuasion.
- The persuasion process must be seen as part of the analysis. It may be effective to do the study in two stages – finding out what to recommend and recommending it convincingly – but the two stages must form a single process. The most serious pitfalls of applied systems analysis await those who separate planning from deciding and using, or thinking from doing.

3

TO GET A GOOD MODEL

Systems analysis usually, but not always, involves modeling. Modeling is a term for simulating the systems being analyzed. It is done many ways – empirically, mathematically, and others. Several types of modeling are often combined in a single study. Computers are sometimes – but not always – used.

However the modeling is done, it is important to bear in mind that formulating the problem and modeling are closely related. Modeling must be considered from the start, and this chapter notes some of the ways this initial phase of analysis can go wrong.

Formulation dangers

The systems analysis process starts when someone is dissatisfied with a current or projected state of affairs. He may have only the vaguest idea where the problem lies. By the time the analyst arrives, some version of the problem will have been expressed. The analyst must first identify the problem anew (see box below) and then limit its scope. The task is difficult. He must find an

CONFUSING MEANS WITH ENDS

A decision maker says his goal is to choose a site in his district for a new comprehensive health center. His actual goal – to improve health services in his community – has not been identified. This goal might be achieved more effectively by one or more of several other means: by establishing several small neighborhood health centers, by expanding the outpatient facilities of existing hospitals, by encouraging physicians to form more group practices, or by increasing services in medical specialties with heavy patient loads. If the analyst in this case merely sets out to find the optimum site for a health center, he will not use the full potential of analysis – and he runs the risk that a better plan may come to light and push his work aside.

acceptable and implementable solution within economic, political, technological, organizational, and other restraints. This formulation-and-modeling process can go wrong in a number of ways.

- A desire to accept the user's appraisal of the situation combined with eagerness to get on with the analysis can result in not paying enough attention to formulating the problem. This can produce work that has little relation to the basic issues or that cannot be carried through to implementation with available time and resources.
- The formulation can be inappropriate for the use intended. For instance, to identify alternative policies, many variations must usually be screened rapidly and inexpensively. But for implementation – such as choosing among similar vehicles after a general means of transportation has been selected – the analysis must be detailed and concrete. In such a case the alternatives are similar, so they differ in detail rather than in concept. The most common pitfall of this type is to provide detailed and concrete analysis of limited alternatives for implementation when a wide variety of alternative policies needs to be considered.
- Goals cannot be set independently of the means to obtain them. It is usually impossible to select satisfactory objectives without some idea of their costs and difficulties. For instance, the goal of landing a man on the moon was not set until the achievement became feasible.
- It is not completely unknown for a decision maker's constraints to be arbitrary and ill-founded. Some users have refused to consider alternatives, for example, merely because they were proposed by others in their organizations. Here again, sufficient attention to the formulation can avert serious problems later on.
- In formulating the problem, achievement must often be measured by surrogates. A good surrogate tells how well an objective is being attained, but pitfalls lie in not recognizing its limitations. For instance, mortality rates are used to measure the health status of a population. This provides a gauge, but mortality rates do not reflect many factors that are important to good health. Similar dangers lurk in measuring output by input, such as comparing the quality of primary school education in various districts in terms of expenditures per pupil.
- Other difficulties arise when the analyst misjudges the complexity of problem solving in the practical world of affairs as contrasted to the laboratory or classroom. The analyst must understand how problems in the real world tend to proliferate. One danger lies in failing to take important consequences into considera-

tion. Another is to try to do more than time and resources allow.

- The analyst must guard against bias, particularly at the start. Some biases are well known, such as deliberately giving preference to aspects of the problem that are easy to quantify. Others are more subtle, such as biases introduced because the analyst unconsciously acquires the preferences and goals of the particular segment of the organization for which he works. Parochialism and adherence to cherished beliefs are major causes of miscalculations.

Modeling dangers

There are many forms of models – physical, natural language, mathematical equations, computer programs, and others. The method of prediction may be judgment, physical manipulation, numerical approximation, simulation, and others. The role of the policy model is to tell what will happen if the decision maker adopts a particular course of action, and in some cases to indicate the best course.

