

Heathens, Heretics, and Cults: The Religious Spectrum of Decision Aiding

RONALD A. HOWARD

*Department of Engineering-Economic Systems
Terman Engineering Center
Stanford University
Stanford, California 94305-4025*

Over the past quarter century decision analysis has helped decision makers achieve clarity of action in fields that range from business to medicine. Some consulting companies practice primarily within the decision analysis paradigm. Major corporations strive to integrate decision analysis into their decision processes. Yet there are dissenters. To use a religious metaphor, heathens are those who pursue decision-aiding procedures that have different underlying philosophies. Heretics follow the general ideas of decision analysis but wish to change some underpinnings in a ruinous desire to achieve greater consistency with certain experiments involving unaided decision makers. Cults are composed of those who superficially follow the paradigm, but are willing to bend their practice in ways that allow the decision maker to avoid the dictates of logic while appearing to have done a decision analysis. Our examination of these views is based on the warranties each approach can support. The common sense warranty requires, for example, that the addition of a noninformative new alternative cannot make a decision situation less desirable. A decision recommendation is no better than its warranties.

I did not intend to prepare an article for this issue, not because I did not think it a suitable forum, but because I believed that what I might say would already have been said by others. While this is probably true, I realized on receiving Rex Brown's article [1992] for possible review that it would be appropriate and timely to offer my own contribution. I write not to take exception to all of Rex's views; for example, I agree with him on the need to integrate theory and practice. However, I believe that many of his views are not in accord with what I consider to be current practice. While some of my comments are directly related to those in Rex's paper, I shall also supplement them by offering more general observations on the state of this subject.

I have elsewhere [Howard 1992] called adhering to decision analysis axioms following the "old time religion"; in that vein, I have used some religious analogies to make my case. They should be taken lightly, and certainly not personally. Let me begin by discussing some of the challenges that decision analysis has encountered over the past several years; I shall divide them into conceptual and professional challenges.

Conceptual Challenges

Challenges to the conceptual framework of decision analysis come both from those who reject or ignore the usual axiomatic structure of the field and from those who generally accept the structure but wish to tinker with it in different ways. I shall call these external and internal challengers, respectively, or heathens and heretics.

The heathens who pose the main external conceptual challenges embrace fuzzy

set theory approaches (hereafter, Fuzzy) and the analytic hierarchy process (AHP). Both approaches have an extensive mathematical development and academic support that preclude dismissing them summarily. I have seen multiple sessions on each of them at national TIMS/ORSA meetings. Proponents of both claim that they handle the same problems treated by decision analysis, and some proponents would say that they do it better.

Potential users of decision analysis are not immune to the blandishments of these alternatives. I am on occasion asked by a client what I think of these approaches or simpler ones like Kepner-Tregoe that are based on such ideas as identifying alternatives and weighting their importance by assigning points.

When asked about the simple approaches of the more humble heathens, I reply that they may have something to offer. Just as it is difficult to practice modern medicine in a society that does not have good hygiene, clean water supplies, and effective sewage control, so it is difficult to perform decision analysis for a person or an organization that is unclear that alternatives and preferences exist. Some of these simple approaches may be effective in introducing mental decision hygiene as a precursor to modern professional decision help. However, few of the clients that I encounter are in need of such education.

If I am asked about the Fuzzy or AHP approaches of the more pretentious heathens, I first say that almost any close and careful examination of a decision is likely to be helpful, but beyond that we must speak about what warranties the approach can give to the decision maker. The deci-

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sion maker can then judge whether to adopt an approach that cannot warranty a property deemed to be important. While I will not present here a complete discussion of warranties, a brief one will show what I mean.

Warranties

Three of the warranties that I would like to have in any decision situation are that

- (1) The decision approach I am using has all the terms and concepts used so clearly defined that I know both what I am talking about and what I am saying about it;
- (2) I can readily interpret the results of the approach to see clearly the implications of choosing any alternative, including, of course, the best one; and
- (3) The procedure used to arrive at recommendations does not violate the rules of logic (common sense).

These warranties protect me from, respectively: (1) garbage in, (2) garbage out, and (3) garbage in-between. Both Fuzzy and AHP fail to provide such warranties.

