FITTING DECISION AIDS TO SITUATIONS: ORGANIZATION DESIGN ISSUES[1]

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Abstract

A major obstacle to aiding decisions effectively in organizations is that the aid is not adapted to the organization. The appropriate aid to use, if any, and how to use it, varies with the institutional context, including decision processes, interests to be served, reward structure and communication channels. We explore precepts for aid organization based on our consulting experience. We then specify further research to develop and authenticate general guidelines.

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1 PROBLEM BACKGROUND

Early in the search for a federal nuclear waste site—which is still ongoing—DOE had to decide on a short-list of candidate sites. Based on a major decision analysis effort (DOE 1986), DOE staff recommended three sites, which the Secretary of Energy rejected, amid much political controversy. Senior DOE staff confided that they would never use decision analysis again. This clear decision aiding failure appeared to be due to organizational, not technical, flaws. The organization of the aiding effort impeded critical communication between aiders and decider. Moreover the reward system favored technical excellence over usefulness (Brown, in press). (The study indeed won a prestigious professional award). "The operation was a great success but the patient died".

Such experience is not unusual and I believe that poor fit between organizations and decision aids accounts for these not realizing their substantial potential to enhance institutional decision making (Grayson, 1973; Simon, 1988). This paper attempts to contribute to solving that problem.

1.1 Decision aid as internal organizational action

According to Simon (1973) the central function of organizations is to take purposive action. For example, a company invests to make money; an agency disposes of nuclear waste to protect the public efficiently; the military launches attacks to destroy the enemy safely. These are external organizational actions, and their performance largely determines the success of the organization—however that is understood—and even its survival.

Internal measures, notably the design of decision processes, are (ideally) designed to support external action—not always effectively. Use of decision aids such as OR, decision analysis, expert systems and computerized decision support systems. The success of decision aid depends on many factors, such as how high the stakes, how clear the options, how perplexing the comparative evaluation, available resources and technical considerations (e.g. short reaction time in high intensity warfare). Our focus here, however, is on distinctively organizational factors, such as reward system and managerial decision processes.

1.2 Adapting decision aid to organization

Organizational design issues bearing on aid effectiveness include:

- Should any decision aiding procedure be used and of what kind?
- Is its role to enhance or to justify decisions?
- Where in the organization should it be located?
- Who should be involved in decision aiding and how?
- Should its use be required/optional/reviewable?
- Should an aid indicate a "preferred" external action (or, say, merely alert decider a danger)?
- Should that action be mandated/for information only/disclosed publicly?

Specific decision aiding precepts can be broad, narrow or situation specific. A broad precept covers a wide rang of cases, such as: “Decision aid staff should report to the decider they are to aid, except where the technical skills needed can only be provided centrally.” A narrow precept covers a few situations, such as: “Regulatory agencies, subject to adversarial scrutiny, should seek to issue reviewable rationales that can justify their decisions without relying on controversial judgments”. A situation-specific precept would be typified by: “If the administrator of EPA wishes to avoid Congressional interference, he should not disclose how an EPA decision was derived from decision analysis”.

Improving the organizational fit of decision aids through sound aid organization precepts calls for prescriptive research, which has been largely neglected, compared with the normative and descriptive research that it fuses (Bell et al. 1988; Brown and Vari 1992). The scientific and consulting communities have noted the need for, and lack of, prescriptive research, as implied by their comments:

- "Organizational foolishness" is prevalent (March and Shapira 1982).
- Institutions, including governments, are so far from a "rational unitary actor" model as to have risked World War III in the Cuban missile crisis (Allison 1971).
- Decision analysis and management science more generally, have as yet done little to help (Grayson 1973; Ulvila and Brown 1982; Brown 1989b).
- The state-of-the-art is still primitive (Brown 1991), though some would dissent (Howard 1991).
- Basic research to enhance decision-aiding art is lacking [2] (Simon 1988).
- "The political nature of organizational decision making (is) the cause of the relatively limited adoption of decision analysis" (Thomas 1989).

1.3 Limitations of organizational prescription

It is unlikely that prescriptive theory can ever, intrinsically have the unity and compactness of descriptive theory——in *any* field. Though what should be done in any particular situation may be clear, it resists generalization. Prescription for *organizational* action, whether internal or external, is especially elusive, because

- circumstances are more complex, variable over time and ambiguous than for individual decision-making.
- Evaluation of performance evaluation is never entirely user-independent and therefore universal.
- Prescription has to take all relevant considerations into account (whereas description can be partial);
- Appropriate precepts may be highly conditional: "if this, and this, and this, then do that," such that its generality is highly circumscribed.

Prescription may depend radically on whose interests are being served. As Mort Halperin has observed "Where you stand depends on where you sit". Requiring the executive branch of government to publicly justify its actions with some kind of decision analysis may be appealing

[2] Also personal communications to author March 1981, Simon 1987).

to Congressmen wishing to assert their control and the public wanting accountability, but anathema to bureaucrats whose freedom of action it limits (Porter, 1989).

Organizational prescription generally also changes more over time than for immutable human nature. (Ageless organizational precepts like Machiavelli's on the art of government are rarer than Ovid's personal advice on the art of loving.) Simon (1987) has observed that "proverbs of administration" come in contradictory pairs (on a par with "he who hesitates is lost" and "look before you leap"). There may only be suggestive regularities, not universal truths.

