
MULTIPLE CRITERIA DECISION MAKING

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This short chapter is one of the most important in the entire book. It departs from the static view of decision making as an *act* of selecting the most desirable alternative and treats it, instead, as a *process*: a dynamic and interrelated unity of predecision, decision, and postdecision stages. Such a view implies that decision making's normative aspect—the question of how decisions *should* be made—is a natural outgrowth of its descriptive aspect—the question of how decisions are made. Without this connection, normative emerging out of descriptive reasoning, the present book would be an unpersuasive exercise in static mathematical formalism.

In a chapter on the stages of the decision process, *decision trees* might usually be introduced. Although such a logical and temporal structuralization of decision making is quite useful and instructive for dealing with simple problems, it is not adequate for dealing with complexity. Decision trees are well covered in most standard texts on decision making (see the Bibliographical Note); we shall not pause to discuss them here.

The chapter concludes with a diagram of the decision-making process. This diagram is by no means a unique representation; many different versions are possible. However, it provides a basic conceptual model that can be modified for more particular situations. The reader is invited to study the diagram, run a few imaginary decisions through it, and modify it as necessary.

It is hoped that the reader will study this chapter several times. It has been made intentionally short to allow such repeated passes through before one plunges into the next couple of chapters.

The real decision taking process involves a lot of people, and the whole structure is redolent with feedback. At every decisive moment, of which there will be great many within the total decision, we range ahead and back and sideways. We gauge the effect of this sub-decision on everything we have tentatively decided already, and on the sub-decisions left to take. This is why I think the decision tree is an artefact, and of little use to us. You cannot isolate these nodes either in time or in logical connectivity, and anyone who has ever taken a complicated decision knows this.

Stafford Beer
Platform for Change (1975)

3-1 TWO BASIC APPROACHES TO DECISION MAKING

There are essentially two basic approaches to modeling human decision making:

1. The *outcome*-oriented approach, based on the view that if one can correctly predict the outcome of the decision process, then one obviously understands the decision process. The decision outcome and its correct prediction are at the center of this approach. Normative decision analysis, single- and multiattribute utility theories, etc., are examples of this orientation, which asks questions like what and when rather than how.
2. The *process*-oriented approach, based on the view that if one understands the decision process, one can correctly predict the outcome. Essentially descriptive, this approach has prescriptive and normative features as well: Knowing how decisions are made can teach us how they should be made; the reverse causal linkage, unfortunately, does not follow.

It is important to distinguish between the processes of measurement and search on the one hand and decision making on the other. What is traditionally presented as decision theory is in fact mostly concerned with measurement of comparative indexes of merit. If one obtains a correct measure of the total attractiveness of each available alternative, one can predict with confidence

that the most attractive one will be chosen. It is remarkable how much can be built upon such a simple and trivial tautology.

Technical measurement, followed by mechanical search, designed to predict the most attractive alternative, here in fact become a substitute for decision making and its theory. For if an adequate measurement of net attractiveness is obtained, i.e., a single number evaluates each alternative, the decision has implicitly been made, and its subsequent discovery is relatively trivial: Find the largest (or the smallest) number and select the corresponding alternative. Thus, the technical problem of mechanical search has replaced the actual decision-making process.

It is important to realize that whenever we face a single attribute, an objective function, a utility function, or any other single aggregate measure of merit, there is no decision making involved. The decision is implicit in the measurement, and it is made explicit by the subsequent search, as we asserted in Sec. 2-5.

It is only when facing multiple attributes, objectives, criteria, functions, etc., that we can talk about decision making and its theory. As alternatives of choice become more complex and are characterized by multiple attributes as well as multiple objectives, the problem of combining these various aspects into a single measure of utility becomes more difficult and less practical.

Decision making is a dynamic process: a complex search for information, full of detours, enriched by feedback from casting about in all directions, gathering and discarding information, fueled by fluctuating uncertainty, indistinct and conflicting concepts—some sharp, some hazy; the process is an organic unity of both predecision and postdecision stages overlapping within the region of partial decision making. Man is a reluctant decision maker, not a swiftly calculating machine.