Fuzzy

The main problem with Fuzzy is that the construction and interpretation of the membership function are arbitrary. For example, how do I create a membership function for the event "product success" as a function of sales? Note that this membership function is a separate issue from the chance I would assign to any level of sales.

The membership functions of Fuzzy are even more problematical when interpreting results. I once had two excellent doctoral students investigate for a seminar to the best of their abilities the potential of fuzzy analysis of decisions. They reported such results as "the membership of alternative

A in the set Good Decision is 0.61; the membership of alternative B in the same set is 0.49." Of course, the question is, So what? There is no warranty that using the alternative with the highest membership in the set Good Decision is the right thing to do in any sense that I can explain to a decision maker.

The arbitrary rules for fuzzy set union and intersection are equally disturbing. Using the greater of the two membership functions for union and the lesser for intersection does provide the correct logic in the case of crisp definitions. However, such practice is inconsistent with the way you would treat the same issues with probability theory even if you make several simplifying assumptions.

I am sometimes asked why I am skeptical about Fuzzy in the face of its apparent usefulness in certain control problems. My answer is that a system that incorporates uncertainty even in a flawed way may well outperform a system that ignores uncertainty. But both will be inferior in performance to a system that treats uncertainty with the proper use of probability theory.

Analytic Hierarchy Process

AHP has similar problems. Inputs like "factor X is extremely more important than factor Y" are understandable in everyday conversation, but they lack the precision required by a strong recommendation for action. Similarly, when an alternative A receives 1.2 times the weight of alternative B, we still do not know what warranty we are receiving that A is better than B. This is particularly bothersome because it is possible for the AHP to reverse the ranking of A and B when a new and independent alternative is introduced [Dyer 1990]. While

AHP advocates do not apologize for and even defend this characteristic of their approach, I find it disturbing.

For example, I would be uncomfortable giving the following recommendation to anyone: "If you can choose among ice cream flavors vanilla, chocolate, and strawberry, choose vanilla; but if you can choose among vanilla, chocolate, strawberry, and pistachio, then choose chocolate." Of course, if the availability of pistachio told you something about the nature of the other flavors, then there would not necessarily be any reason to question the advice. The problem is that AHP can provide such recommendations even when the availability of the new alternative tells you nothing about the others.

In this discussion of alternatives to decision analysis, I have omitted discussion of Dempster-Shafer and credibility weighting approaches to inference. Both fall short in their warranties, but neither, as I understand them, is offered as a complete approach to decision making. See Lindley [1982]

Heretics

Now let us turn to those approaches that are similar to decision analysis in that they use such ideas as probability and utility but use them in ways that are different from the way they are used by decision analysts. These approaches are the result of an attempt to tinker with the axioms decision analysts use, perhaps with the desire to make acceptable descriptive behavior that is inconsistent with decision analysis axioms.

The number of heresies is large and growing. While some heresies may be the result of a sincere questioning of the foun-

ditions, one must wonder whether the necessity for publication has encouraged others to suggest changes that seem far from persuasive on either conceptual or practical grounds.

The Scales Fall from My Eyes

My concern with heresies was sparked by a particular event. Previously, I had considered them harmless aberrations that no one took seriously. The event I refer to I have described elsewhere [Howard 1988], but I shall repeat it briefly here. A few years ago, I attended a national meeting where a distinguished decision theorist reviewed decision theory. As part of his lecture, he presented the example illustrated in Table 1.

A symmetric die with six sides numbered 1 through 6 is to be rolled; you assign probability 1/6 to each number appearing. Before the die is rolled, you have a choice between two attractive deals. Deal A pays you \$600 for a 1, \$700 for a 2, up to \$1,000 for a 5, but only \$500 for a 6. Deal B pays \$500 for a 1, \$600 for a 2, up to \$1,000 for a 6. The question is do you prefer Deal A or Deal B.