1.4 State of the art

By and large, relevant theory in the organizational literature has been descriptive, rather than directly prescriptive. Others have made significant contributions to understanding how organizations make decisions, what stands in the way of their effectiveness, and indeed what constitutes effectiveness (Staw 1980; Scott 1981; Levinson 1974; Heller 1988; Hackman and Morris 1975; Goodman et al. 1979; Alderfer 1976). March and Simon, for example, have found, that most organizations are driven by attention-allocation rather than optimizing, as in "garbage can" and "funny soccer" game metaphors (March and Shapira 1982, March and Simon 1958; Cohen, March and Olson, 1972).

Disciplines other than strictly organizational have also produced relevant descriptive theory[3]:

- sociology, the relation between authority, interaction and sentiment (Homans 1950);
- social psychology, on social judgment (Hammond et al. 1975);
- administrative science, on radical vs. adaptive decision making (Lindblom 1979)
- anthropology, such as Radcliffe-Brown's (1952) work on structural functionalism.

The literature on prescription *specific* to decision aiding appears to be largely limited to:

- Prescriptive asides during a descriptive thesis (Simon 1979);
- Special-purpose guidelines for limited practical problems such as the design of R&D organizations. Lawrence and Lorsch (1968) found that decision-aiding technology is more likely to be adopted in organizations if an interpretive group with an intermediate orientation is interposed between technicians and deciders.
- Informal tips for management scientists (Ackoff 1969).
- Implementing decision analysis in business (Brown 1970).

[3] Any explicitly prescriptive orientation has usually been aimed at organizational issues not directly related to decision aiding (Hedberg at al. 1976). These include command structure (e.g. Jacques seminal work on the time span of discretion) and leadership (Vroom and Yetton 1973). Formal models have been developed and studied for special cases. For example "team" theory (e.g., Marschak and Radner, 1972; McGuire and Radner, 1972) provides formal, prescriptive models of the decision behavior of those rare organizations those members have like interests and objectives——only their information varies.

Decision theorists have made limited efforts to address our objectives directly (Phillips 1980; Horowitz 1989; Hogarth 1981). Thomas (1989) notes that using the analyst in a trainer role can promote policy dialogue, which may be at a high premium in certain organizational situations.

1.5 Scope of paper

This is an attempt to develop an effective process of prescribing aid organization. Learning how to fish (prescription methodology) is more important than catching fish, though we need to catch a few (develop actual prescriptions) to make sure we know how. We hope some of these fish will prove tasty (useful precepts).

Two basic phases of deriving prescriptive principles—possibly interleaved—are considered here:

- Exploring promising hypotheses through "passive" intrusive participant observation (as a by-product of consulting).
- Confirming and developing such hypotheses through "pro-active" research dedicated to that task.

The first exploratory phase of research is inductive: to exercise and "formatively validate" methodological hypotheses in the context of current and past decision aiding problems, including risk management, military and environmental policy consulting cases. Part 2 summarizes results of this work. This phase may be considered "The first step of a journey of 1000 miles".
It attempts to lay the stage for a follow-up research program to develop and authenticate more general guidelines that an organizational designer can draw on with some confidence. Part 3 describes some promising avenues for such research.

2 RESULTS OF EXPLORATORY RESEARCH

2.1 Prescription based on experience

2.1.1 Experience based hypotheses

The exploratory phase pulls together a number of largely anecdotal research strands, stimulated by many years of active decision aiding. As a consultant to government and business, I have observed and responded to the organizational complications of using decision aids in a wide variety of cases. This has suggested practical insights from lessons learned, including a number of tentative hypotheses (Porter 1989, Fiske 1980).
Since useful methodology has to clear all implementation hurdles--logical, psychological and institutional—aid organization prescription needs to deal parsimoniously with a large number of issues. It is thus "divergent", as contrasted with more traditional "convergent" research. The focus is just as sharp, but it is directed at a single operational problem, rather than on a single disciplinary topic (Brown 1989a).[4]

[4] The approach is illustrated by Brown's (1990) work on assessment uncertainty technology.

The primary research approach has been inductive: to exercise methodological hypotheses on a sampling of real current and past decision aiding problems. I have taken advantage of consulting assignments to do, in effect, obtrusive participant observation of the evolving decision aiding process, and to demonstrate the feasibility and relevance of hypotheses. These may suggest or confirm more general hypotheses, which can later serve in a deductive role. The limiting conditions and caveats of individual cases are relaxed to seek progressively more general prescriptive hypotheses, which can be tested elsewhere. (C.f. Newton inducing laws of gravity from falling apples, and later using them deductively).

Other decision-aiders' cases, drawn largely from an older survey of twenty business organizations to study the factors influencing the successful adoption of decision aids (**** 1970), add scope, objectivity and credibility to my own.

2.2 Examples of inductive process

Motivational impediments in designing a battle aid. A representative example of this research mode is provided by a real consulting case. Navy chiefs were concerned that submarines in fleet exercises waited too long to fire their torpedoes at "enemy" submarines. I was charged with developing decision aids to enable commanders to make better decisions. Decision analysis confirmed that decisions were indeed poor. Typically, firing torpedoes was delayed so long that risk of counter-detection and destruction outweighed any improved chance of finding and destroying the enemy on any plausible assessment of probabilities and values.