- Analysts sometimes confuse modeling with analysis – and even with policy making. Models are only one of the steps of analysis. The process includes searching out the right problem, designing alternatives for consideration, interpreting the model, and

‘The danger is in acting as if the model were more important than the problem.’

relating the interpretation to the decision maker's problem. The danger is in acting as if the model were more important than the problem. At worst, the analyst concentrates on fitting the model to the problem situation without thought of the problem itself, the decision to be made, or the decision maker's needs. The model and the results of analysis may then be irrelevant and unusable.

- The analyst may favor a particular modeling approach – optimization, systems dynamics, or input–output – and adapt the problem to fit the approach. For instance, simulation may be chosen as the best-understood, easiest to set up, and cheapest technique. But it can sometimes produce an undesirable model because it offers no explanation of observed results and because it is slow, which may raise costs to unacceptable levels.

- Uncertainties about which something is known or at least can be inferred with some confidence tend to get more attention than uncertainties about which little is known. The calculable uncertainties are seen as a challenge. Neglecting the more difficult uncertainties can give poor results that cause new problems when implemented.

- Some models are designed for relevance with the problem as a guide. Others aim for realism, trying to simulate the real world in detail so that many questions can be answered about the situation. For instance, there have been attempts to model the behavior of a city, its population, and its government so realistically that the model will predict growth, population movement, industrial development, and other changes. Then if the analyst is criticized for omitting aspects of the situation, he can only make the model even more inclusive and detailed. This may not stop the criticism because many important factors will still be left out. Or the model may become too complex to handle. To avoid such pitfalls, the problem should determine what goes into the model.
- It is particularly dangerous to assume that the model can be validated conclusively. At best it is possible to have a good understanding of the model's strengths and weaknesses. It is evidence – useful in drawing conclusions but not the final word on what the future can bring.
- Models are sometimes built to satisfy academic criteria rather than policy goals. Modelers ordinarily come from the academic world, and so do their rewards. From the academic point of view, the ideal model permits a large number of inferences not perceivable by direct observation. It derives power from a minimum of carefully selected assumptions, is cost effective, and is capable of reproducing results based on the system's past behavior. From the decision maker's point of view, though, the ideal model is relevant, reliable, cost effective, and able to produce findings that can be used as a basis for action.
- Many modelers assume a policy model can be made comprehensive enough to internalize the policy-making process, capturing the user's preferences and constraints and substituting for the decision maker. While this can be done in some narrowly prescribed situations, decision makers should not expect merely to plug in the numbers and get back correct decisions on complex matters.
- Ignoring or minimizing the importance of the costs of the analysis is one of the most serious errors analysts can make. Users need realistic information on the costs of the analysis, the costs of delaying action, and the costs of implementing the policy alternative chosen. As the next chapter indicates, costs are the cause of many difficulties in systems analysis applications.

4

THE COSTS OF ALTERNATIVES

Analysts and users alike tend to underestimate the importance of knowing the costs of policy alternatives. Serious difficulties arise from failures that range from ignoring costs altogether to missing good cost alternatives. Before starting an analysis, users should know the costing dangers outlined here.

Ignoring costs altogether

While most analysts avoid the folly of paying no heed to costs, the error is common enough to note. Goals may be considered vital at any cost because of concern for lives, human dignity, or the environment. But such high ideals are mistakenly conceived because

‘Contrary to a common assumption, the more important the goal, the more important the cost analysis.’

goals and costs are closely bound together. Painstaking consideration of costs can bring to light feasible alternatives for reaching goals. Contrary to a common assumption, the more important the goal, the more important the cost analysis.

Seeing only some of the costs

The care with which cost data are collected, the sophistication of cost formulas, and the caution with which aggregate cost projections are presented all distract from the most critical aspect of cost analysis – completeness. Impressively supported fine estimates of some tiny part of total costs merely create an illusion of completeness.

- The cost analysts may argue that they should restrict their efforts to the bounds of their competence. But this can sometimes amount to the easily measurable aspects of costs, which may then be presented as an estimate of total costs. Experienced cost analysts are aware of several types of costs: monetary expenditures, other costs that can be measured in monetary units, costs that can be quantified in some way other than monetary units, and costs that resist any reliable quantification. All these costs need attention.

- Long-run costs are also important. Both the analysts and the users may be inclined to neglect the costs of the distant future. The analysts may find these costs difficult to identify and assess; the users may have near horizons because of short-term political appointments.

