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FACULTY WORKING
PAPER NO. 1156

Subjective Aspects of the Art of Decision Analysis:
Exploring the Role of Decision Analysis in Decision
Structuring, Decision Support and Policy Dialogue

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Abstract

The paper argues that until very recently, decision analysts have devoted relatively little attention to the processes of problem formulation and subjective judgment in handling ill-structured strategic decision problems. Therefore, following a brief review of existing varieties of decision analysis, a modified 'policy dialogue' model of decision analysis is presented which integrates decision analysis with decision aids and decision support technology. This model is developed using as an illustration strategic problems drawn from the insurance industry. The paper concludes with some suggestions for the successful application and implementation of decision analysis.

Introduction

Formal approaches to organizational decision-making have been rarely applied, apart from a restricted set of techniques applied to specific operational problems. Indeed, concern has been expressed in the Management Science literature regarding both the breadth of applications and the rate of acceptance of consequent recommendations, (Schultz and Slevin (1975), Ackoff (1979a,b) and Eilon (1980)). In the decision analysis context, Kunreuther and Schoemaker (1980) argue that when decision theory analysis is viewed as a multi-stage model for rational choice among alternative options, its impact on organizational theory and managerial behavior tends to be less than might have been hoped for or expected (Behn and Vaupel, 1976; Grayson, 1973; Brown, 1970). The limited attention given to the descriptive aspects of problem formulation (Hogarth (1980)) and the inherently political nature of organizational decision-making has often been cited as the cause of the relatively limited adoption of decision analysis approaches.

However, numerous examples exist to demonstrate that decision analysis has been usefully and successfully applied to the analysis of such well-structured, well-specified situations as, for example, new product decisions, manufacturing investment, oil and gas drilling decisions (Brown, 1970; Brown, Kahr and Peterson, 1974; Grayson, 1960; Moore et al., 1976; Kaufman and Thomas, 1977). More recently, Keeney (1982), Keeney and Raiffa (1976), Kaufman and Thomas (1977) and Ulvila and Brown (1982), report an increase in the applications of decision analysis to complex, difficult, ill-structured problems and argue that

decision analysis is especially valuable in such situations. Its extended use in both the corporate and public policy areas (see for example, Howard and Matheson (1984)) suggests it may yet fulfill its potential as a useful decision aid for the formulation and analysis of complex problems.

It is argued that certain adaptations of the basic 'rational choice' decision analysis paradigm are required for it to be effectively applied to strategic decision and policy situations. In particular, the existence of structural uncertainty means that much attention must be focussed on problem structuring and formulation. Therefore, decision analysis is presented here as a vehicle for generating dialogue about problem assumptions, formulation and available options, rather than as a means for the determination of an optimal strategy. This modified decision analysis approach is regarded as a support system for problem solving rather than as an optimal statistical technique.

Thus the paper is structured as follows. The modifications necessary to apply decision analysis to ill-structured problems (McCaskey (1982), Mason and Mitroff (1981)) are outlined initially and illustrated using existing consultancy models of decision analysis. Particular attention is given to the role of decision analysis in policy dialogue. This is followed by some discussion of work undertaken in the insurance industry which illustrates the links between decision analysis and decision support and also highlights some implementation problems. Attention is then focused upon the need for analysts to develop clinical skills and strategies in order to increase the

probability of acceptance and successful implementation of the ensuing
policy recommendations. The paper concludes by summarizing the impor-
tant features of the policy dialogue framework for decision analysis.

Applying Decision Analysis to Ill-Structured Problems

The decision analysis approach (Raiffa, 1968; Moore and Thomas,
1976; Keeney (1982)) is normally applied in terms of a series of
distinct steps or stages (see Figure 1). These are:

(i) <u>Structuring the problem</u>: definition of the set of alternative
strategies; the key uncertainties; the time horizon and the
attributes or dimensions by which alternatives should be
judged.

(ii) <u>Assessing consequences</u>: specification of impact or con-
sequence measures for the decision alternatives.

(iii) <u>Assessing probabilities and preferences</u>: assessment (or defi-
nition) of probability measures for key uncertainties and
utility measures to reflect preference for outcomes.

(iv) <u>Evaluating alternatives</u>: evaluation of alternatives in terms
of a criterion for choice such as the maximization of expected
utility.

(v) <u>Sensitivity analysis</u> in relation to the optimal strategy which
may lead to further information gathering.

(vi) <u>Choice</u> of the most appropriate strategy in the light of the
analysis and managerial judgement leading to implementation of
the preferred strategy.

<u>Insert Figure 1 about here</u>

Since this basic paradigm was proposed, the experience gained by
both consultants and academics has stimulated changes designed to make
the decision analysis approach more flexible to the needs of managers.
In many applications the attention has moved away from the "purity" of
the analysis and the search for an optimal solution. Instead the
focus is more frequently upon such factors as the "mess" (Ackoff

(1970)), the complexity, and the bargaining, debate process which characterizes so many ill-structured policy and strategy problems. Indeed, such consultancies as Woodward-Clyde in San Francisco, Decisions and Designs (DDI) in Washington, Decision Science Consortium (DSC) in Washington and Stanford Research Institute in Menlo Park, have adapted their versions of decision analysis to the realities of the market place and the increasingly ill-structured problems which they seek to resolve.

It is useful to examine how these consultancies have used the decision analysis approach and have developed distinct styles in relation to their differing areas of application. For example, Figure 2, shows the steps in decision analysis as conceived by the Decision Analysis Group at Woodward-Clyde Consultants in which Ralph Keeney and Craig Kirkwood were perhaps the most well-known principals.[1] The group has worked most closely with problems in the environmental, regulatory, social and legal areas such as the siting of energy facilities. Typically, these problems involve high stakes, have complicated structures, need multiple viewpoints for resolution (i.e., there is no single expert). In addition, the decision-makers are usually required to justify decisions to regulatory authorities, corporations, and the public at large.

Figure 2 notes the complexities of such problems which require the adaptation of the basic, single decision-maker Raiffa-type paradigm.

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[1] Ralph Keeney and Craig Kirkwood are now associated with the Universities of Southern California and Arizona State respectively.

As a result of law or regulation they involve the consideration of multiple objectives and involve many impact groups. They have long-time horizons, are characterized by significant uncertainties and involve many decision makers who are forced to recognize the inter-disciplinary substance of the decision situations. Using such approaches Woodward-Clyde have generated considerable academic and practical research in the application of the technology of multi-attributed utility theory (MAUT) (Keeney and Raiffa (1976)) to the class of decision problems involving the interface of the organization with legal, regulatory, social and economic environmental forces. Such cost/benefit type analyses require a keen awareness of strategic management of interorganizational forces and typically use MAUT as the input to a debate process concerning policy choice. These implementation concerns are familiar to generations of cost-benefit analysts working on applications in the area of welfare economics.

In contrast, the Decision Analysis Group at SRI, originally founded by Professor Ronald A. Howard and Dr. James Matheson,[2] has a much greater model building emphasis than the other consulting groups. They structure their version of the decision analysis process in terms of the decision analysis cycle shown in Figure 3. The deterministic phase calls for problem formulation, structural modelling, the specification of value and time preferences and, particularly, extensive sensitivity

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[2]Professor Howard and Dr. Matheson are now the principals of the Strategic Decisions Group in California. Their decision analysis philosophy is also closely associated with the Department of Engineering/Economic Systems at Stanford.

analysis which provides the link between the deterministic and probabilistic phases. The probabilistic phase introduces probability distributions for certain key numerical and structural factors and generates a probability distribution for a performance criterion such as net present value (NPV), which displays the perceived risk of various alternative strategies. The determination of certainty equivalents for these distributions enables value judgements in relation to risk to be made. The informational phase stresses the economic value to be obtained from reducing the uncertainty characterized in the probabilistic phase. Additional information-gathering may thus be deemed uneconomic in terms of a cost/benefit tradeoff between time and money (Howard (1984)).