The reader should not infer from this characterization that decision making has no structure or that no formalization of the process can be attempted. But surely, it cannot be captured by a decision tree, by a decision table, by a single mathematical function, or by other simple mechanistic artifacts. Its structure is functional, capable of generating its own path toward the decision. The final decision unfolds through a process of learning, understanding, information processing, assessing, and defining the problem and its circumstances. The emphasis must be on the *process*, not on the *act* or the *outcome* of making a decision; hence the orientation of this book is on the second or process approach to decision making.

The decision-making process consists of *predecision*, *decision*, and *postdecision* stages. These stages are interdependent; the postdecision phase often coincides with the predecision preparations for the next decision. Each decision stage is itself composed of a series of *partial decisions*, characterized by their own pre- and postdecision stages. We shall first describe these main stages of the decision-making process verbally. Later on we shall present a symbolic equivalent of the decision process, a mathematical model, in Chap. 6.

3-2 THE PREDECISION STAGE

First there is a sense of conflict. Conflict provides the decision-motivating tension, a frustration and dissatisfaction with the status quo. The underlying source of the predecision conflict is the *nonavailability of suitable alternatives* and particularly the *infeasibility of the ideal alternative*. While the main criteria are being selected, the decision maker immediately examines and evaluates the various alternatives in their light.¹ It is soon realized that the ideal alternative is not feasible (see Sec. 1-4.2).

Experiencing conflict, the decision maker starts searching for new alternatives, preferably for those approximating the ideal. The limits of individual attribute levels are soon attained. A first, tentative ideal image may be displaced during the process and the conflict amplified further.

As the component values of the ideal alternative become stabilized and clearly perceived, the decision maker recognizes its infeasibility, and the conflict between the achievable and the available sets in. The search for alternatives continues, but now it becomes purposefully directed toward the point of reference—the established ideal alternative. We know the attribute mixture of this desired alternative; is there one which is also empirically realizable? Or, at least, is there one close to it?

The evaluation of alternatives becomes more systematic as the decision maker realizes that a choice among alternatives already generated, rather than a discovery of new alternatives, will dominate the process toward the conflict resolution. Observe that if the ideal alternative became a feasible choice, the decision process would cease and the conflict would be fully resolved. Because such conditions are quite rare, an effort toward conflict resolution is replaced by an attempt at conflict reduction or, in many cases, at conflict containment. The decision maker asks the question, Which alternative will reduce the conflict to an acceptable level?

The process of careful reinterpretation and reassessment of alternatives ensues. The decision maker seeks a greater divergence in attribute scores of attractiveness. The greater the divergence, the more information is transmitted by each attribute, and the sounder the basis for a decision. A small divergence of values, nondistinct evaluations, and equal attractiveness of alternatives, render decision making difficult. Recall the fable of Buridan's ass, which starved to death while facing two readily available but precisely equidistant stacks of hay.

The *divergence process* leads to a search for new information, not only outside the system but also hidden, implicit within the system. Raw score measurements are checked; subjective assessments are scrutinized; prefer-

¹It is important to be able to trace the conflict to the set of available alternatives if one is to avoid treating conflict symptoms only, such as cognitive differences, multiobjective disparity, an abstract "need," and subjective perception.

ences are questioned. Additional decision makers may be brought into the picture as the decision maker reaches for a consensus of opinion.

This information-gathering and evaluation process is highly objective and impartial at first. But as the decision maker realizes that additional information is unlikely to reverse or appreciably influence the existing order of preference, the process becomes more biased and subjective. Then only particular pieces of information are admitted; some information is consciously or unconsciously ignored; some may be reinterpreted or even dismissed. Festinger (1964) provides experimental evidence that the closer the alternatives in their attractiveness and the more varied the information acquired, the greater the amount of information that will be sought before a decision is taken. There is less need for additional information if the alternatives are sufficiently divergent and the information is uniform and single-dimensional. As the predecision process becomes stabilized, a partial decision can be made.