However, submarine commanders resisted a "better" time-of-fire aid. Probing, through interview and observation, I surmised that the problem was not decision skill but motivation: commanders were evaluated on how accurately they pin-pointed the enemy's location, rather than by whether they would have survived. So I recommended the Navy abandon this type of decision aid, in favor of bringing the reward structure into line with national interest.[5]

This experience prompted consideration of a more generic prescriptive hypotheses about the role of motivational field:

- Conflict of interest might be reduced if local military commanders in general are required to justify critical decisions with analysis that lays bare value judgments--and perhaps inhibits them from acting on indefensible motives. This hypothesis might be tested through comparable real war case studies of the Pueblo, Stark and Vincennes incidents,

[5] I was not qualified to make a firm prescription on reward structure, a broader issue that depended on more considerations than I was privy to. Nevertheless, I felt able to predict the probable impact of motivational field on the quality of such external time-of-fire actions. In fact, further consideration persuaded me that current practice might not, after all, be harmful. In a real war commanders might be motivated to fire too *soon*, and their contrary bias from exercise experience might just cancel this one out. In any case, these were hypotheses that could be tested by others through convergent empirical research.

which were free of the artificiality of fleet exercises (which are analogous to laboratory experiments on individual human behavior).

- Aid designers should address a checklist of issues such as: Whose cooperation is needed? What do they care about? How will the aiding option impact on their interests?

Culture-dependent aiding prescription. A study of Russian and American decision aiding in the Arctic environment provided a test bed for some hypotheses related to differences between countries (Flanders et al. 1999)

The use of reviewable rationales (such as decision analysis), for controversial decisions may be suited to the formal regulatory requirements and structured litigiousness of the American system; but not to an anarchic and vulnerable new Russian bureaucracy. In a military context, American battle commanders are required to use a simple form of decision analysis to select among a few "courses of action" to be approved by higher command. This requirement might be even better suited to the more centralized Russian system. Although the course of action may be specified as a "once-and-for-all" commitment (e.g. "attack from the North"), in practice, US commanders can and do commit incrementally and use on-the-spot discretion to change course if developments warrant. This may not work in an authoritarian Russian culture (Staw 1976).

Historical precedent in decision aiding practice may be a distinguishing setting variable. March and Shapira (1982) argue that an organizational practice is more acceptable when it has become a "standard operating procedure". The cost-benefit analysis of the McNamara era may have smoothed the path for decision analysis in US government more generally; Russia may have no such facilitating precedent.

2.3 Preliminary hypotheses

Many of the insights developed hinge on the “motivational field” within which key organizational players operate, as in the above battle aid case. Figure 1 presents a view on how the motivation of the decision aider depends on organizational design and in turn influences the effectiveness of the aid. The various influences are discussed in detail in **** (in press).

FIGURE 1

The following are illustrative of candidate prescriptive hypotheses that may be broadly applicable (with notes on supporting argument):

Staffing policy. Decision aiding technology should generally be offered within an organization by technical staff that reports to whomever makes the decisions. Argument: centralization may enhance the quality of external actions recommended, but render them less likely to be adopted (Brown 1970; Carter 1972; Galbraith 1977).

Role of decider. Decision aid users should be intimately involved in the decision to implement decision-aid technology and in its development. Argument: it increases acceptance of a decision and facilitates implementation (Adelman 1982; Vroom and Yetton 1973.

Actions suggested by procedures (like decision conferences) that centrally involve people who are to take action are more likely to be implemented than by analyses involving only technical staff.

Aid design. Decision aids should be designed to be compatible with the decision makers' approach to decision making. Example: Wolek (1975) cites a typical case where a "rational system" for selecting R&D projects was formally adopted, but never used, because it conflicted with the personal leadership style of the company's president.

To obtain prediction and value inputs to a decision analysis, an anonymous, mechanized procedure (such as Delphi) is preferred in a politicized public context (it minimizes political heat by appearing unable to be manipulated) and if the group is heterogeneous in status (it reduces intimidation). Otherwise a more informal, interactive pooling of experts (such as nominal group technique) is preferred, especially, if the experts have access to different sources of information. It enhances quality of external action, by bringing more information into play. (Fischer 1972).

Qualitative or analog procedures are preferred to those requiring numerical manipulation (e.g. maximizing probability weighted utility) if people who supply the inputs or use the output lack a quantitative culture, except in controversial cases where having a reviewable rationale is overriding.

Constituency conditioning. It is not uncommon for congressmen to urge that major executive branch decisions be supported by something like reviewable decision analysis. Executive branch officials, by the same token, resist it on the grounds that it gives Congress unwonted power to intervene in executive branch affairs (Porter, 1987). The acceptability of an aid depends on the constituency served (i.e., who has to be impressed for it to be adopted).

When DOE is picking a nuclear dumpsite, the agency's interests may be best served by a binding contingency rule controlled by data still to be gathered. Argument: it promises to reduce political heat when the time comes. On the other hand, society's interests may be best served by delaying commitment until the last minute. Argument: that takes advantage of important unanticipated developments and so improves the decision.