The speaker said that he preferred Deal A because he would win more money in five of the six ways the die could fall. However, he added, if he faced the same choice with the change that the amounts of money involved were hundreds of thousands of dollars rather than hundreds of dollars, then he would prefer Deal B. Why? Because he would feel such regret if

Die	1	2	3	4	5	6
Deal A	\$600	700	800	900	1000	500
Deal B	\$500	600	700	800	900	1000

Table 1: Would you choose Deal A or Deal B?

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he chose Deal A and the number 6 appeared on the die.

After digesting this, I asked whether he was being descriptive, meaning that some people might make these choices, an observation that would be quite reasonable. "No," he said; he meant that the theory he was advocating should be taken normatively, as a guide for action. I pressed and said, "If I were acting as your agent in these situations, would you want me to make the choices you expressed?" He said, "Yes," and he added that he knew that such choices could lead him to express intransitive preferences.

I now realized that the heresies had to be confronted. As a check on my understanding, on my return home I asked several colleagues which deal they preferred. In every case, they acted as if I had either lost my senses or made an error in presenting the choices. None was other than indifferent.

And I Begin to Preach

At this point, I began to sound the tocsin on this issue. My intent was to explicate the power of the old time religion, to show how the heresies lead to unthinkable consequences (like intransitive preferences that lead to "money pumps"), and to point out that accepting any of them would mean, as a result of both conceptual and practical difficulties, the end of decision analysis and the great value it has brought to countless decision makers. Much of the argument appears in print [Howard 1992]; here I shall note only that various heresies would lead to calamities like negative value of clairvoyance, negative value of a new alternative, and the loss of tree roll-back as a computational procedure. They

thus violate the third warranty's requirement of common sense.

You might now ask, between the heathens and the heretics, do we not have enough problems? The answer is, unfortunately, no. The heathens who practice are, for the most part, clear that they are not doing decision analysis. The heretics generally do not practice, so the heresies are seldom seen by potential users, although they pose a danger to students. Still another challenge consists of people who are doing something they call decision analysis but whose work is significantly different from that of most decision analysts. We might call them members of cults.

Professional Challenges

This brings us to the paper by Rex Brown in this issue, the one that prompted me to prepare this article. First let me say that I thank Rex for placing his views on record so that they may be openly discussed. Few people engaged in assisting decision makers as their primary profession are as concerned with publishing their accumulated knowledge. In the ensuing discussion, it is possible that I have misunderstood some of Rex's views; I am sure that such misunderstandings will be corrected.

A New View of Practice

Rex caught my attention right away in his third paragraph. He states,

Decision analysis as an applied and useful art is in a state of rapid development—as is the theory on which it is based. This is true at both the strategic and the tactical levels of decision analytic practice.

Up to now, I can only agree. He continues,

Many of the basic procedures, which are advocated in virtually all the major textbooks includ-

ing our own [Brown, Kahr, and Peterson 1974; Howard and Matheson 1983; Schlaifer 1969; Watson and Buede 1987], are now obsolete, in the sense that they are no longer the methods of choice among the most successful practitioners in industry and government.

Well, that is news to me. I read on, and I suggest the reader do so, up to

The low level of attention to prescriptive research has limited the practical impact that formal decision-aiding technology has had on decision making in business and government [Grayson 1973; Ulvila and Brown 1982; Brown 1987].

noting carefully the references, and,

The client (the Department of Energy) made a decision at variance with the MUA, at least partly, I believe, because the analysis did not accommodate certain political and programmatic constraints [Brown 1991].

I am beginning to see a pattern here, and finally I read,

The third phase, the use-and-user-oriented phase builds on the previous two and accommodates institutional and psychological reality. This often involves some sacrifice of logical sophistication for the sake of user compatibility. . . . A cluster of Washington-based consultants (myself included), which we might call the East Coast school, typify its practice.

I believe I detect someone who is concerned mainly with helping people in government make decisions, a practice that I have discussed with grave concern some time ago [Howard 1980]. I would suggest that more accurate names for his school would be the "Washington, DC school" or the "Beltway school."

The idea seems to be to characterize modern decision analysis (non-Beltway) as narrowly numerical rather than insight focused. This has never been true; furthermore, evolutionary developments in both concepts and computation over the past 10

years have made insights even easier to obtain without sacrificing rigor. Yet Rex seems to present his clinical art as a flexible, adaptive approach that gets to the right answer without being embarrassed or even encumbered by numbers, the handmaidens of knowledge, logic, consistency, and reason.