3-3 PARTIAL DECISIONS

Partial decisioning includes a directional adjustment of the decision situation. Such an adjustment may consist of discarding alternatives that at the moment appear obviously inferior, returning previously rejected alternatives to the feasible set, and adding or deleting criteria.

As all alternatives are compared with the ideal, those which are the farthest away are removed from further consideration. There are many important impacts of such partial decisions. First, discarding an alternative may shift the maximum available score to its next lower feasible level. Thus, the ideal alternative is displaced closer to the feasible set. Such displacement induces further changes in evaluation, attribute importance, and ultimately in the preference ordering of the remaining alternatives. All alternatives are now compared with respect to the new, displaced ideal. This dynamic process is illustrated in Fig. 3-1. The ideal $\star$ and its subsequent displacements are numbered sequentially.

Another important consequence of a partial decision, or of any decision, is the cognitive dissonance that emerges after the decision has been taken. Festinger (1964) shows that the longer and more difficult the predecision stage, the greater the dissonance that follows. Thus, there is a tendency to justify the partial decision just made, i.e., to reduce the resulting dissonance. The decision maker initiates a process of subjective reevaluation of attributes. This evaluation is carried out in such a way that the attractiveness of discarded alternatives is diminished and that of the retained alternatives is amplified. After each partial decision there is still some residual conflict, the displaced ideal alternative is still infeasible, and a new predecision stage is entered.

The question often arises of whether the divergence process, the spreading apart of the attractiveness of individual alternatives, occurs mainly in the predecision or the postdecision period. We maintain that these two stages of the