Disclosing decision rationale. If industry is entrusted with large budgets to research a major decision--such as the billions earmarked for nuclear site characterization--government should impose an explicit *data gathering* decision rules to discipline resource allocation. Argument: it avoids contractors' commercial interests perverting efficient use of scarce public funds.

Government risk regulators should avoid publishing any formal decision rationale before a controversial choice, if avoiding "administrative hassle" and preserving discretion is more important to them than demonstrating accountability to the public.

Aider expertise. If difficult analytic concepts, such as second order probability, are to be used, thoroughly trained deciders are needed. (Otherwise concepts will be mis- or not applied, even if logically essential, for example in determining when enough supporting research has been done.

2.4 Further divergent research

The above experience-based start at developing a body of usable organizational precepts can be characterized as follows: Available methodology is applied to practical problems, identifying logical and practical deficiencies and lessons learned; these are incorporated into methodology to be upgraded for the next round of application. In engineering design cycles this as referred to as the "build-test-build-test" cycle. A great deal more can be done along these lines, especially by other researchers whose varied perspectives can compensate for limitations and biases in my own.

3 SUGGESTIONS FOR CONVERGENT CONFIRMATORY RESEARCH

Turning exploratory precepts like the above into a firmly based set of guidelines can be advanced by quantified models whose inputs have passed some reviewable validation.

3.1 A decision theoretic paradigm

Personal decision analysis (PDA). The established conceptual paradigm for developing prescription for an individual decider is personalized decision analysis (PDA). It numerically characterizes an individual's options, uncertainties and preferences (Raiffa, 1968), and the preferred choice corresponds to maximum expected (probability weighted) utility. PDA is a well-established research field in decision theory and cognitive psychology (von Winterfeldt and Edwards 1986).

However, it is common practice among decision analysts to implement PDA without adaptation for organizational clients. The fact that there is ambiguity, to say the least, about what exactly constitutes the organizational counterparts of choice, probability and utility is commonly finessed by the analyst imputing his own "reasonable" determinations to the organization; or by taking some individual (e.g. company president) to represent the organization.

Organizational decision analysis (ODA). Brown (1982) has suggested an adaptation of PDA to organizations, which we might call organizational decision analysis (ODA). It takes account of the critical multiple/ambiguous constituency and decider problems. Prescription may be radically different depending on whose interests are being served: "owners", participants or society at large. Keeney's and Kirkwood's (1975) response to Arrow's impossibility theorem, relates to group aggregation of individual utilities, Howard (1975) offers an interpretation of social utility.

Decision analysis as an aid (Internal action). We do not assume that ODA (or PDA) should be used as a decision aid in the organization itself. A busy business layman may prefer the Analytic Hierarchy Process (Saaty 1978) to decision analysis if any logical disadvantage is more than outweighed by the appeal of inputs easier to provide. On the other hand, the rigorous reviewable rationality of decision theoretic evaluation may make it appropriate for *we technical people* to evaluate decision aids with before a scholarly audience

3.2 Matching aid to organization context

Certain features of an organizational setting put a premium on different kinds of aid property, and these in turn favor different aiding strategies—including using no aid at all. Brown and Ulvila (1977) have proposed a general scheme for matching analytic approaches to decision situations, but not specialized to organizational design.

It involved mapping a taxonomy of problem situations onto a taxonomy of decision aid performance requirements; and mapping these onto a taxonomy of decision aiding options (including organizational design as a small subset). They illustrated the process with:

- a simple option of broad interest, viz. how much decision analysis effort (if any) to devote to a decision problem, as a function of its features (not limited to organizational setting);
- a sampling of matchings for a wider range of options;
- the prescription of a complete decision aiding strategy in three illustrative case studies.

Figure 2 lists some illustrative items in the three-way taxonomy.

There is not space here to explore these linkages in any detail, and in any case there is no hard-and-fast mapping possible, since the total determinants of an appropriate decision-aiding strategy are immensely complex (including the characteristics of any given decision problem).

FIG 2

3.3 Evaluating organizational options.

Within an ODA paradigm Brown (1982) has proposed a special purpose structuring scheme to permit internal actions, decision aiding organizational design in particular, to be evaluated in a given organization context. It models, not necessarily formally, causal linkages between:

- design variables (e.g. nature of aid, how used, organization adaptation);
- setting variables (e.g. nature of organization, external circumstances, culture);
- mediating variables (institutional fit, implementer satisfaction);
- performance variables (e.g. quality of resulting external actions, in terms of performance variables such as; public protection, employee morale, cost, individual effectiveness).
- aggregate evaluation (taking relative importance of performance variables into account).

Figure 3 illustrates a somewhat standardized structure for evaluating whether DOE should use publicly disclosed decision analysis to support nuclear waste management decisions. Essentially, the internal options affect the relevant performance variables, notably the resulting

external decisions, directly or via intervening variables. Features of the organizational setting may themselves affect the corresponding linkages. Aggregate evaluation depends on the relative importance of the performance variables, which depends critically on the constituency served, as we have seen.