The Sale of Indulgences

As desirable as this must seem to Rex, to me it sounds like glossing over logical inconsistencies and permitting the introduction of hidden personal biases. Such a practice allows some decision-making body to claim that a decision analysis has been done with "all the cards on the table," while retaining political control of the result. The activity has the patina of rigorous decision analysis without the constraints imposed by openness and logic. It conjures up images of perpetual motion machines that are certified because they are "in the national interest" or balance sheets that depict financial soundness but do not follow the rules of accounting or arithmetic.

I would have serious, but less, objection to this if it were presented as "Rex Brown's Decision Aiding Method" rather than the self-styled "East Coast School of Decision Analysis," for I do not see it as decision analysis at all.

The Charge of Obsolescence

Rex continues his presentation with the discussion of "Obsolete Precepts in Textbooks." He states,

Many of the decision analysis techniques they presented have been found to be seriously deficient as prescriptive tools: valid aspects of successful decision makers' thinking were missing; much of the input required could not be readily supplied by human assessors; and deciders often could not use the output.

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These are serious charges, but unfortunately for the reader and fortunately for orthodox decision analysts, we see no evidence for them. If I encountered such deficiencies in a decision analysis, I would consider them shortcomings of the decision analyst, not of decision analysis. In reading these charges, I am puzzled about what a "successful decision maker" is. Do we determine this by observing decision processes or decision results? Continuing in this vein we find

Decision analysis technology can be tested by comparing it with the unaided processes and conclusions of intelligent decision makers addressing the same problem and drawing on the same data and judgments. Divergences between the two provide valuable insights into deficiencies in one or the other. Those common but by no means universal cases where comparison has favored the unaided decision maker have stimulated enhancements in decision analysis technology.

Again, I am intrigued by the standard of "intelligent decision makers," and about the unspecified cases, "where comparison has favored the unaided decision maker." I suggest that Rex provide references or publish this work for professional scrutiny.

Three examples of the "obsolete" practices are provided.

(1) Failure to do "plural analysis." If by plural analysis Rex means using different frames for the decision problem or different ways of encoding knowledge, then I can assure him that these are an active part of West Coast practice.

Proper framing means being sure that you are working on the right problem rather than Freud's "presenting problem" [Howard 1988]. We are beginning to develop formal techniques to help us insure this goal [Matheson 1991].

We customarily use influence diagrams to represent the knowledge of individuals or groups, revealing and reconciling the source of different beliefs [Howard 1989]. (2) Using the "rollback" decision tree technique. This technique, according to Rex,

... implies that decisions subsequent to the one immediately under consideration can be predicted with certainty, given certain modeled conditioning information (see the hurricane seeding case in Howard and Matheson [1983]. Decision makers do not usually share that certainty, I find, and with good cause. Their common sense can be accommodated and codified, for example treating subsequent acts as uncertain events [Brown 1978]."

This belief of Rex's follows from a view that a decision tree represents what is going to happen in the future rather than a current coherent thought about the future. When a future decision arrives there is no need to be bound by any earlier analysis, for much will usually have been learned in the interim. Nevertheless, coherent thought about the future requires that the future decision be modeled as the one that the decision maker would make according to the current state of knowledge [Howard 1992].

In fact there is no difficulty in incorporating appropriate effects of uncertainty in future decisions. In two cases, I have encountered companies where there was doubt about whether the future culture of the company would permit pursuing commercialization of an R&D success should it occur.

One case involved a major oil company that had the possibility of a research breakthrough that would be a major advantage in producing rubber tires. The executives of the company were unanimous

in stating that should the breakthrough occur, the company would prefer to license the technology rather than pursue the market by itself. They believed this even though the analysis showed and they agreed that internal commercialization would be more profitable. The reason was that the company had entered the tire business many years before with disastrous results. In view of this earlier debacle, only a very bold executive was going to propose another attempt at the tire business.