Thus SRI sees decision analysis as an interactive process. In essence, the simplest initial analysis (i.e., deterministic) consistent with the structural model should be carried out. This is referred to as a pilot-level analysis. Guided by the results of this analysis, a more detailed prototype study (involving probabilistic analysis) is undertaken. If deeper analysis and system sensitivity analysis is required then a final stage "production" level of analysis can be generated. The economics of information gathering is seen to be controlled by analyses of the value of such information. The SRI approach is perhaps more engineering and systems oriented than other approaches. Models are seen as providing a road-map for decision logic and allowing, through the process of decomposition, various information sources to be very specifically targeted. They thus involve a capital

investment beyond the use for which they were originally constructed. They provide a basis for ongoing decision analyses and for a continuing client-consultant relationship.

Stanford Research Institute has worked extensively on both commercial and public sector analyses. These range from company-wide planning and strategy models to such public sector applications as decisions to 'seed' hurricanes and plan fire protection for the Santa Monica mountains in Los Angeles (Kaufman and Thomas (1977), Howard and Matheson (1984)). Their work increasingly involves ill-structured problems and their operational paradigm is to break the decision problem into its constituent parts, reassemble them in a step-by-step approach and improve the analysis in a cyclical way.

In common with many of the newer decision analysis consultancies such as the Decision Science Consortium, DDI perhaps represents a more process-oriented decision analysis technology relative to the more focused modelling approach of SRI. Therefore, DDI focus much more attention on the process of generating alternatives and of helping decision-makers to structure alternatives. They often use extremely simple linear additive MAUT approaches suggested by Edwards (1976) to identify alternatives, sometimes using an user-friendly interactive MAUT package (Humphreys and Wisudha (1979)) to clarify the hierarchy of value attributes relevant to the problems. DDI's use of linear models can be seen as a decision simplification mechanism to enable decision-makers to develop better alternatives. Successful passes of this process are used to develop a better understanding of assumptions and a more realistic set of alternatives.

Essentially, DDI's view of the world argues that a decision analyst does not have to structure the entire problem. Decision analysis is seen as most useful in describing and debating possible implications of some aspects of the problem rather than optimizing with respect to all of them. Rex Brown and Cam Peterson[3] cite a DDI analyst who gives an example concerning the use of decision analysis in comparing alternative disarmament strategies. The analyst focussed attention solely upon the prediction of how long it would take NATO to mobilize given a Warsaw Pact attack. Decision analysis was used as a descriptive device. That is, NATO was assumed to make the mobilization decision as a rational unitary actor and then the assumptions were relaxed and debated so that decision-makers could accommodate the analysis to the actual operations of complex bureaucratic processes. Thus, DDI used a mixed-scanning multiple viewpoint approach to top level decision-making suggested by such writers as Allison (1971) and Etzioni (1967).

Much of DDI's applied experience has been in the public sector and, especially, in military and defense applications. The complexity of such public sector problems has probably influenced changes in their analytic style involving the use of decision analysis as a decision-aiding technology and a decision support system rather than simply a solution technology.

Thus it is argued here that these consultancies have developed and refined decision analysis. There is less concern about methodological issues such as probability and utility assessment. More

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[3]Rex Brown and Cam Peterson were among the early principals of DDI. Rex Brown is now associated with the Decision Science Consortium in Virginia.

attention is now given to aiding the decision-maker in problem for-
mulation, screening of alternative options and in promoting effective
dialogue about problem characteristics and policy issues. In other
words, the important principle in modifying decision analysis should be
that formulation and evaluation of ill-structured problems requires a
creative mix of analytic inputs and continual debate. It must be
recognized that it is almost impossible to undertake anything other
than an exploratory and preliminary analysis at the first attempt. If
so, this "first pass" analysis should be documented and subjected to
critical comment and review by the policy-making group. In the course
of this process, debate about the problem will become more focused
around questioning of assumptions, generation of further alternatives
and anticipation of future contingencies.

As Keeney and Raiffa (1972) say:

> Simply stated, the major role of formal analysis is
> "to promote good decision-making." Formal analysis
> is meant to serve as an aid to the decision-maker
> and not as a substitute for him...
> ...As a process, it is intended to force hard
> thinking about the problem area: generation of
> alternatives, anticipation of future contingencies,
> examination of dynamic secondary effects, and so
> forth. Furthermore, a good analysis should illu-
> minate controversy--to find out where basic dif-
> ferences exist, in values and uncertainties, to
> facilitate compromise, to increase the level of
> debate and undercut rhetoric--in short, "to pro-
> mote good decision-making." (1972:10-11)

This modified decision analysis is an approach and a broad investi-
gative research strategy rather than a technique, and is not necessarily
performed in a series of sequential steps. Some steps may be excluded
or handled in an informal manner. The order of the steps may be varied
and, indeed, the relevance of the objective structure, problem assump-

tions and the importance of excluded factors may be continually reassessed. In particular, the philosophy of the modified decision analysis approach strongly emphasizes the point that the identification of new options is even more important and necessary than anchoring firmly on analysis and evaluation as goals of the analysis.

Clearly, this modified decision analysis approach can still incorporate the techniques outlined in Figure 1. Indeed, when dealing with well-structured problems (such as oil and gas exploration) the traditional and modified paradigms are identical. The value of the new paradigm is embedded in its flexibility which is needed to deal with increasingly complex and unstructured policy and strategic management issues. It requires deliberate and disciplined use, but yields greatly enhanced understanding of the nature of the problem and the available options.

The goal of this modified approach should be judged in terms of its contribution to organizational processes rather than specifically recommending an action and getting it adopted. Very often the understanding derived from the process of structuring the problem and the information related to outcomes and actions may significantly influence the quality of the decision process.

Decision Analysis As An Aid For Policy Dialogue

The previous sections of this paper argue that analysts have increasingly sought to build flexibility and adaptability into the analytic process. In nearly all applications an initial, very preliminary model of the decision situation is developed which gives

decision maker(s) an opportunity to explore and understand the problem situation more clearly. For example, it may often be preferable for decision-makers to examine the outcomes of alternative policies in terms of a time-stream of indicator variables, rather than in terms of a single criterion such as expected utility, whether or not that utility function is expressed in multi-attributed form. In this manner, policies can be discussed and debated even more thoroughly by managers to see whether they fit in terms of a broad spectrum of indicators. This is particularly important when excluded factors and problem assumptions are re-examined. Discussion typically leads to the advocacy of different policies and views of the world. Consensus about problem formulation can only be achieved through an inquiry system which encourages strategic dialogue about the consequences of alternative assumptions, problem formulations and scenarios.

In practice, the application of decision analysis to ill-structured strategic problems sometimes involves an effective policy dialogue about alternative options. Examples are available in Bunn and Thomas (1977), Thomas (1982), Holling (1974), Bell (1977), Meyer (1976), Keeney and Raiffa (1976), Keeney (1982), Ulvila and Brown (1982), Hertz and Thomas (1983), Hertz and Thomas (1984) and Howard and Matheson (1984).

Perhaps the clearest message from these more recent applications of decision analysis is that there is no unique way to ensure that the problem is adequately structured and the set of probabilities are well assessed. Decision-makers and organizations vary greatly. Analysts

need to be flexible and creative in applying decision analysis. Therefore, the approach adopted must recognize the characteristics of the organization, the ambiguity inherent in the decision problem and the training, experience and personalities of the key decision-makers.