Although the model should be useful without explicit quantification, causal dependencies between variables can be expressed mathematically, such that the impact of alternative design on aggregate evaluation, given setting can be calculated. In principle, hierarchical regression or influence diagrams, producing probabilistic output evaluation would be appropriate (Shachter 1986). However, in their common forms, these procedures may be impracticably burdensome and perhaps unnecessary. Simpler qualitative algorithms of the type developed by Russian decision scientists may prove appropriate (Flanders et al. 1999).

Fig 3

3.4 Substantive content of evaluation model

Any actual design evaluation--generic or case-specific--requires explicit or implicit characterization of linkages in the model, which may be descriptive (organizational practice), predictive (what it commonly leads to) or evaluative (relative importance). Issues include: motivational field, "turf" conflict, cultural mismatch, myths of executive certainty, determinants of relative power and standing, and non-rational administrative processes. The weakest form of substance is simply prioritizing variables in a preset menu, e.g., which mediating or performance variables are primarily affected and which are most important in a given type of case.

Predictive building blocks. To assist in predicting performance given design, empirical default judgments can be developed for pieces of the evaluation frame corresponding to a position on the above issues. These are descriptive, not prescriptive, propositions.

Due to the highly situation-specific nature of aiding prescription, there is little prospect of general-purpose quantitative models. The most that can be hoped for is somewhat general-purpose model structures (along above lines) with judgmental inputs informed by broad research-based generalizations.

Descriptive theory is typified by prescriptively relevant organizational theory, such as Cohen, March and Olsen's (1972) garbage can, Allison's (1971) Bureaucratic process models of decision making, Watson's (1977) empirical research on social utility functions, and directed social theorizing and field work generally.

- The Lorsch-Lawrence (1967) theory of integration and differentiation suggests that decision-aiding technology is more likely to be adopted in business organizations if an interpretive group with an intermediate orientation is interposed between technicians and deciders.

- Action suggested by procedures (like decision conferences) which centrally involve people who put a decision into effect are more likely to be implemented than by analyses conducted primarily by technical staff.
- Government bureaucracies care more about how internal action rewards their individuals and sub-groups than about the social value of the external actions it aids.

Social science cannot yet serve as the primary source of hypotheses, but rather as a help to corroborate, explicate and refine hypotheses generated by direct experience and observation. The fact that a well-regarded recent book of readings on "Organization and decision theory" (Horowitz 1989) makes almost no reference to organization or other social theory literature suggests there is not yet much overlap.

Values. Generalizations about values and their relative importance are constituency-specific. A performance variable like transparency of an executive agency's decision rationale may be of positive value to Congress and the general public, but negative to the agency itself. (The agency may not wish to reveal that empire building, reduction of "administrative hassle" and other politically embarrassing considerations influence its external decisions). A related common issue is the relative importance of the quality and defensibility of external decisions. Defensibility may favor a crude mechanical decision rule over the exercise of sound judgment (e.g. a process- over a performance-based test of regulatory compliance).

Candidate value hypothesis: "Government bureaucracies care more about how an aid affects the rewards of individuals and sub-groups than about the social value of the external actions it aids".

3.5 Validation.

Implementing and developing validation methods requires major experimentation and monitoring (Levin and Minton 1986). This might involve

- computerized recording of the use and implementation of aids
- extensive expert evaluations (Adelman et al. 1985).
- Empirical validation based on principles for pre-testing unreplicable organizational innovations
- measuring the quality of decisions after the fact (Brown and Campbell 1990),
- "build-test-build-test" formative validation common in engineering design.
- principles for pre-testing unreplicable organizational innovations (Brown and Watson 1977).

Surveys among organizations active in decision aiding, along the lines suggested in Brown (1989b), could establish the room for improvement in unaided decision processes and the impact of past aiding efforts. Although my colleagues and I have some experience of this type of research (**** 1970; **** and ***1982; **** and **** 1975), it is probably best done by other than decision aiders themselves, for conflict-of-interest reasons.

REFERENCES

Ackoff, R. L. The uses and abuses of operations research. *Management Science*, 1969, *14*(4), B147-B156.

Adelman, L., Donnell, M.L., Phelps, R.H., and Patterson, J.F. An iterative Bayesian decision aid: Toward improving the user-aid and user- organization interfaces. *IEEE Transactions on Systems, Man, and Cybernetics,* 1982, SMC-*12*(6), 733-742.

Alderfer, C. Change processes in organizations. In M.D. Dunnette (Ed.), *Handbook of I/O Psychology*. Chicago, IL: Rand McNally College Publishing Company, 1976.

Allison, G.T. *Essence of decision: Explaining the Cuban missile crisis.* Boston, MA: Little, Brown and Company, 1971.

Brown, R.V. The state of the art of decision analysis: A personal perspective. *Interfaces,* **22**, 6 Nov-Dec 1992, 5-14.

Brown, R.V. Do managers find decision theory useful? *Harvard Business Review,* May-June l970, 78-79.

Brown, R.V., and Ulvila, J.W. *Selecting analytic approaches for decision situations* (Revised Edition). McLean, VA: Decisions and Designs, Inc., December l977. (NTIS. AD A047965 Vol. I; AD A047880 Vol. II; AD A048228 Vol. III).

Brown, R.V. Prescriptive organization theory in the context of submarine combat systems. In *Proceedings of the 5th MIT/ONR workshop on C^3 systems (LIDS-R-1267).* Cambridge, MA: Laboratory for Information and Decision Systems, Massachusetts Institute of Technology, December 1982, 149-155.