In the second case, a machinery and chemical company, "metal benders," according to the president, was contemplating an investment in a monoclonal antibody venture. The question was whether the leadership of the company 10 years hence would have the taste and ability to deal effectively with a pharmaceutical breakthrough, should it occur.

Both cases were explicitly modeled by introducing uncertainty about future corporate culture. Note however, that the thought took place now.

(3) Use of hypothetical assessments. We read,

the hypothetical assessments (notably likelihood functions) called for by the fashionable Bayesian updating paradigm [von Winterfeldt and Edwards 1986] are sometimes awkward for people to make in nonlaboratory situations. A new method, decomposed error analysis, makes such hypothetical assessments unnecessary [Brown, Lilien, and Ulvila forthcoming].

I am puzzled by the use of the word "fashionable" for a procedure that dates back to the 18th century. I am very pleased to hear that Rex has an approach that overcomes this problem; I only regret that I could not review it in time for this article. Here again, the knowledge map

approach based on influence diagrams [Howard 1989] works wonders in arranging for assessments that are well within human capacity.

New Technical Developments Not Yet in Textbooks

While I find some of the points Rex raises here, like the one on influence diagrams, quite important, in fact, much of this material is currently finding its way into textbooks. [Clemen, 1991]. Other points such as

interactive computer-aided procedures for "splicing" the decider's own judgment into a completed decision analysis, illustrated by Mendez, Brown, and Bresnick [1984] and Ulvila and Thompson [1988]

raise the specter once again of an "accommodating" or "flexible" "decision analysis" where the decision maker can choose whatever alternative he or she wants for whatever reason and still say that a decision analysis supports the action. Such an accommodating approach may be an attractive marketing feature for a consulting business and merely regrettable in a business spending its own money, but it is dangerous when used in the one part of society with a legal monopoly on physical force—the government.

Rex mentions the growth of decision conferencing. The "decision conference" means many things to many people. The real issue is what goes on at the conference. If it is to be decision analysis, then it should be a concentrated dose of the old time religion. I sometimes favor a two or three-day full-time on-line decision analysis that will lead to action. For many this is a very appropriate form of decision analysis.

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The discussion of technology gaps states that specifying the options to be modeled constitutes a major weakness. The gap is at least partly filled by the strategy table [Howard 1988]. A strategy table allows us to select which alternatives are to be evaluated from among the myriad of potential choices.

Rex is correct in pointing out the importance of organizational considerations in performing an effective analysis. Any competent strategy study in an organization is carried out with particular sensitivity to the organizational issues cited as the highest priority gap.

Needed Research and Practice

Rex's views on needed research are personal, and I will not comment on them. However, I join Rex in stressing the value of becoming involved in real decision problems if one wants to develop truly new aids for helping decision makers. It is my opinion that building on the written research of others, which I call "journal research," while often valuable, is unlikely to produce the breakthroughs that a fresh look at the problem engenders.

To be vital in decision analysis research and persuasive in teaching decision analysis, I believe that academicians should consult and in some cases pursue residencies in consulting companies. They must have something to offer to the company, but if they do, they will find themselves surrounded by people on the cutting edge of practice. Similarly, practitioners, professional full-time consultants, should consider sabbaticals at universities to share their practical experience and to learn what the academy has to offer their practice. To paraphrase a famous scientist, there is

nothing more practical than a good theory.

The State of Decision Analysis

Decision analysis, the old time religion, is alive and well and contributing value to decision makers. Decision makers who are truly aided will keep coming back for more and will create such abilities in their organizations and themselves. What is developing, or perhaps returning to its original conception, is a broad yet rigorous view of decision analysis.

I now describe decision analysis as a "quality conversation about a decision designed to lead to clarity of action." The conversation may be short: a personal mental reflection to reveal that once sunk costs are ignored the best course is clear. It may be long: a complex multi-month analysis involving computer models, many assessments, and carefully examined preferences. It is clear that most people trained in decision analysis use it in the first way almost every day.