However, it seems sensible to ask whether confusion or clarity is generated by advocating the use of combinations of planning and analytic approaches to develop alternative and often conflicting problem viewpoints for policy dialogue. In a laboratory experiment involving business executives, Schwenk and Thomas (1983b) provide evidence demonstrating that the presentation of conflicting analyses is more effective than a single analysis in improving decision-making performance.

Finally, the advent of available computer and communication technology has enabled sophisticated decision analysis models to be provided in a 'video-conferencing' mode using the concept of managerial decision support. The development of user-friendly software for assessing probabilities and utilities and observing the potential impacts of alternative strategic options in graphical terms has also strengthened the viability of the concept of decision analysis as a strategic inquiry system (Churchman (1971)). Some of the available decision support systems for automating the process of decision analysis are discussed in the next section. Probability assessment packages such as Schlaifer's MANECON package (1971) and SRI's Automated Aids for Decision Analysis (1976) are reviewed briefly followed by an example of a strategic decision support system drawn from the authors' recent research in insurance (Samson and Thomas (1985)).

Decision Support Systems for Decision Analysis: A Brief Review and
An Example

The MANECON programs (Schlaifer (1971)) provide a suite of

programs which help decision-makers to ensure consistency of subjec-

tive assessments of probability and utility. Although not immediately

user friendly they have been adapted in doctoral theses by researchers

such as Peter Burville (London) and Michael Middleton (Stanford) to

provide on-line probability assessment procedures in decision making

contexts.

The research of Stanford Research Institute's Decision Group (1976)

consciously attempts to widen the focus of decision analysis away from

the traditionally narrow orientation involving the stress upon such

factors as assessment quality and consistency. They emphasize the

logical and analytical steps necessary for the analysis of a wide

variety of decisions and link decision analysis with the new tech-

nologies of decision support systems. This decision support focus

which is echoed also in Schwenk and Thomas's (1983a) Omega paper on

"Formulating the Mess," has produced (1976:1):

    (1) a characterization of the different kinds of decision
        situations that arise in practice and an exploration of the
        implications of these characteristics for automated deci-
        sion aids.

    (2) a description of the types of decision models available for
        analyzing a variety of decision situations.

    (3) a description of the process of constructing decision models
        and

    (4) an identification of several easily understood modeling con-
        cepts that provide a basis for designing and constructing a
        pilot-level system of automated decision aids.

Other researchers have also focussed on the role of decision analysis approaches as aids in decision making. For example, Humphreys has developed the MAUD system (1979) for automating multi-attributed utility assessment in decision-making and Herbert Moskowitz of Purdue has produced a user-friendly program for assessment of probabilitic scenarios in complex decision-making situations. Perhaps one of the main problems associated with forecasting "fuzzy" futures is the need to assess adequately key scenarios and the assumptions which underlie the construction of such scenarios. Hertz and Thomas (1983: 308) also report that the probability tree, or "fault" tree, as it is commonly referred to by engineers, is a very useful aid for structuring the thinking process provided that the decision-maker is encouraged to think about the range of possible outcomes. A number of corporate planning groups which encourage scenario construction for "futures" have identified "anchoring" bias around central or "status quo" values, and have modified assessment procedures to avoid asking for the "most likely" scenario.

Many other suggestions for reinforcing decision analysis's role in decision support could be presented here (see, for example, Slovic (1980). Instead, a practical example of the comprehensive development of decision support involving decision analysis is discussed below. This example illustrates practical problems of assessment and implementation in the context of the insurance industry.

Decision Support and Insurance

The decision support system discussed here describes strategic planning problems commonly faced by many insurance companies. In

addressing these problems, elements of subjectivity enter the problem and model structuring phases as well as the numerical assessment phase. Indeed the process of generating alternative strategic plans requires experience and creativity and hence is more effectively performed by managers than by their computers. However when managers are efficiently supported by computers, their problem solving ability can be increased. The effectiveness of their subjective judgements can be increased as a result of the high quality of analytic information supplied by the computer. The decision support system described below is one which provides building blocks (i.e., modules) from which the manager constructs models of future strategic scenarios. The computer then evaluates each of these scenarios and based on these evaluations, the manager and computer can interact in an iterative manner in an attempt to create improved strategies (as measured by an appropriate utility function).

Strategic Problems in Insurance

Some important strategic questions which have to be considered in insurance organizations include the following:

1) What portfolio of types of insurance (lines of business) should the company underwrite and what operating strategies should be adopted for each line of business?

2) How should premium income and other assets (known as reserves) be invested given uncertainties in stock, bond and option markets and other investment opportunities?

3) What reinsurance arrangements should be made to spread corporate risk?

Individually these decisions are quite complex, for they involve interrelated variables, as well as uncertainty about problem structure

and the values of key parameters. Clearly, analysis of these problems in isolation constitutes a form of so-called suboptimization and the solutions thus generated may not be sensible when the insurance organization is viewed as a corporate portfolio of activities.

However, recent computer developments have allowed the corporate portfolio problem to be more simply analyzed. For example, a modular decision support system (such as that shown in Figure 4) can provide the user with flexibility in structuring as well as enabling the inclusion of relationships between variables (where such relationships may be deterministic or probabilistic) and relevant problem constraints. Such a system allows top management to expand their role in corporate planning and particularly in the stages of strategy generation and evaluation.

<u>Insert Table 1 about here</u>

The data requirements of the system are shown in Table 1. For uncertain quantities, probabilities can be assessed as discrete values (essentially in histogram form) or distributions can be called up from a bank stored by the system (in which case parameters must be specified, see Spetzler & Stael Van Holstein (1984) and Moore and Thomas (1975) for assessment methods.).

The DSS can be used as a model for the examination of retained earnings as a function of various sets of decision variables. The decision analysis approach also allows for the determination and use of a preference (utility) function for the user as part of the system. The retained earnings expression is described in an expanded form in Appendix I. Figure 4 also provides an overview of the DSS.

Insert Figure 4 about here

The underwriting module requires the input of policy design and price variables and estimates in the form of probability distributions for premium volume, claims and expenses. These inputs are made separately for each underwriting line or type of insurance.

The investments module requires input data involving investment opportunities and probability distributions about likely returns. From this data an aggregate ROI distribution is determined.

The reinsurance module requires inputs of reinsurance types, extents and costs (i.e., reinsurance premiums). Reinsurance can be of proportional or non-proportional form or a combination of both and can be taken out either on a line by line basis or on an aggregate basis. All of these options can be evaluated using the DSS.

The output resulting from the three basic modules (underwriting, investments and reinsurance) is then used as an input in order to determine a probability distribution for retained earnings in the retained earnings module of the DSS. It should be noted that simulation approaches are typically used to generate the distribution for retained earnings because exact analytical solutions are only possible with particular forms of input distributions. Figure 5 shows a typical set of probability distributions (of retained earnings) obtained for three alternative strategies. The value of the overall strategic plan could be addressed in a number of ways. For example, the system can be used to develop managerial knowledge and understanding about the likely results of underwriting, investment and reinsurance activities and

their effects on performance measures such as retained earnings.

Evaluation of strategies can also be accomplished through interpreta-

tion and debate about the expected utility of alternative strategic

plans derived from the DSS's utility functions module. Alternatively,

the principles of stochastic dominance may be applied to the retained

earnings distributions to determine a feasible set of strategies.