Brown, R.V. Commentary on "Implementing Decision Analysis." In Ira Horowitz (Ed.), *Organization and Decision Theory*. Kluwer-Nijhof Academic Publishers, 1989a.

Brown, R.V. Toward a prescriptive science and technology of decision aiding. *Annals of Operations Research, Volume on Choice Under Uncertainty, 19,* 1989b, 467-483.

Brown, R.V. and Vari, A. Towards an agenda for prescriptive decision research: The normative tempered by the descriptive. *Acta Psychologica,* 1992.

Carter, R.E. What are the risks of risk analysis? *Harvard Business Review,* 1972, N4, 72.

Cohen, M.D., March, J.G., and Olsen, J.P. A garbage can model of organizational choice. *Administrative Science Quarterly,* 1972, *17*.

Fischer, G.W. *Four methods for eliciting group judgments.* Falls Church, VA: Decision Science Consortium. 1972

Fiske, F. *The science of making up your mind.* Transcript of National Public Radio Broadcast, Decision Science Consortium, Inc., January 8, l980.

Flanders NF, Brown RV, Andre'eva E. Larichev OI, Justifying Public Decisions in Arctic Oil and Gas Development: American and Russian Approaches. *Arctic*. Vol. 51, no. 3, p. 262-279. September 1998.

Galbraith, J. *Organization Design*. New York: Addison-Wesley, 1977.

Grayson, C.J. *Management science and business practice.* Harvard Business Review, July-August, 1973.

Goodman, P.S., Conlon, E., and Bazerman, M. Institutionalization of planned organization change. In Staw, B.M., and Cummings, L.L. (Eds.) *Research in organizational behavior* (Vol. II) (NR 180-884). Greenwich, CT: JAI Press, 1979.

Hackman, J.R., and Morris, C.G. Group task, group interaction process and group performance effectiveness: A review and proposed integration, in L. Berkowitz, Ed. *Advances in Experimental Psychology, 8* 45-109, 1975.

Hammond, K.R., Stewart, T.R., Brehmer, B., and Steinmann, D.O. Social judgment theory. In M.F. Kaplan and S. Schwartz (Eds.), *Human Judgment and Decision Processes.* New York: Academic Press, 1975.

Hedberg, B.L., Nystrom, P.C., & Starbuck, W.H. Camping on seesaws: Prescriptions for self-designing organizations. *Administrative Science Quarterly*, 1976, *21*, 41-65.

Heller, Frank A. *Decisions in Organizations.* London: Sage 1988.

Hogarth, R.M. "Decision Making in Organizations" *Proc. Biennial Conference on Subjective Probability, Utility and Decision Making*, North Holland, 1981.

Homans, G.C. *The human group*. New York: Harcourt, Brace, 1950.

Horowitz I. *Organization and Decision Theory* Boston: Kluwer 1989.

Howard RA Decision analysis: cult or heresy? . *Interfaces*, **22**, 6 Nov-Dec 1992, 5-14.

Keeney, R., and Merkhofer, M. Siting nuclear waste repositories. *Risk Analysis, April 1988 [?]*

Lawrence, P.R. and Lorsch. J.W. *Organization and environment.* Homewood IL: Irwin, 1967.

Levinson, H. *Organizational diagnosis.* Harvard University Press, 1974.

Lindblom, C.E. Still muddling, not yet through. *Public Administration Review, 39*, 517-526. 1979.

Lorsch and Lawrence, *Differentiation and integration in industrial organizations*, 1968.

March, J.G., and Simon, H.A. *Organizations*. New York, NY: Wiley, 1958.

March, J.G., and Shapira, A. Behavioral decision theory and organizational decision theory. In Ungson, G.R., and Braunstein, D.N. (Eds.) *Decision-making: An interdisciplinary inquiry*. Boston, MA: Kent Publishing Co., 1982.

March, J.G. Decisions in organizations and theories of choice. In A. Van de Ven and W. Joyce (Eds.), *Assessing Organizational Design and Performance*. New York: Wiley, 1981.

Marschak, J., and Radner, R. *Economic theory of teams.* New Haven, CT: Yale University Press, 1972.

McGuire, C.B., and Radner, R. (Eds.) *Decision and organization: A volume in honor of Jacob Marshak.* New York, NY: American Elsevier, 1972.

Phillips, L.D. Organizational structure and decision technology. *Acta Psychologica*, 1980, *45*.

Porter, H. Profile: A Decision Analyst Reflects on His Work. *Chance*, *2*, No. 4, 38-40, 1989.

Radcliffe-Brown, A.R. *Structure and function in primitive society.* NY: Free Press, 1952.

Raiffa, H. *Decision analysis: Introductory lectures on choices under uncertainty.* Addison-Wesley, 1968.

Saaty, T.L. Modeling unstructured decision problems: The theory of analytic hierarchies. *Mathematics and Computers in Simulations XX*. Amsterdam: North-Holland, 1978.

Schacter, R.D. Evaluating Influence Diagrams. *Operations Research*. 34. 1986.

Scott, W.R. *Organizations: Rational, Natural and Open Systems*. Englewood Cliffs, N.J.: Prentice-Hall, 1981.