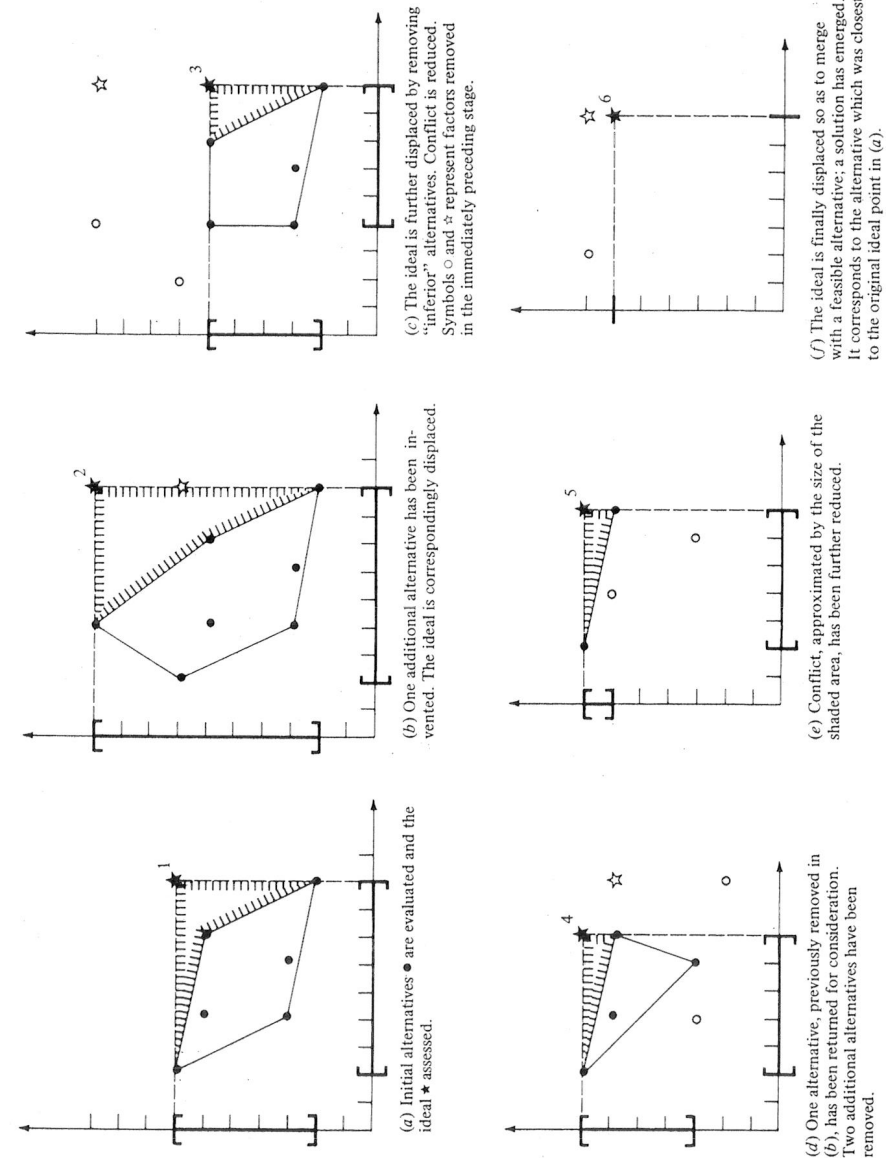


Figure 3-1 Decision-making process dynamics and the displacement of the ideal ($\star$).

decision process are not dynamically different. Any postdecision stage is also a predecision stage in the continuum of partial decisions traversed before the final decision is reached. In this sense, the "act of decision," or better, the "act of partial decision," is not critical within the decision process as a whole. Similar or even identical psychological processes occur both before and after a partial decision.

But what about the endpoints of the decision process? That is, how significant are the predecision stage before the first partial decision and the postdecision stage after the last partial decision, i.e., the final decision? We attempt an answer in the next section.

3-4 THE FINAL DECISION STAGE

We have already described the predecision conflict as originating from the perceived infeasibility of the ideal alternative. This conflict is initially sufficiently large to trigger the decision process. After the first partial decision the conflict is reduced by the ideal being displaced closer to the set of available alternatives. However, the cognitive dissonance, which was not operating initially, is now increasingly compounded with the residual conflict. The conflict and the dissonance tend to reinforce each other. At the beginning, the iterative deletion of inferior alternatives is relatively easy, but the process becomes more and more difficult as the number of alternatives diminishes and their attractiveness converges. The greater the difficulty in making partial decisions and the closer together the alternatives, the greater is the postdecision cognitive dissonance.

Postulate The overall level of a decision maker's dissatisfaction, which is necessary to trigger and maintain the process of decision making, consists of two components: *predecision conflict*, generated by the infeasibility of the ideal, and *postdecision dissonance*, induced by making a decision. At the beginning of the decision process the predecision conflict almost completely dominates, while at the end the cognitive dissonance completely dominates. As the dissonance increases, the conflict decreases, while the overall intensity of dissatisfaction stays sufficiently high to assure the completion of the decision process.

Let us summarize the essential dynamics once more: At the start, under the conditions of conflict, the information-gathering and evaluative activities are quite impartial and objective. As partial decisions are made and some alternatives discarded, cognitive dissonance begins to dominate. The number of alternatives diminishes, and so does their variability. The process of divergence becomes more subjective and biased toward the few remaining alternatives. The information gathering and interpretation also become biased and

directional. When the final decision unfolds, the ideal alternative has been displaced entirely in the direction of the chosen alternative, and the predecision conflict has been fully resolved. However, the magnitude of the postdecision dissonance is at its highest level and completely dominates. The divergence process still continues, but it now becomes biased toward the chosen alternative. All impartiality or objectivity is abandoned; there is no need for it, the decision has been made. (We assume, of course, the irreversibility of the decision. Otherwise, it would be only a partial decision, and previously described processes would be at play.)

Observe that dissonance-reduction processes become stronger as the number of alternatives still in the running becomes smaller. The decision maker becomes more and more committed to a smaller number of options, which in turn move closer to each other in attractiveness. The level of commitment reaches the highest point when the final decision has been made.

3-5. THE POSTDECISION STAGE

The dissonance-reduction process should not be viewed as one of distortion and biased judgment. Rather, it is the gradual process of reevaluation, reassessment, and cognitive "tune-up." The information search and processing is, however, directional. The decision maker enhances the attractiveness of preferred alternatives and reduces that of rejected alternatives. The objective predecision information search is gradually replaced by a selective postdecision information search. For example, after we purchase a new automobile, the advertisements we read tend to support our choice. We experience a clear preference for reading "own car" ads.