Insert Figure 5 about here

Constraints and Conditions on Parameter Values

The overall aim of the system is to allow the user to determine

values for those strategic variables important for maximizing the

expected utility of retained earnings, subject to certain constraints

and conditions. These constraints need not be explicitly included in

the program, i.e., the user can check to see that they are satisfied

for any set of variables prior to using the DSS. Examples of con-

straints may be those imposed by government regulators regarding mini-

mum surpluses or premium/surplus ratios. Alternatively, they may

involve internally imposed constraints on the composition of an

investment portfolio, as for example, bounds on the proportion of

assets invested in bonds. However, the implications of these

constraints can be included in the DSS and examined comprehensively

within the system for each set of input variables.

Many correlations exist between strategic variables which are not

binding constraints and these can also be either included or excluded

from the DSS. An example is the relationship between claims adjustment

expenses and reinsurance premiums. In general, increasing efforts (and

hence expenses incurred) in claims adjustment would tend to lower claims and thus should lower reinsurance premiums. The relationship is a complex function of claims adjustment effectiveness, claim frequency and severity and reinsurance policy variables. The DSS can be adapted to include such relationships and dependencies or alternatively they can be accounted for externally to the system. A compromise option is to program the DSS to monitor such relationships without knowing their explicit functional form. When a change is made to a variable of interest, appropriate correlations can be calculated for the user thus allowing appropriate changes to be made to related variables. Thus, the system can be made more "artificially intelligent," so that, for example, it is capable of suggesting reasonable responses in decision variable levels to changes in exogenous conditions (such as trends in various insurance markets).

This type of DSS may, therefore, be applied to any one of a large number of situations which are clasified here as global (corporate-level) strategic planning, or business unit level planning. In both types of applications, many subjective judgements must be made about problem structure and the design of strategic actions as well as about the values of relevant variables and their associated probabilities. The user builds the structure and can perform 'structural sensitivity analysis'. In complex problems such as this one, there is not an objectively known correct structure, but rather a number of possible modelling structures and a number of alternatives to be evaluated. The model structuring and alternative generation processes are important subjective phases in decision analysis.

In a global strategic planning process, the user can examine the effects of alternative business strategies in combination with various assumptions regarding environmental variables such as market conditions, reinsurance prices and regulatory constraints. In this manner the DSS acts both as a structuring and an aggregative evaluation framework since it provides the user with information on the combined effect of many interconnected actions.

In many companies changes are often considered for one business line which may have secondary effects on other strategic activities. For example, a general insurer may be considering the introduction of a new policy type and a new product line. The DSS can be used to examine the effects of different operating strategies by inputting various sets of prices and policy designs (along with accompanying probabilistic estimates for premium volume, claims and expenses). Secondary effects on other variables such as the effect on investment funds of the new premium income can also be assessed. The strengths of the DSS in this case are in its ease of use and its ability to relate all policy changes to the aggregate financial performance of the firm (i.e., retained earnings). Since the system is based on the decision analysis paradigm, uncertainty is accounted for as well as the organization's attitude towards risk.

Recent technological advances have made computers available to many managers and the processes of structuring and solving complex, messy problems can be aided and supported by the power of computers. The risk analysis approach and complex multivariable sensitivity analyses no longer pose computational difficulties even for complex

problems. As a result, fewer simplifying assumptions are necessary in modeling processes so that larger and more realistic models are being made available to the manager on his desk top computer.

It is clear however that the increasing managerial use of sophisticated decision analytic models for complex problems places an increased burden upon managers to properly structure problems and assess key uncertainties. Our experience with decision support systems and decision aiding processes in general has led to the conclusion that flexibility in problem definition and structuring is at least as important an issue as the design of appropriate subjective probability assessment procedures. Further, analysis takes place in a complex organizational decision-making process and requires analysts to develop clinical strategies to handle clients and facilitate problem definition and structuring.

DEVELOPING CLINICAL SKILLS AND STRATEGIES

Modifying the decision analysis paradigm requires consequent changes and improvements in the conduct of the implementation process. Based on experience in applying the decision analysis as policy dialogue approach some implementation guidelines are suggested below. By way of introduction, Fischhoff (1980) considers the problems that may arise in decision analysis as a result of low awareness of clinical issues, and defines the skills relevant to psychotherapists as follows: "...they must instil confidence in clients, choose the appropriate questioning procedures to elicit sensitive information, handle crises, understand what is not being said, avoid imposing their own values and

perᴿeptions, and cooperate in creating solutions." The implication is
that the skills required by decision analysts are similar.

The implementation problems are briefly discussed in the following
paragraphs. A much more detailed discussion of these issues can be
found in Lock and Thomas (1985).

The initial contract

During the initial stages of the decision analysis process, the
analyst must explain the requirements of the process in terms of
information requirements and the preferred degree of access to
organizational decision-makers. In some more politicized organiza-
tions, sponsoring coalitions or individuals may attempt to control
access to the analyst or the analyst's access to other participants.
This should be recognised beforehand in developing the initial struc-
turing of the problem and deciding which groups' views are essential
in devising acceptable strategies and representing preferences.
Interested groups might include a wide range of stakeholders,
including owners (the state, shareholders, community, etc.),
employees, consumers, managers and society. Yet, the incorporation of
the views of other groups can lead to a decision analysis model rather
different from that anticipated, or welcomed, by the sponsor
(Kunreuther (1982)).

The role adopted by the analyst. The analyst may interface with
clients in a spectrum of possible roles ranging from the "expert" at
one extreme to the "trainer" at the other extreme. In the expert
role, the structuring and analysis is largely performed by the analyst

without significant organizational involvement. In contrast, in the trainer role the analyst aims to teach organizational decision-makers to structure analyses and evaluate alternative strategies on their own, and, thus, develop the ability to use the techniques in the absence of the analyst.

It should be noted that involvement and resulting commitment on the part of decision-makers increases as the analyst moves from the "expert" to the "trainer" role. The tendency for the conventional decision analysis paradigm to follow the first path partially explains the resultant low commitment to conclusions and recommendations in a number of case studies reported in the literature.

Diagnosing, exploring and structuring the problem. One view of the decision analyst is that of a passive encoder of client-provided information. However this view assumes essentially that the organizational decision-makers have a fully developed understanding and representation of the decision problem. In complicated applications, problem formulation is frequently the most time-consuming phase (see, for example Bunn and Thomas, 1977). Despite the apparent critical importance of problem structuring and formulation in the strategic decision process literature (Mintzberg et al, 1976; Lyles and Mitroff, 1980), mainstream decision analysis texts have tended to bypass it, suggesting that the process is more art than science. Others have also argued that problem structuring is learned by experience (Moore and Thomas, 1976; Brown, Kahr and Peterson, 1974).

Recent studies in personal decision-making give much greater emphasis to the formulation process and state that much of the value of decision analysis seems to come from the structuring phase (Jungermann, 1980; Humphreys, 1980) when subjects' representations of the situations and problems are developed. Several specific areas in which probing by the analyst is valuable have, thus, been identified. One area is the elicitation of the range of goals and decision criteria. These in turn assist the definition of the range of alternative actions (Jungermann and von Ulardt, 1982). The second area is exploring how actions are linked to outcomes. As well as specific questions of how different situation aspects are affected by particular actions, it is also necessary to identify who will be affected by a particular decision and their likely response.

The aim of the structuring phase is to generate an acceptable decision analysis model (Phillips (1982)), which captures concisely problem elements and provides a problem description that can be discussed with the decision-makers to aid problem understanding. Subjectivity and creativity is required in model design so that only diagnostic events and critical trade-offs are retained. The remaining information gathered may be used in later sensitivity analyses.