In a short conversation, the key insight may be that one alternative dominates all others regardless of future developments, or that the decision maker must be crystal clear about a term that is being used loosely, like *proven reserves*. In a slightly more involved conversation, the decision analyst might do a "back-of-the-envelope" value of clairvoyance calculation to see that pursuing an information-gathering option has no value, or perform a simple inference to learn how much new information has changed beliefs.

While these uses may seem simple, I see again and again the mistakes that decision makers (executives, doctors, engineers, and so forth.) commit because most of them are not trained in such precise thought

about decision. Decision analysis is so simple in conception that it is easy to underestimate its power. Conversations about decision making can be effectively conducted with this philosophy in a broad and powerful manner unachievable by any other approach of which I am aware.

Conclusion

Decision analysis is growing, not dead. Reviewing course materials some 20 years old showed me that those same courses could be given today, word for word, to a new class of students without apology. The editor suggested that this sounded as if the subject were stultified, if not dead. To me it means rather that the subject is so fundamental, like probability or calculus, that it changes only marginally at its core. For example, the concepts of probability as an encoding of knowledge, of the distinction between the quality of a decision and the quality of its result, and of the value of information are as important as they ever were.

However, decision analysis has grown—it has been expanded, broadened, and made more efficient. New constructs, like the influence diagram [Howard 1990] and the power of modern computation, have permitted decision analysts to perform the same quality of analysis at much lower costs. The automobile of 1972 is not that of today, but it got you where you wanted to go safely, economically, and comfortably.

We should not let our desire for constructive change in decision analysis tempt us to dilute or even denature our profession so that it will appeal to a wider audience on false pretenses.

There is nothing more difficult to earn or easier to lose than your good name.

Acknowledgments

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Response from Rex Brown:

I am glad to have engaged the attention of so notable and respected an adversary as Ron Howard. His reply to my paper underscores the major differences between what I have called the "problem-oriented" phase of decision analysis and the "use-

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and-user" phase, promoted by the Stanford and "Washington, DC" schools (as I am happy to have Ron call us), respectively.

They and we have set ourselves tasks that differ in subtle but important ways. He, I believe, puts priority on producing a logically sound solution to the decision problem at hand, with a strong predilection for the paradigm to which he arrogates the term *decision analysis*.

We, on the other hand, are preoccupied with producing what "works" for the user in the given personal and institutional context—that is, we want it to be used and useful. For prescriptive purposes, multiple attributes must be evaluated, including:

- Technical soundness, that is, the technique should logically incorporate all available information that may contribute to the quality of the decision;
- Cost, including delay and cognitive burden; and
- Acceptability, both institutional and psychological.

The appropriate articulation of these attributes, and the balance among them, (corresponding, at least implicitly, to importance weights in a multiattribute utility analysis) will be highly situation-specific; a technique may fit one situation, but not another.

Thus, if we were helping a druid to choose a propitious time for sacrifice, we might pick examining chicken entrails over "decision analysis," if acceptability (*his* old time religion) is more critical than technical soundness (because there is not much to choose between sacrifice times, and therefore decision quality is not crucial).

More to the point, AHP is not necessarily to be rejected simply because it has log-

ical flaws, such as preference reversal (though I am not taking a position on its overall merits). The anecdotal indications are that it competes well on the acceptability attribute and possibly on the cost attribute, but how about technical soundness? The issue boils down to this: How does AHP fare on decision quality? How far short is the decision that emerges likely to fall from the ideal one that accurately extracts and properly uses all relevant expertise and data [Brown and Campbell 1991; Watson and Brown 1978]?

In spite of what Ron seems to imply, there is no warranty that any particular application of old-time decision analysis (however skilled the exponent) will get close to the ideal. One might reasonably argue that with enough effort it could get close. However, at realistic cost there will inevitably be loss due to imperfectly assigned inputs; either because they do not tap into enough of the potentially available sources of knowledge or because these sources are elicited inaccurately. Given the complaints one hears from substantive experts about having to produce probability and utility numbers (often out of the elicitor's earshot), AHP may have a strong case here.