Simon, H.A. Report of National Academy of Sciences Panel on Research needs for decision making. In *Impact and potential of decision research on decision aiding.* (Report of a Department of Defense Research Roundtable Workshop sponsored by Decision Science Consortium, Inc. and the American Psychological Association.) APA, 1988.

Simon, H.A. Rational decision making in business organizations. *American Economic Review*, 1979, *64*(4), 493-513.

Staw, B. Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. *Organizational Behavior and Human Performance*, 1976, *16*, 27-44.

Staw, B. Rationality and justification in organizational life. In B.B. Staw & L.L. Cummings (Eds.), *Research in Organizational Behavior* (Vol. 2). Greenwich, Conn.: JAI Press, 1980a.

Thomas H. Implementing Decision analysis: problems and opportunities. In *Organization and Decision Theory* Ed. Horowitz I. Boston: Kluwer 1989.

Ulvila, J.W., and Brown, R.V. Decision analysis comes of age. *Harvard Business Review*, September-October l982, l30-l4l.

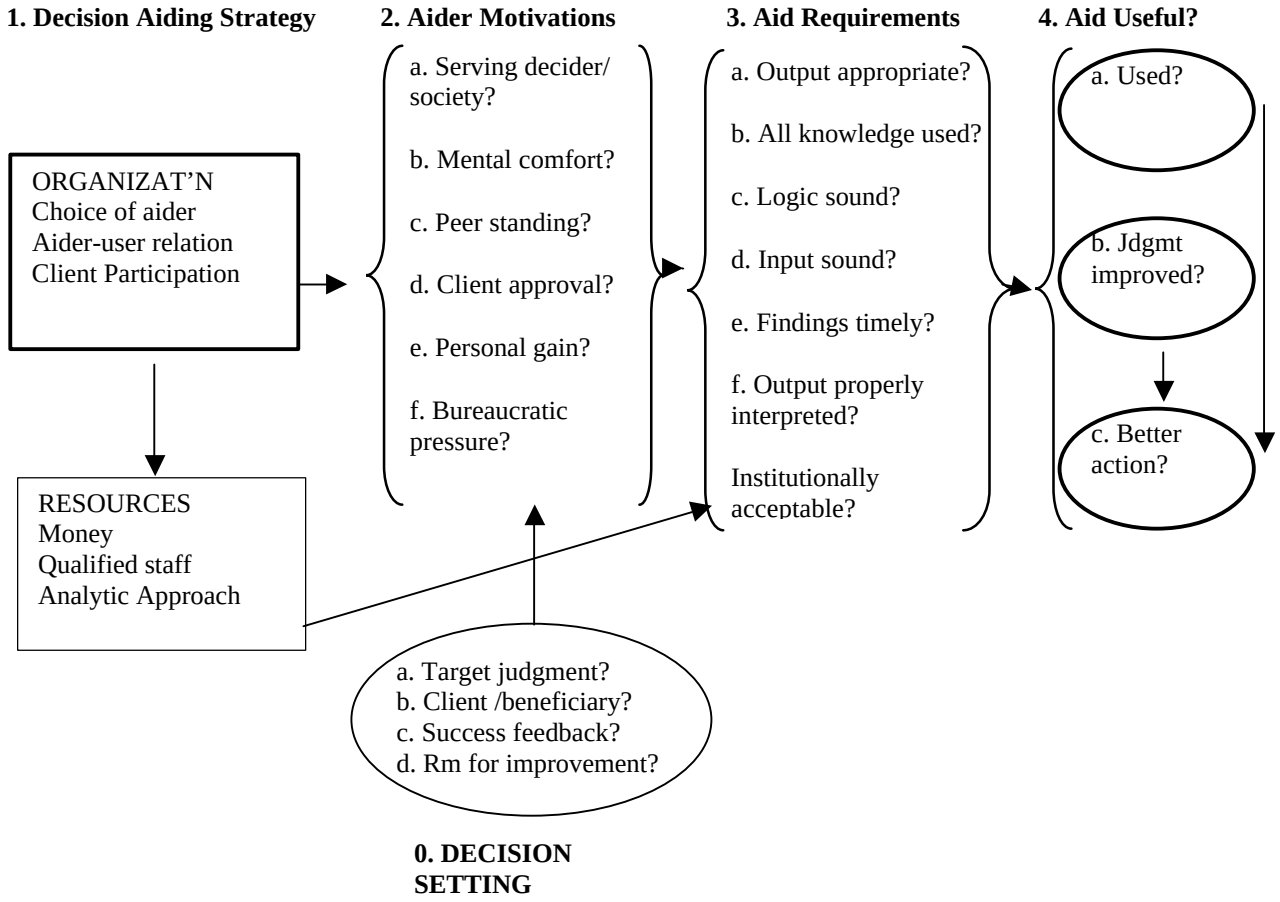
U.S. Department of Energy. *A multiattribute utility analysis of sites nominated for characterization for the first radioactive-waste repository: A decision aiding methodology, DOE/RW-0074.* Office of Civilian Radioactive Waste Management, Washington, D.C., 1986.

von Winterfeldt, D. and Edwards, W. *Decision analysis and behavioral research.* New York: Cambridge University Press, 1986.