The presence of cognitive dissonance leads to a selective exposure to information. Consonant information is favored over dissonant. Dissonance-increasing information is not simply avoided or ignored but rather tends to be reinterpreted and incorporated in the direction of the chosen alternative.

In summary, we have shown how the predecision and postdecision stages of the decision process are interrelated and how the act of decision both evolves from the predecision stage and influences the postdecision stage. The transition occurs gradually through a series of partial decisions. As soon as the decision has been made, all the negative aspects of the chosen alternative and all the positive aspects of the rejected alternative become salient to the decision maker. As the choice is forced on smaller and smaller subsets of alternatives contrasting less and less, there is a tendency to counteract the increasing postdecision dissonance expected by succumbing to increasingly stronger postdecision regret. Leon Festinger states this effect as follows:

Avoiding post-decision dissonance can also be accomplished to some extent by psychologically revoking the decision as soon as it is made. (Festinger 1964, p. 99)

Postdecision regret simply manifests the fact that the dissonance has suddenly become salient. Then there is a tendency to reverse one's decision immediately after making it. This period, when the chosen alternative seems to be inferior to the rejected one, is followed by the dissonance-reduction process described earlier.

Postdecision regret and dissonance are strongest at the end of the decision process. This complements the fact that the predecision conflict has been resolved by displacing the ideal, i.e., by lowering one's aspiration level. In this sense the conflict, although resolved, has not been actually removed or dissolved but rather transformed into postdecision dissonance. A theory of conflict dissolution is discussed in Sec. 4-2.

Obviously, the final choice—say, between two remaining and equally attractive, although not identical, alternatives—is the most difficult to make. Postdecision regret is maximal; the tendency to reverse to the other alternative is uncomfortably strong.¹ After the final decision has been made, the level of cognitive dissonance is the highest. Moreover, the decision maker continues to seek new information. Its purpose now is to increase the decision maker's confidence and to reduce postdecision regret and dissonance.

Thus, the postdecision stage of the decision process is extremely important for an understanding of the decision-implementation process. This implementation phase is an organic continuation of the process of decision making. A good decision is not independent of its implementation attributes. Implementation activity can be viewed as the final postdecision process, characterized by the maximum of dissonance and a full commitment to the chosen alternative. The information gathered is biased in favor of the alternative being implemented; it is intended to increase the decision maker's confidence, which is necessary for an effective implementation through negotiation, team building, and action taking.

3-6 THE DECISION PROCESS: A DIAGRAM

Figure 3-2 summarizes the stages and dynamics of the decision process in a fluid and imprecise flow diagram. This is not intended as the only possible representation of the decision process; obviously, many alternative descriptions are possible. But we want to stress the *process* quality of human decision making, the interrelatedness of its stages, and the evolutionary nature of its main outcomes, i.e., decisions. One should imagine that all of the activities described are more or less parallel and mutually dependent.

There is another kind of "parallelism" involved: No individual decision making is completely independent of the social or collective framework in

¹In comparing two otherwise identical alternatives, their potential for allowing changing one's mind, to reverse a decision, becomes a very salient attribute. There is a tendency to postpone final choice and to preserve the ability to "switch" as long as one can.