The different kinds of costs

The way the costs of alternatives relate to the analysis must be considered carefully. A false picture of the process can be drawn by considering too few – or too many – cost factors.

- Including irrelevant costs in estimates is just as common as ignoring relevant costs. Only the costs that result from the specific decision being analyzed are relevant.
- Failure to sort out relevant costs is especially likely when costs are averaged. For instance, in deciding whether to expand a program, variable costs, but not fixed costs, should be in the estimate. Or, in deciding whether to complete or to continue a program, incremental costs, but not sunk costs, should be included. Recurring and nonrecurring costs should also be differentiated when changes in a program are contemplated.
- Relevance and concern are sometimes confused. If you paint your house purple, it will lower its value – and the value of your neighbor's house as well. Similarly, it is tempting to assume that cost analysis should be confined to a narrow scope. But whether the scope is narrow or not, the analyst should always make himself aware of the user's concern, or lack of it, for broader constituencies. The tendency is for an agency or community to ignore other agencies and communities – a deficiency that the cost analyst must make an effort to prevent.
- Levels of analysis are sometimes confused. The analyst may merely identify the resources needed to carry out a plan. Or, he may attempt to identify the most attractive alternative uses of the resources or go further and assess the benefits of the alternatives. If different components of the cost analysis have extended through various levels of analysis, they must not be omitted or double-counted.

The different cost dimensions

In all matters relating to costs, no pitfall is more tempting than to assume that money or monetary measures can simply be added up. Money values differ in different situations.

- The costs and benefits accruing to separate entities of a program cannot easily be compared. Say a government agency must choose between two sites for a power generating plant that will not be welcome by property owners in either area. The agency wants to compare costs to home owners at each site. A survey estimates that $3,500 a year would compensate the home owners at one site, while $4,200 a year would be needed for those at the other site. If the agency is planning compensation, a direct comparison of the costs at the two sites is reasonable. But if no compensation is intended, so that the costs must be absorbed by the home owners, the comparison of costs may not be reasonable. At one site, homeowner income levels may be considerably higher than at the other, so that these residents will have a far smaller cost measured as a percentage of income.

- Means of determining the depreciation of currency have limitations that are not always apparent. Cost analyses for governmental agencies use a variety of yardsticks to measure currency erosion – prime interest rates, government bond rates, estimates of the marginal efficiency of capital, and indexes of consumer prices. Each means has its characteristic strengths and weaknesses, and they can affect the cost analysis greatly.
- Cost analysis can be affected significantly when expenditures are made ahead of schedule or postponed. This results partly from depreciation of currency over time and partly from budgetary and other constraints within the funding agency. A simplified example suggests how the factors involved can interact. An agency postpones repairs to the roof of a building. Next year, repairing the roof and the damage that leaks will have caused by then increases the total expenditure by 50%, not counting a 10% erosion of the currency anticipated for the coming year. The agency can also postpone another expenditure of like amount at an increased cost of only 25% over a year's time. Other considerations aside, fixing the roof and postponing other expenditures makes sense. But if the analyst's attention is focused at a higher level of authority, it may prove far more practical to shift funds – and make both of these expenditures right away for the savings possible.

Summing up costs

Cost analysis must be seen as analysis of alternatives. If not, pitfalls of two general types lie ahead.

- Costs that are not easily included in monetary calculations are neglected. The danger is in allowing attention to shift from costs to the monetary units used to measure them.
- Analysts and decision makers seek a single answer to costs, which can only rarely be found. The danger is in not recognizing a range of alternatives that depend among other things on the level of authority, the influence of that authority, and the resources available.

5
TO BE EFFECTIVE

The pitfalls of systems analysis listed in chapters 2 through 4 of this report are internal. They are danger points where the adequacy of the analysis can be compromised. The remainder of this report deals with external factors – points where a technically sound analysis can lose effectiveness.

As noted earlier, the presentation is not chronological. Some of the internal pitfalls mentioned previously occur in late stages of analysis, while some of the external pitfalls discussed in chapters 5 and 6 occur at the start.