Nor should AHP's failure to provide Ron's third (internal coherence) warranty be considered too damning, since it may provide for useful elicitation redundancy (which is inherently incoherent). I would not go so far as to argue that "consistency is the hobgoblin of little minds"; but neither would I pay it too much reverence (nor agree with Lindley who used to say "coherence is all"). For example, whenever you enrich a decision analysis by adding

an alternative model of the same choice (plural analysis), you introduce the prospect of incoherent inputs. This clearly does not have to impair decision quality (even if you do not reconcile inputs but pool outputs).

Paradoxically, the best approach to making a comparative (second-order) evaluation of decision-aiding approaches (for making first order choices) may well be to use the "old time religion"—or the MUA variant of it. (I follow Merkhofer and Keeney [1987] in abbreviating multiattribute utility analysis as MUA.) The point is that MUA scores very well (third order evaluation!) on the technical soundness attribute, which is particularly important in evaluating contending technologies for a scientific audience.

The practical implications of the differences between Ron's decision-aiding practice and mine should not be exaggerated. Ron is satisfied his decision analysis "works" (and always has. "The automobile of 1971 . . . got you where you wanted to go safely, economically, and comfortably"). Conversely, I also try to pay critical if not sole attention to the logical soundness of a decision-aiding approach.

Nevertheless, I am persuaded that current decision-aiding practice of whatever stripe has a long way to go before it generally meets the prescriptive test I suggested earlier. When it does, I believe it will become a dominant force in how major decisions are made in this society. As the NAS panel on decision making and problem solving has forcefully pointed out, this is now far from the case [Simon 1988].

For this reason, I urge (as the NAS panel

did) significant prescriptively oriented research to improve the state of the art.

Practitioner tinkering, however essential and inspired (as that of Ron and his disciples has often been), cannot be expected to achieve much more than "gothic embellishment" of the old ways. Enough dissatisfaction is heard from the decision-making market (inevitably one hears more about one's competitors) to suggest that these old ways (including ours) will not do. Indeed, major research is needed to go beyond anecdotal evidence on just how well they are doing and where the critical room for improvement is.

Let me now respond to some of Ron's more specific points. He takes issue with my contention that many of the procedures advocated in decision analysis textbooks (including his and ours) are obsolete or at least commonly inappropriate, for example, rolling back decision trees [Brown, Kahr, and Peterson 1974, pp. 238-269; Howard and Matheson 1983, pp. 47-52; Watson and Buede 1987, pp. 42-53]. I refer the reader to the references cited in my "examples." I can readily accept that Ron and his cohorts, like us, have learned not to stick slavishly to these procedures (as he notes in regard to plural analysis).

As for my criticism of the "rollback" procedure, Ron is mistaken in thinking I take the

. . . view that a decision tree represents what is going to happen in the future rather than a coherent thought about the future.

Nor would I dispute that

When a future decision arrives there is no need to be bound by any earlier analysis, for much will usually have been learned in the interim.

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My point is rather that the "earlier analysis" should take this prospect into account. The conventional decision tree procedure assumes that we can specify now with certainty what the decider will do if the event-act path modeled to the left of that subsequent act transpires (that is, he or she will take the action with the highest conditional expected utility). By design or inadvertence, the tree rarely models possible intervening circumstances (including a change of heart, that is, utility function) so completely. Hence, a logical and realistic decider should have some uncertainty now about what he will do if he gets to that point in the tree.

I agree with Ron that the significance of decision conferencing depends on how it is done. The brand that I hold is booming and with cause is the "use-and-user-oriented" kind pioneered by Cam Peterson, a psychologist by training and the leading light of the Washington School. The essence is to focus on effective institutional implementation, with quantified decision models limited largely to serving as an organizing framework for reflection and discussion. The point is that it has a use-and-user-oriented goal (fostered by shared understanding of the problem and commitment to action among key players in the decision process) rather than one of providing a logically satisfying but disembodied solution to a decision problem.

A self-proclaimed heretic [Brown 1978], not I hope above learning from heathens, I have taken on some of Ron's "old time religion"—though mostly the fundamentalist rites rather than the basic deity. Pursuing (and as needed abandoning) such heresies is important for the health and growth of

the decision aiding profession. The stakes are high, but at least they are no longer those that Galileo had to worry about being burnt at.

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