Vroom, V.H., and Yetton, P.W. *Leadership and decision-making.* Pittsburgh, PA: University of Pittsburgh Press, 1973.

Wolek, F.W. Implementation and the process of adopting managerial technology. *Interfaces*, 1975, *5*, 38-46.

Figure 1. Decision Aid Usefulness: Strategy and Motivation*



*Adapted from ****, in press.

Figure 2. Influence of Organizational Setting on Decision Aiding Strategy

Organizational Features →	*Aid requirements* →	*Aiding Strategy*
Type of institution Business Government	Enhanced performance External decisions	Any aid? Scale? ($)
Dispersed Decision authority? Sources of information	Aid features Transparent Confidential Defensible Acceptable Manipulable	Form of output Decision? Inference? Partial evaluation?
Decision process Prescribed? Effective? Aid-compatible?	Cost Time Money Administrative hassle	Mode of use Private? Optional? Reviewable?
Organizational structure Constituencies? Centralized?	Organization process Policy dialogue Consensus building Commitment to implementation	How offered Central service? User collaboration?
External pressures On performance On process? Controversial options		Source of input User judgment? Expert judgment? Database? Analyst only?
Internal pressures Interest conflict? Time stress? Power, turf, status Morale		Analytic approach PDA? Model intensive? Judgment intense? Comprehensible? Simple approximation
Staff Analytic culture? Individual motivations?		Role of analyst Expert Trainer

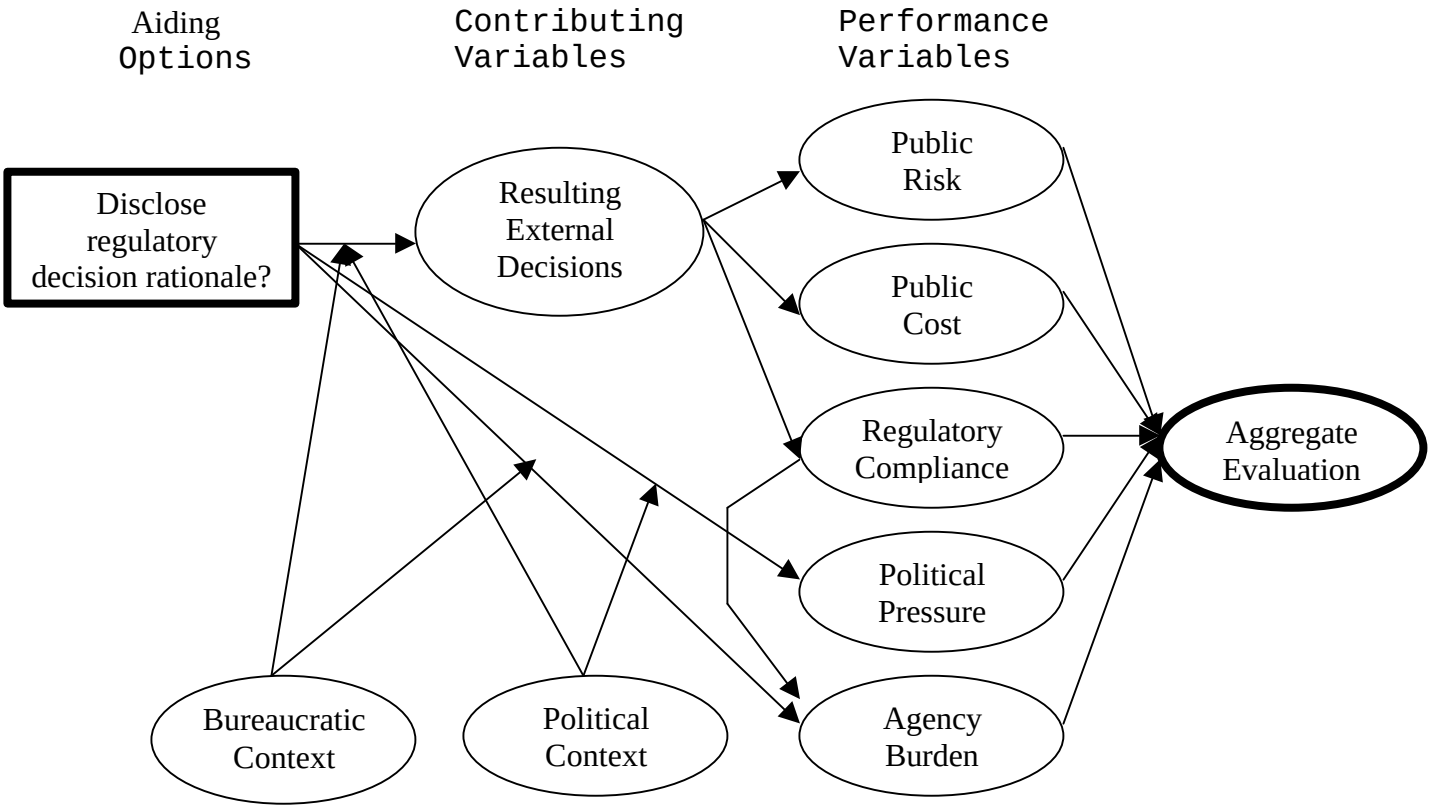


Figure 3. Evaluating aid organization precepts