From the above it may be seen that the process is a cyclical one in which the technology is a structuring aid in itself (Thomas, 1982; 1984). This process of formulating ill-structured strategic problems may also require specialized aids. A number of aids have been proposed to assist this process, for example: the concepts of creativity stimulants (Prince (1970)); devil's advocate (DA) (Schwenk and Cosier

(1980)); dialectical inquiry (DI) and strategic assumptions analysis
(Mason and Mitroff (1981)) and, finally, of Delphi decision analysis
(Wedley (1978)). Schwenk and Thomas (1983a) provide an integrative
model incorporating decision aids into the decision analysis process
(see Figure 6). They present a process by which a range of alter-
native scanning models (devils' advocate, dialectical inquiry, creati-
vity stimulants and decision analysis as policy dialogue) can be used
to develop a sound decision problem formulation. The process is pre-
sented as a cyclic search process in which decision-makers are
encouraged to cycle back through previous stages of analysis. For
example, either a structured debate (DA or DI) (Cycle 2) and/or
creativity stimulants (Cycle 1) may be needed to reformulate a problem
following a dialogue (Cycle 3) about the initial decision analysis.

Insert Figure 6 about here

Approaches such as the devil's advocate and dialectical inquiry
involve the introduction of conflict into the corporate problem formula-
tion process. In particular, writers in the area (e.g., Mitroff and
Emshoff (1979)) suggest that three activities exist which can improve
the quality of problem formulation in uncertain environments. The
first is the generation of conflict between the decision-making group
or within a decision-maker. The second is the identification of
assumptions about the nature of the problem, and the impacts of the
internal and external decision environments. The third is the
challenging of assumptions.

If there is a potential drawback to the adoption of such processes,
it seems that decision-makers may resist adoption because of the need to

continually re-examine assumptions, even when a solution has been proposed. This continual re-examination imposes a time requirement which may not be feasible or acceptable and may open up areas which are regarded as particularly politically sensitive (Schwenk and Thomas (1983b)).

The analysis process: Presenting solutions. Having arrived at an appropriate initial problem structure, assessment of the probabilities and preferences identified within the representation of the structured decision problem can proceed using appropriate encoding aids. Ultimately the "first-pass" analysis has to be useful to decision-makers and they have to feel confident about it. The presentation of a single best option does not always inspire this confidence. Strict optimization is less attractive than the ability to explore the problem through policy dialogue of several passes of the analytic model involving varying assumptions about problem elements. A major role for computer-based decision support models exists in the facilitation of manager-based sensitivity analyses and the ability to respond to "what-if" questions. Decision-makers acquire commitment to the solution by feeling both that they have some control over the policy recommendations and that they have contributed to its development.

Implementation: Dealing with Conflict

The main elements in devising an implementation strategy relate to identifying the key groups and individuals, how they can be induced to contemplate change and how they will respond to any particular proposals. The person with the perceived responsibility for the decision should be

in charge of the implementation strategy rather than the decision ana-
lyst. Further, it is clear that decision-makers often dislike conflicts,
particularly highly personal ones, and seek to avoid them. In many
situations, changes and decisions are postponed until they are imposed
by an external agency. By this time, the organization's survival may
even be threatened.

The alternative is to consider to what extent it is possible to
improve the client's or the client organization's ability to deal with
conflict. Porter et al (1975), Thomas (1976) and MacCrimmon and Taylor
(1976) discuss various ways of resolving conflict. In cases where
conflict is not directly resolvable it may be feasible to assist
people to handle overt conflict and to confront political issues
openly through the use of conflict-based decision aids (Schwenk and
Thomas (1983b). This appears to be a development strategy that may
require a longer time horizon than is usually available in a decision
analysis study.

Summary and Conclusions: The Policy Dialogue Paradigm

The decision analysis dialogue paradigm (and the associated role
of decision analysis as a decision support system) presented in this
paper should be seen as a vehicle for a continuous policy dialogue
involving analysis, assumptions and contingency planning. Examples
using such dialogue processes have emerged from applications in the
insurance industry, research and development and in new product and
diversification planning (Hertz and Thomas (1982), Lock and Thomas
(1985), Samson and Tnomas (1983, 1985), Thomas (1983, 1985)).

In the context of developing and sustaining the policy dialogue, the following questions are relevant (see also Fischoff (1980) and Slovic (1980)).

(1) What are the assumption bases of the decision-makers and the analyst? If different, how do they know when they are arguing from different premises?

(2) On whose assumptions is the preliminary formulation based?

(3) What justification is there for the assumptions? Which internal sources might be used for data? Can the assumptions and data collected be checked and extended from external sources and environmental scanning? How accessible are the problem assumptions?

(4) Can one generate alternative problem representations? Which is most useful?

(5) What methods are available for assessments of probability and preferences? Which are most appropriate?

(6) How is analysis to be used in problem finding and solution? How should one perform the initial screening, and subsequent contingency and sensitivity analyses?

(7) To what extent are the variables interrelated? Can one perform some cross-impact analysis?

(8) Has appropriate consideration of political, legal and organizational factors been made?

(9) How should the analysis be evaluated?

(10) Is it possible to generate external criticism to improve the analysis?

It is argued that decision analysis as an aid for policy dialogue is a useful adjunct to other approaches for formulation and analysis of ill-structured problems. However, typically its value will be situation specific, and is likely to be both an adjunct to group discussion processes and an aid in clarifying policy evaluation and choice.

To quote Mason and Mitroff (1981:302):

> In our view, the task of policy, planning and stra-
> tegy should not consist of attempting to demonstrate
> the superiority of one approach or framework for all
> situations but rather of showing their mutual depen-
> dency...Whatever methods are used they should always
> aid in challenging strategic planning assumptions.

The key theme in the dialogue approach is that with messy problems
the initial problem formulation is very much a 'first pass?' By feeding
back structured information from the "first-pass" model, decision-makers
will be able to improve both the range of options being considered and
the representation of the relationship between options, critical exoge-
nous variables and attribute outcomes. The emphasis is on a cyclical
process where effort has to be made to avoid premature closure of any
one phase. The skills involved in the representation process--modeling
the option structure--are likely to come from a wide range of disci-
plines. Decision trees are but one way of approaching the modeling
problem and can quickly be a cumbersome aid in modelling complex
problems.

On the behavioral side, sensitivity to the organizational climate
and the organizational consequences of any decision are likely to be
crucial to both the likelihood of implementation and the success of
such an implementation. The view of the role of the analyst as a
change agent enables one to focus on the strategy that should be
adopted in this role and the degree of client involvement that should
be sought. This in its own way also tends to be an ideological issue
reflecting the analyst's goals and their relationship with those of
the client. The role of formal techniques in the policy and strategy
framework is one of aiding organizational decision processes rather
than supplying a single "optimal" solution.

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APPENDIX

Construction of the model begins with a set of accounting relations as follows:

$$\Delta A_D = \Delta C + \Delta R + \Delta RE. \qquad (1)$$

The financial parameters of the firm can be represented as:

$$\Delta A_D = \Delta FA + \Delta DA + \Delta I + \Delta WC - \Delta LD \qquad (2)$$

where A_D = total share capital and reserves at time n

   ΔA_D = change in A_D during period n to n + 1

   ΔC = change in paid up capital during period

   ΔR = change in reserves (share premium, asset revaluation)

      during period (NB these are not claims reserves)

   ΔRE = change in retained earnings during period

   ΔFA = change in fixed assets during period

   ΔDA = change in deferred assets during period

   ΔI = change in investments and loans during period

   ΔWC = change in working capital

   ΔLD = change in long term debt.