Knowing the decision maker

A technically sound analysis may fail because of misunderstandings that were not recognized in time. The damage is progressive. Eventually the decision maker is likely to judge the work misguided or irrelevant, and then there is very little hope that it will be effective. The shortcoming in such cases is usually the same: the analyst did not know what matters most to the user. The work can then go wrong several ways.

- The decision maker may work in a setting where opinions count more than facts. The practical reality of his needs may blur distinctions between facts and values, private and public interest, political process and policy, and decision making and moral judgment. The analyst's alternatives must fit the user's options.
- The analyst may make his results more complex than necessary. To be convincing, the analysis must be clear. Unfamiliarity with the user's needs can lead to foggy prose, vague references, and reports that offer more detail than needed. This can cause an otherwise sound analysis to be rejected.
- Some policy is made by a single decision maker, but usually a number of people are involved. An analysis directed to a single, rational decision maker is rarely appropriate. Some analysts explain policy outcomes in terms of interactions among social institutions, groups, and individuals who share the power to influence decisions. Other analysts concentrate on organizational settings. Either way, the dynamics of various types of group behavior must often be considered to avoid pitfalls in putting the analysis to use. The analyst and the user may collaborate on various strategies to make the work effective, such as aiming for satisfaction rather than max-

imum improvement, or focusing on bottlenecks and proceeding incrementally.

- Gaining an understanding of the decision maker and his needs can also invite dangers. The analyst who begins to think like the user of the analysis may adopt the user's point of view uncritically. Unconsciously sharing the user's biases and blind spots can undermine the analyst's scientific detachment. The analyst must understand the user's motives in seeking the analysis without making them his own.

The pitfalls outlined above suggest how an analysis with high marks for technical adequacy can fail to be effective at any point in the analysis from A to Z. To illustrate the ways analysis can be diverted from its aims, some examples from actual cases are presented here. They are arranged by the main phases of analysis as outlined in Chapter 2.

Setting the problem and gathering data

The Secretary of the US Department of the Interior had to decide whether to continue building the Bonneville Unit of the Central Utah Project. The project was a large, multipurpose irrigation and water development system. He had to know whether to approve awarding the contracts for building Currant Creek Dam, the next part of the Bonneville Unit to be undertaken. The question was largely one of priorities.

His analysts studied issues and alternatives and presented their findings, which argued that completing the unit would create

‘A technically sound analysis may fail because of misunderstandings that were not recognized in time.’

problems. Cheaper and less environmentally damaging alternatives were available to meet the most important water needs of the area. Also, the alternative sites would avoid troublesome questions of the water rights of the Ute Indian tribe, a matter of growing concern in the area.

The Secretary then wanted to know the consequences of building only Currant Creek Dam – without completing the entire Bonneville Unit. Would it be useful without building tunnels, aqueducts, or pumping plants? If so, and if the construction would not pose serious cost, environmental, or Indian water rights problems, would it be better to go ahead while taking more time to study the bigger issues?

Enamored of the task of evaluating the entire Bonneville Unit, the analysts had not considered the narrower possibility that was attractive to the Secretary. Under political pressure to go ahead with the construction and facing other issues that were more important to the department, he had merely wanted to know whether he could delay consideration of the bigger issues. In the end, the answer was yes. The analysts had not erred in evaluating the Bonneville Unit as a whole. Their mistake was in failing to consider less exciting but more practical alternatives.

Developing tools and methods

A study of the San Francisco housing market was conducted as part of the city's Community Renewal Program. The overall objective of the analysis was to develop a comprehensive, integrated policy for public and private actions that would improve the living environment of the city, with special concentration on the housing market. The task of the analysts was to develop a framework that adequately replicated the operation of the private housing market.

The first problem was setting geographical limits on the study. They settled on San Francisco, knowing that the relevant housing market was more extensive than the city. Plans developed for the city would be weakened by leaving so much out. But plans for the entire region would be irrelevant, since agreement on action by all the various decision-making entities serving the area would be far beyond the means of the user.

The next problem was even more threatening to the study – disagreement on the amount of detail needed. The city planners wanted a detailed analysis based on a vast amount of data. But the operations research people, who had had experience with simulation models getting out of hand, wanted simplicity. The analysts struck a compromise, but it was too simple to provide what the city planners wanted and too complicated to please the operations researchers. The pitfall here was lurking in the way the analysts presented their modeling proposals to the users.