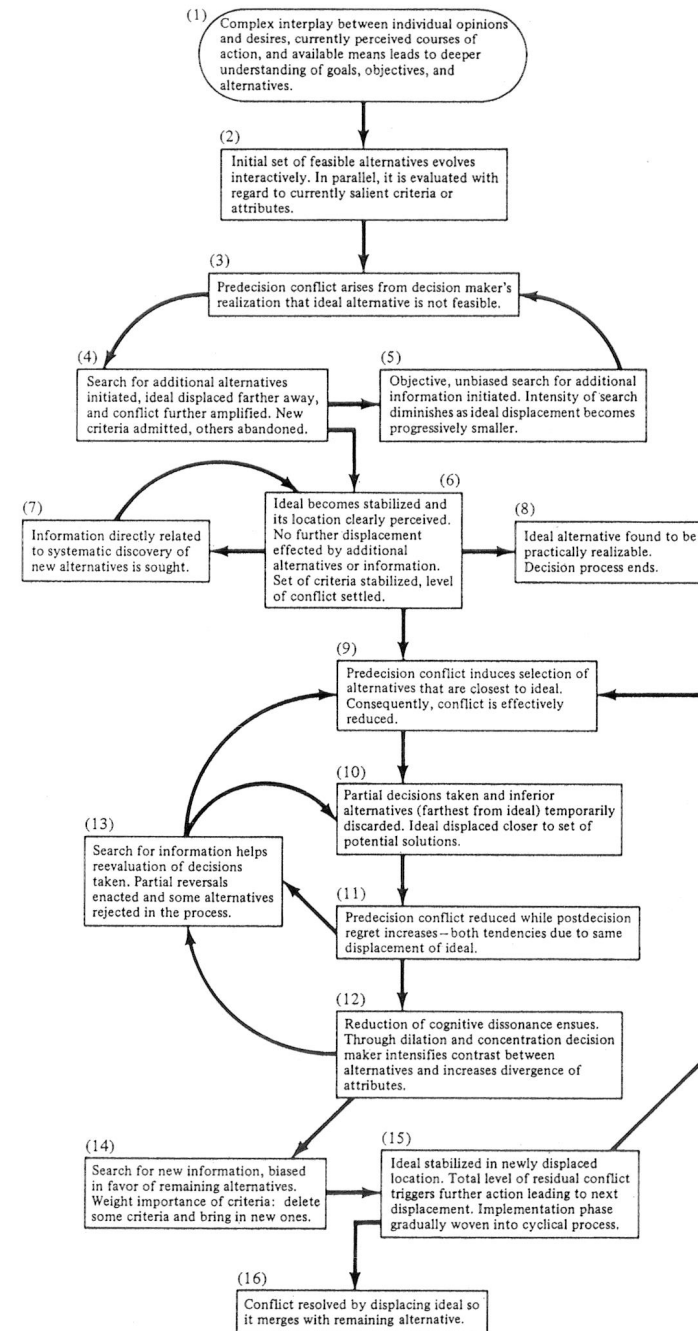


Figure 3-2 A diagram of the decision process.

which it takes place. Other people, their values, objectives, and constraints, interact with the individual decision-making process. Rarely can we concentrate on the pursuit of our own objectives without acknowledging the impact of our decisions on others, or without understanding how actions taken elsewhere influence the effectiveness of our efforts. Directly or indirectly, the diagram is a part of a larger, interdependent network, of a collective decision-making process. But at this stage we should not complicate the diagram any further. We shall attempt to make this diagram operational in the next sections, particularly in Chaps. 5 and 6.

3-7 BIBLIOGRAPHICAL NOTE

In this chapter we have characterized decision making as a process. The literature dealing with such a dynamic view of decision making is still rather sparse. One of the best descriptive books is Janis and Mann, *Decision Making: A Psychological Analysis of Conflict, Choice, and Commitment* (1977), in which the student will find process diagrams similar to the one presented here. Janis and Mann is strongly recommended as a supplementary reading for this chapter. It contains a wealth of descriptive material, examples, and empirical findings which provide a rationale for the type of analysis used here.

The first process view of decision making was advanced by Festinger (1957, 1964). His theories of cognitive dissonance and conflict resolution, his empirical experiments supporting the process view, and his careful analysis of postdecision regret are the foundation for current descriptive methodologies.

Stafford Beer in his *Platform for Change* (1975) also subscribes to the process view of decision making and criticizes the static methodology of decision trees rather persuasively. His view of decision making as a process "redolent with feedback" has become a classic. Brehm, *A Theory of Psychological Reactance* (1966), is a classic in the theory of descriptive decision making.

In the OR/MS literature, the process view of decision making is mostly maintained in the works of Zeleny (1976, 1977, 1979), Yu (1977), and Roy (1977).

Readers who are unfamiliar with the methodology of decision trees will find the necessary information in any standard OR/MS text. But perhaps going back to one or both of the original articles by Magee (1964) would be even better.

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