The term which is most relevant to the decision processes being studied is the retained earnings:[1]

$$RE = (1-T) \ [(1+\lambda_n)P_n - X_n + R_n + PI_n - E_n - PR_n + CR_n] + DR_n - DP_n \qquad (3)$$

_____

[1] Note that the expression for retained earnings is a highly simplified version of many actual accounting situations occurring in insurance companies. Nevertheless, it is valid for purposes of exposition and also can be adapted to suit the activities of any particular insurance firm.

where T = company tax rate

λ_n = insurance premium loadings

P_n = pure premiums

X_n = claims

R_n = investment returns

PI_n = taxable profit/loss of sale of investments

DR_n = Dividends received

DP_n = Dividends paid

E_n = all operating and administrative expenses

PR_n = outward reinsurance premiums

CR_n = reinsurance claims recovered

In decision analysis the aim is to maximize expected utility of assets (A_D)

i.e., Max $E[U(A_D)]$

Since assets are a state variable we can write:

$$A_{D,t} = A_{D,t-1} + \Delta A_D$$

where t = time subscript.

The original problem is therefore equivalent to

Max $E[U(\Delta A_D)]$

for a given $A_{D,t-1}$

In its current form the model does not address changes in capitalization (C) or reserves (R) and hence the system supports decisions whose objective is to maximize the expected utility of retained earnings (as defined in equation 3 above). The model could be further generalized to account for changes in C or R.

Table 1 Variables Included in the Decision Analysis

Profit Centre	Major Decision Variables	Major Sources of Uncertainty
Underwriting Activities	Policy Design Variables Premium Types of Insurance Offered	Claims Expenses
Investment Activities	Total Funds to be Invested Proportions of Mix in Various Types of Instruments Specific Fund Flows	Returns on Investment - stock prices - dividends - variable rate bond yields - real estate values etc.
Reinsurance Indemnity Activities	Types of Reinsurance Reinsurance Policy Basis Extent of Reinsurance Policy Design Variables	Claims on Policies Cost of Reinsurance Ability to Recover on Claims

Figure 1

SCHEMATIC DIAGRAM OF DECISION ANALYSIS PROCESS

[Note: In adaptations of decision analysis it may be useful to categorize variables into three sets i.e., CONTROLLABLE (DECISION POINTS); UNCONTROLLABLE (CHANCE EVENTS) and NEGOTIABLE (prelude to decision points)].
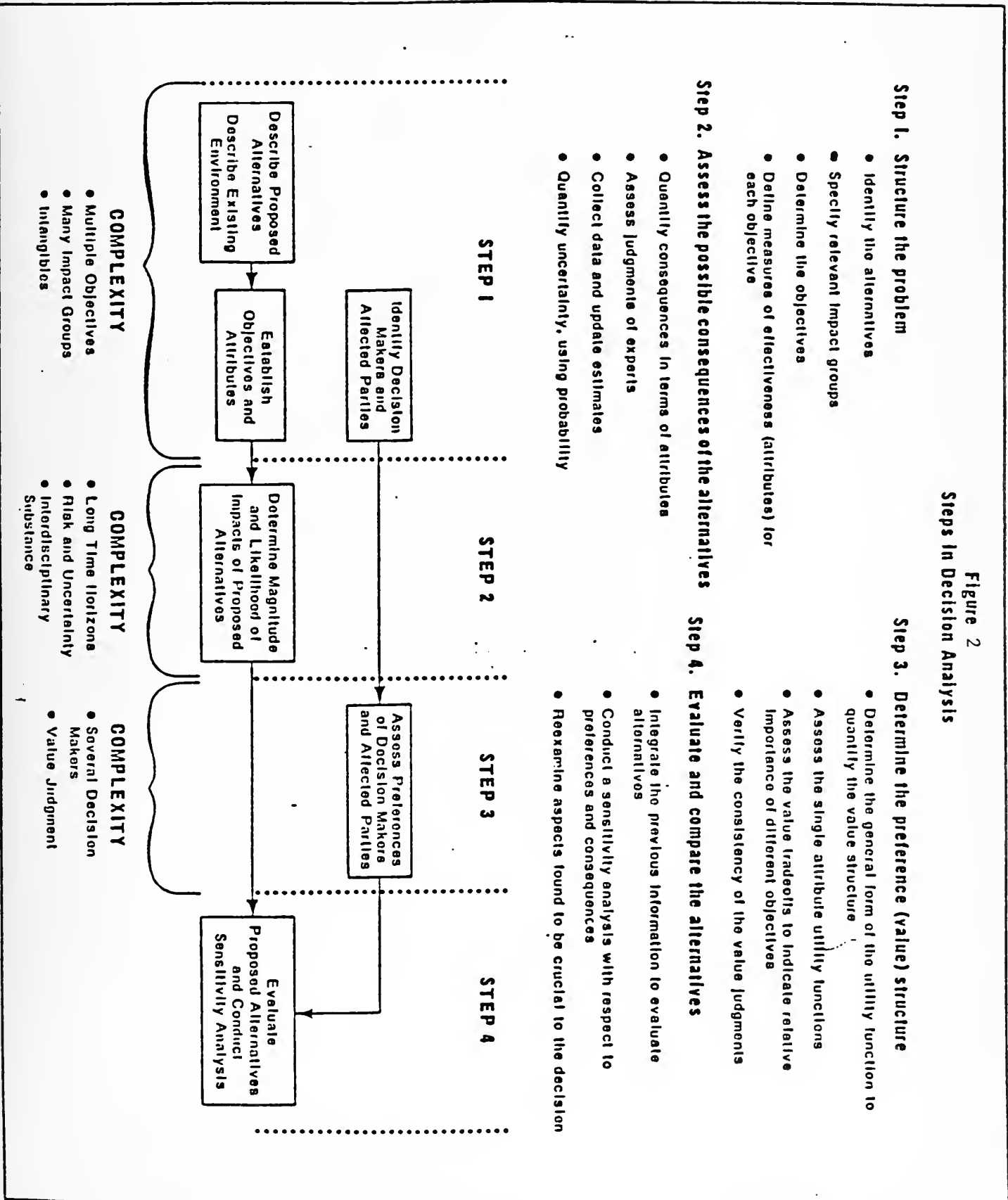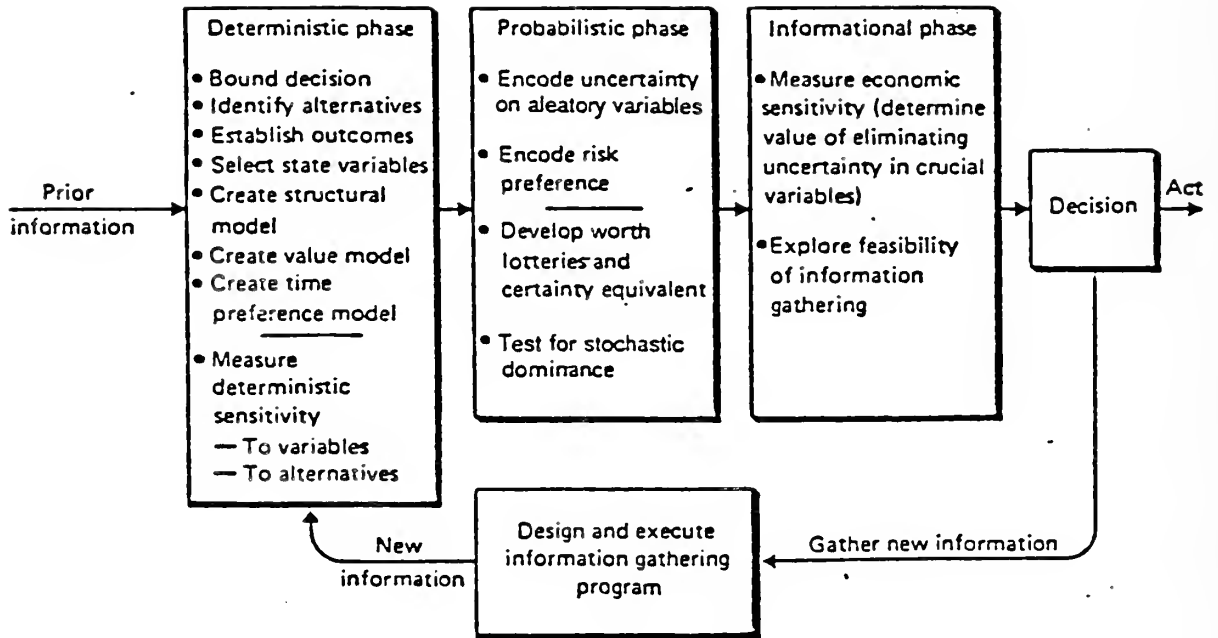
Figure 2