Constructing the argument

The US Environmental Protection Agency wanted to know whether catalytic converters on automobiles produced sulfuric acid emissions that would create a hazard to human health, and whether a delay in implementing statutory emission standards would therefore be justified. Human exposure to sulfuric acid concentrations in the air cannot be measured directly. One group of analysts used a carbon-monoxide-dispersion model to approxi-

GETTING CLOSE – BUT NOT TOO CLOSE

The ideal relationship between analyst and decision maker allows the analyst to maintain his scientific objectivity while seeing the problem from the decision maker's point of view. If the analyst is close to the user – but not too close – he can consider these questions from an informed but detached vantage point:

- Toward what purpose am I working?
- Who am I trying to influence and in what way?
- What types of analytic procedures are needed?
- What approaches to these analytic tasks are most likely to be successful?

The answers are matters of judgment more than of technique – a rational inquiry informed by the intuition that comes of experience with systems analysis applications.

If the analyst understands the decision maker and his needs, he will know before the analysis begins whether it is to be used primarily to solve a problem or to inform the decision maker and others about the problem. Decision makers sometimes use analysis merely for enlightenment without notifying the analyst of such intentions. Knowing the use of the analysis at the outset can help the analyst to provide effective results.

The decision maker must be involved deeply in the analysis to insure its success. When analyst and user work closely together and yet retain a respectful distance, the user can improve the effectiveness of the analysis by monitoring its progress. He will not then be likely to judge final results on second-hand opinions or on misconceptions of the work.

mate peak hourly exposure of pedestrians near major roads for both normal and adverse meteorological conditions.

Based on calculations using the model, they concluded that the risks exceeded the benefits after cars of four model years had been equipped with catalytic converters. The user then made a controversial decision to reduce the pressure put on the automobile companies to install the converters.

Subsequent analyses have revealed that the conclusion rested on a series of worst-case assumptions that combined to produce an improbable scenario. A different picture of the problem would have appeared if uncertainties of the data, the assumptions, and the calculations using the model had been made explicit and if appropriate sensitivity studies had been conducted. More recent estimates of sulfuric acid exposures show that the problem had been greatly exaggerated in preparing the analytic argument.

Using the conclusions

Research at the National Institute of Mental Health in the US showed that rehospitalizing mental patients following discharge could be reduced if a social worker from a patient's county of residence visited the hospital, established a working relationship with the patient, and participated in planning for discharge. The analysts proposed to a state Commissioner of Public Welfare that he implement the practice statewide.

In this case the pitfall was failure to consider implementation problems, which became painfully clear to the analysts when the

'Will anyone feel better for having gone along with this policy if it should be adopted?'

Commissioner responded to their proposal. Would county social workers throughout the state have skills equal to those of the project workers? Would it be possible to maintain the project's small caseloads of about six patients per social worker?

He noted that the social workers in the study had offices near the hospital. Would other county social workers be willing to live away from their families on trips to the hospitals? Who would provide travel funds? Who would provide training? Would hospital social service personnel welcome the county workers? Since the hospital workers would have less to do, some might lose their jobs.

The Commissioner noted that the readmission rates were respectably low to begin with, and he questioned whether the improvement would ever be noticed. He ended with a question no analyst or decision maker should ever fail to ask: "Will anyone feel better for having gone along with this policy if it should be adopted?"

6

PUTTING ANALYSIS TO USE

Systems analysis can be applied merely by taking note of its findings, or it can be used in a policy or program based on the findings. When such a program is implemented, it sets the existing social, political, and economic arrangements in a new configuration. If the new configuration was intended, and if it follows from conclusions drawn from the analysis, the implementation process is often assumed to be successful.

A failed policy does not necessarily imply a failure of implementation. A well implemented inappropriate action will not have the desired results. Implementation in such a case can only be seen to have failed to the extent that it did not help the key actors in the policy process to recognize their conceptual mistakes and to take measures to correct them.

But the opportunity for continuous trial and error should be built into the policy. Therefore, a successful implementation process should not only avoid pitfalls, but seek better and perhaps unpredictable paths to new ends, some of which may be unforeseen at the time the policy is determined. The pitfalls of implementation are largely invisible when the implementation process begins.

The process involves many actors, all working with and against each other for strategic advantage as well as for end results. It may be helpful to see it as a loose series of games, with the outcome of one game affecting play of another. Some of the most common games of implementation, each of which suggests pitfalls of analysis, are outlined in this final chapter under four general types.

Diverting resources

- "Easy Money." Government contracts are the mainstay of many corporations in the private sector of free-market economies. Problems arise when unqualified, unmotivated, or overpriced contractors are given important responsibilities in the execution of policy. A mistake in awarding such a contract is hard to correct. The bad contractor has blackmail power over a program manager who does not want to admit the mistake.
- "Budget." Bureau chiefs like large budgets, and where incremental budgeting is practiced, the more they spend, the more they

hope to get. Higher expenditures are often encouraged by higher authority. Incentives to unproductive spending are greatest when the bureau acts as financial intermediary, commonly as a distributor of grant-in-aid funds to other levels of government. At worst, the intermediary agency is evaluated almost exclusively on its ability to move money, which then is used to less than ideal effect.

- "Funding." A grant-receiving bureau or nonprofit organization maximizes a grant by padding requests for funds and minimizes constraints by foiling the surveillance routines of the donor bureau. Surveillance is especially ineffective when the aims of the program are hard to measure.
- "Easy Life." Some bureaucrats invent ways not to work very hard while appearing to do so. More debilitating to policy implementation, though, is working hard but only within convenient, habitual modes. If the policy requires a break with practice, it can be thwarted by such individuals.
- "Pork Barrel." Political pressures to spread patronage money around are not necessarily detrimental, unless financial resources need to be concentrated in order to reach some threshold of effectiveness. Care must be taken to focus implementation for enough concentration of resources to have the desired results.

Deflecting goals

- "Keeping the Peace." New laws for environmental protection, worker health and safety, and other social regulation create opportunities for zealots to gain control of regulatory apparatus. Others representing the status quo may move in to neutralize the new programs – by installing their sympathizers, by writing weak standards or guidelines, by lightening penalties for violators, or by setting high standards of proof for violations. Implementation can be neutralized in such an environment.
- "Up for grabs." This occurs when opposing policy proponents, each with a different concept of an agency's objectives, alternately gain control of the agency. The effect is similar to Keeping the Peace: neutralization of a policy's implementation.
- "Piling on." If a new program enjoys success, its political support expands. It then becomes a target for interests that have only a minimal commitment to its objectives. By the time the piling on is over, the original program goal may be submerged, or the supporting coalition may have collapsed under the weight of the new interests.

Dissipating energies

- "Tenacity." If participants in the implementation process have different preferences for how fast the program should get under way, those who want speed are vulnerable to manipulation by those who want delay or who are less concerned with speed. The great danger is that the holdout faction will go too far, so that everyone becomes discouraged and the implementation collapses for lack of political or financial support.

- "Territory." Bureaucratic competition for control of the implementation can be constructive, or it can interfere with efforts to coordinate the responsibilities of different agencies at the operating level.
- "Not Our Problem." This game is the opposite of Territory. Agencies shrink from the new responsibility, which is seen as burdensome or unglamorous. It also happens when an agency is getting new assignments without increased budgetary resources. Implementation can be put off for years in such cases.
- "Odd Man Out." The uncertainties of collective action make it practical for actors to keep an option to withdraw from projects. The strategy sometimes entails maneuvering other agencies into losing withdrawal options -- typically by imposing costs on them and thereby giving them too great an interest in the project to abandon it. When the intended victim resists the strategy, the result tends to be a stalemate.
- "Reputation." Politicians seek reputations for being sensitive to their constituencies. Policy analysts seek reputations for being sophisticated, high-powered, and helpful. Policy makers seek reputations for being sound, discreet, loyal, able to shape a consensus, and – let us now hope – able to avoid the common pitfalls of systems analysis. The effects of playing Reputation are not all bad. The dangers come when the actor persuades others that he is doing more or better than he really is, or when his posturing demoralizes individuals doing more constructive but less visible work in implementing a program.

FOR MORE INFORMATION

A more extensive discussion of the pitfalls of systems analysis, including elaboration of many of the points made in this report, is available in: *Pitfalls of Analysis*, edited by Giandomenico Majone and E.S. Quade (Wiley, Chichester, UK, 1980).

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