Figure 2
Steps In Decision Analysis

Step 1. Structure the problem
- Identify the alternatives
- Specify relevant impact groups
- Determine the objectives
- Define measures of effectiveness (attributes) for each objective

Step 2. Assess the possible consequences of the alternatives
- Quantify consequences in terms of attributes
- Assess judgments of experts
- Collect data and update estimates
- Quantify uncertainty, using probability

Step 3. Determine the preference (value) structure
- Determine the general form of the utility function to quantify the value structure
- Assess the single attribute utility functions
- Assess the value tradeoffs to indicate relative importance of different objectives
- Verify the consistency of the value judgments

Step 4. Evaluate and compare the alternatives
- Integrate the previous information to evaluate alternatives
- Conduct a sensitivity analysis with respect to preferences and consequences
- Reexamine aspects found to be crucial to the decision

STEP 1

- Describe Proposed Alternatives / Describe Existing Environment
- Identify Decision Makers and Affected Parties
- Establish Objectives and Attributes

COMPLEXITY
- Multiple Objectives
- Many Impact Groups
- Intangibles

STEP 2

- Determine Magnitude and Likelihood of Impacts of Proposed Alternatives

COMPLEXITY
- Long Time Horizons
- Risk and Uncertainty
- Interdisciplinary Substance

STEP 3

- Assess Preferences of Decision Makers and Affected Parties

COMPLEXITY
- Several Decision Makers
- Value Judgment

STEP 4

- Evaluate Proposed Alternatives and Conduct Sensitivity Analysis

From R. L. Keeney, Decision Analysis: How to Cope With Increasing Complexity,

Figure 3

Deterministic phase

- Bound decision
- Identify alternatives
- Establish outcomes
- Select state variables
- Create structural model
- Create value model
- Create time preference model
- Measure deterministic sensitivity
  — To variables
  — To alternatives

Probabilistic phase

- Encode uncertainty on aleatory variables
- Encode risk preference
- Develop worth lotteries and certainty equivalent
- Test for stochastic dominance

Informational phase

- Measure economic sensitivity (determine value of eliminating uncertainty in crucial variables)
- Explore feasibility of information gathering

Prior information

Decision

Act

Design and execute information gathering program

New information

Gather new information

From Kaufman and Thomas, <u>Modern Decision Analysis</u>, 1977, p. 119.
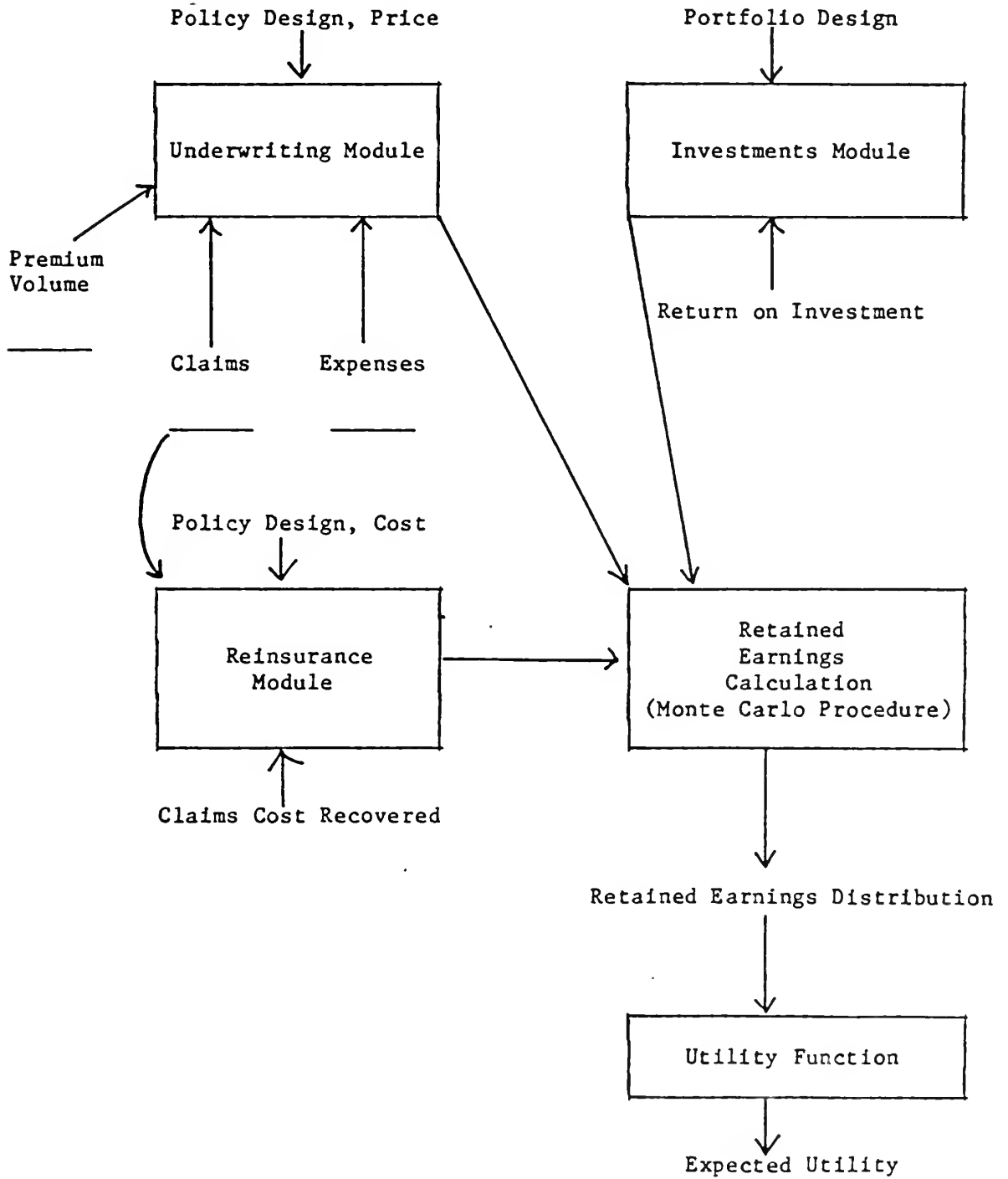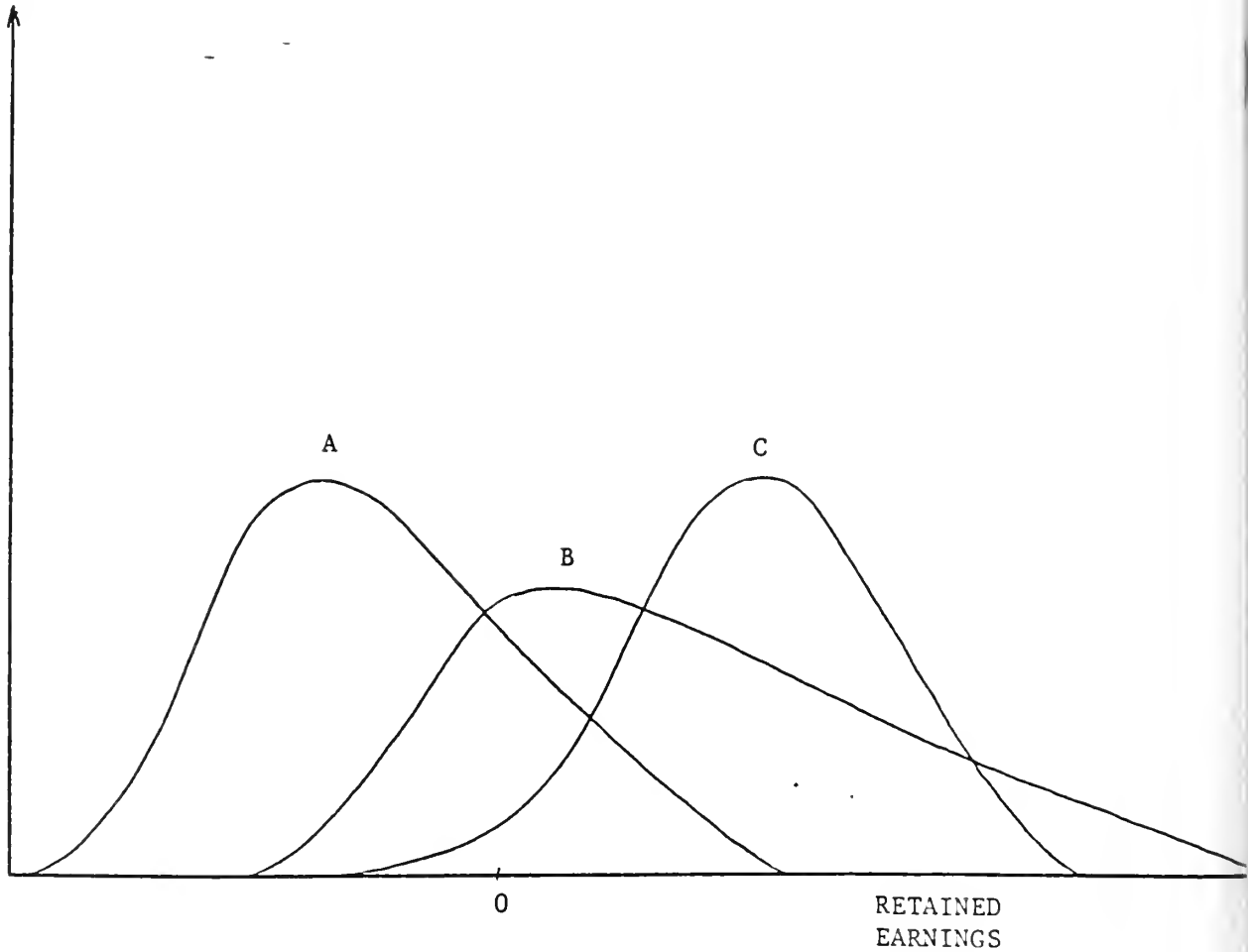
Figure 4

Figure 5

Retained Earnings Distributions for
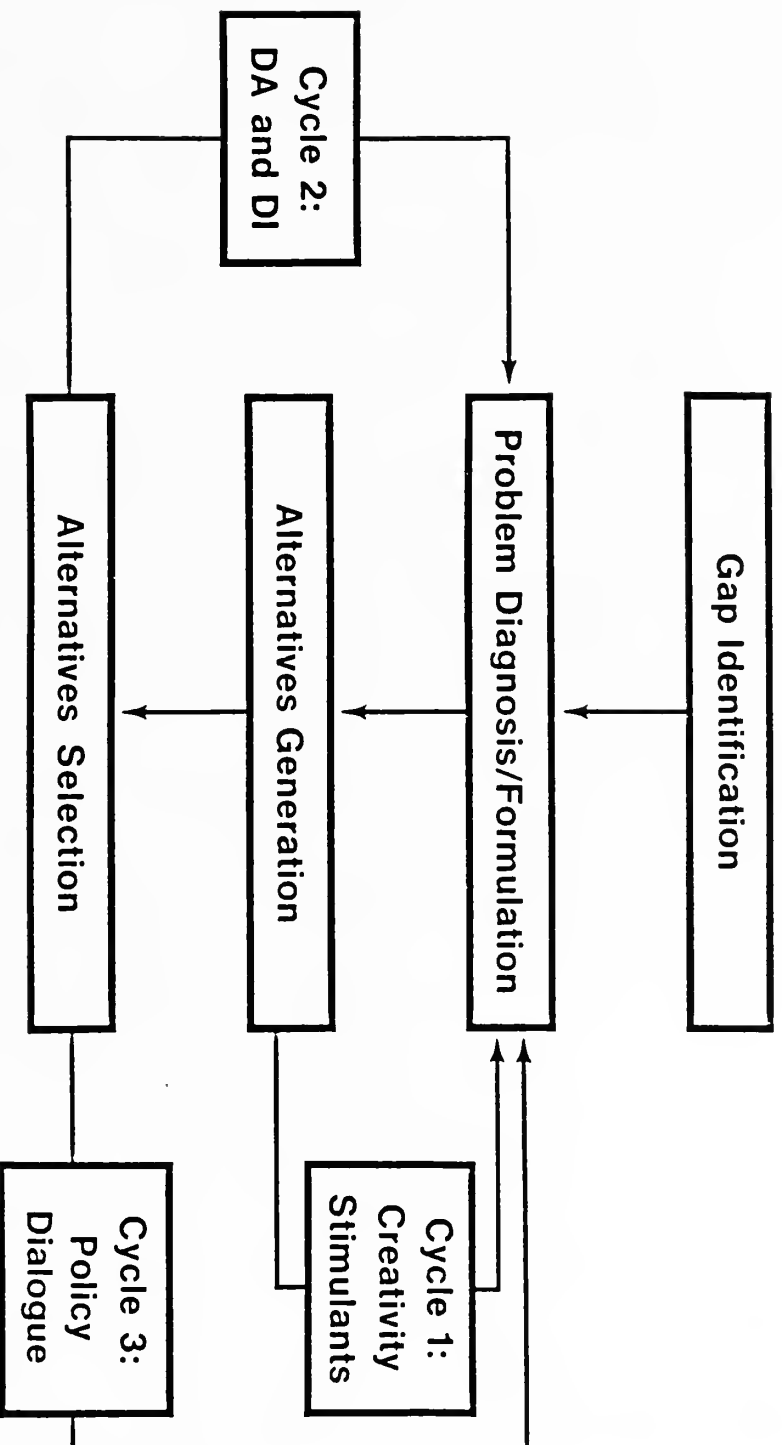### Alternative Strategy Sets

Probability

Note that strategy A is stochastically dominated. In cases where
stochastic dominance can not be used to eliminate all but one strategy,
expected utility rules can be used.

Figure 6

APPROPRIATE USES OF DECISION AIDS IN THE
PROBLEM FORMULATION/DECISION-MAKING PROCESS

Source: Schwenk and Thomas (1983a)