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Photo by Jeff Miller

Naturalistic Decision Making

Figure 1. Four-alarm fire in St. Joseph Hall at the University of Dayton, Dayton, Ohio, on December 22, 1987.

Gary Klein and
David Klinger

The past five years have seen the development of a new model for understanding how people make decisions in real-world settings. Naturalistic decision making is an attempt to understand how humans actually make decisions in complex real-world settings, such as fire fighting (see Figure 1). This work has focused on situations marked by key features as seen in Table 1. These include dynamic and continually changing conditions, real-time reactions to these changes, ill-defined tasks, time pressure, significant personal consequences for mistakes, and experienced decision makers. These task conditions exist in operational environments associated with crew systems, so it is essential to determine how people handle these conditions.

Previous models of decision making were limited in their ability to encompass these operational features. Classical approaches to decision making, such as Multi-Attribute Utility Analysis (MAUA) and Decision Analysis, prescribe analytical and systematic methods to weigh evidence and select an optimal course of action. MAUA decision makers are encouraged to generate a wide range of options, identify criteria for evaluating them, assign weights to the evaluation criteria, rate each option on each criterion, and tabulate the scores to find the best option. Decision Analysis is a technique for constructing various branches of responses and counter-responses and postulating the probability and utility of each possible future state, to calculate maximum and minimum outcomes.

On the surface these strategies may seem adequate, yet they fail to consider some important factors inherent in real-world decisions. Classical strategies deteriorate when confronted with time pressure. They simply take too long. Under low time pressure, they still require extensive work and they lack flexibility for handling rapidly changing conditions. It is difficult to factor in ambiguity, vagueness, and inaccuracies when applying analytical methods. Another problem is that the classical methods have primarily been developed and evaluated using inexperienced subjects, typically college students.

A group of decision researchers is trying to derive models that describe how experienced decision makers actually function. Rasmussen (1985) used protocols and critical incident interviews to study nuclear power plant operators. He has a three-stage typology of skills (sensorimotor, rule-based, and knowledge-based) which highlights how differential expertise creates differences in decision strategy. Hammond, Hamm. Grassia, and Pearson (1987) studied highway engineers and found that intuitive decision strategies were more effective for tasks

Table 1. Features of Natualistic Decision Making

1. Ill-defined goals and ill-structured tasks
2. Uncertainty, ambiguity, and missing data
3. Shifting and competing goals
4. Dynamic and continually changing conditions
5. Action-feedback loops (real-time reactions to changed conditions)
6. Time stress
7. High stakes
8. Multiple players
9. Organizational goals and norms
10. Experienced decision makers

such as judging aesthetic qualities of a road, while analytical strategies were more valuable for tasks such as estimating amount of traffic. Pennington and Hastie (in press) studied jury deliberation as a complex decision task and found that the jurors attempted to fit all the evidence into a coherent account of the incident. Their assessment was then based on this account or story rather than on likelihood judgments of the evidence introduced The jurors focused on whether the prosecution's or defense's story was more coherent. The work of Noble (in press) with Naval Command-and-Control officers and Lipshitz (in press) with infantry soldiers, has generated the same conclusions—under operational conditions, decision makers rarely use analytical methods and nonanalytical methods can be identified that are flexible, efficient, and effective.

Our work shows how people can make effective decisions without performing analyses. For several years, we have studied command-and-control decision making and have generated a recognitional model of naturalistic decision making. We began by observing and obtaining protocols from urban foreground commanders (FGCs) who are in charge of allocating resources and directing personnel. We studied their decisions in handling non-routine incidents during emergency events. Some examples of these types of decisions included whether to initiate search and rescue, whether to initiate an offensive attack or concentrate on defensive precautions, and where to allocate resources.

The FGCs' accounts of their decision making did not fit into a decision-tree framework. The FGCs argued that they were not "making choices," "considering alternatives," or "assessing probabilities." They saw themselves as acting and reacting on the basis of prior experience; they were generating, monitoring, and modifying plans to meet the needs of the situations. We found no evidence for extensive option generation. Rarely were even two options concurrently evaluated. We could see no way in which the concept of optimal choice might be applied. Moreover, it appeared that a search for an optimal choice could stall them long enough to lose control of the operation altogether. The FGCs were more interested in finding an action that was "workable," "timely," and "cost effective."

Nonetheless, the FGCs were clearly encountering choice points during each incident. They were aware that alternative courses of action were possible, but insisted that they rarely deliberated about the advantages and disadvantages of the different options. Instead, the FGCs relied on their ability to recognize and appropriately classify a situation. Once they knew it was "that" type of case, they usually also knew the typical way of reacting to it. Imagery might be used to "watch" the option being implemented, to search for flaws, and to discover what might go wrong. If problems were foreseen, the option might be modified or rejected altogether and the next most typical reaction explored. This mental search continued until a workable solution was identified.

We have described these strategies as a Recognition-Primed Decision (RPD) model (Klein 1989). For this fireground task environment, a recognitional strategy appears highly efficient. The proficient FGCs we studied used their experience to generate a workable option as the first to consider. If they had tried to generate a large set of options, and then systematically evaluated these, it is likely that the fires would have gotten out of control before they could make any decisions.

Three examples of the RPD model are presented in Figure 2 (page 18). The simplest case is one in which the situation is recognized and the obvious reaction is implemented. A somewhat more complex case is one in which the decision maker consciously evaluates the reaction, typically using imagery to uncover

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problems prior to carrying it out. In the most complex case, the evaluation reveals flaws requiring modification, or the option is judged inadequate and rejected in favor of the next most typical reaction.

The model is characterized by the following features, which are summarized in Table 2.

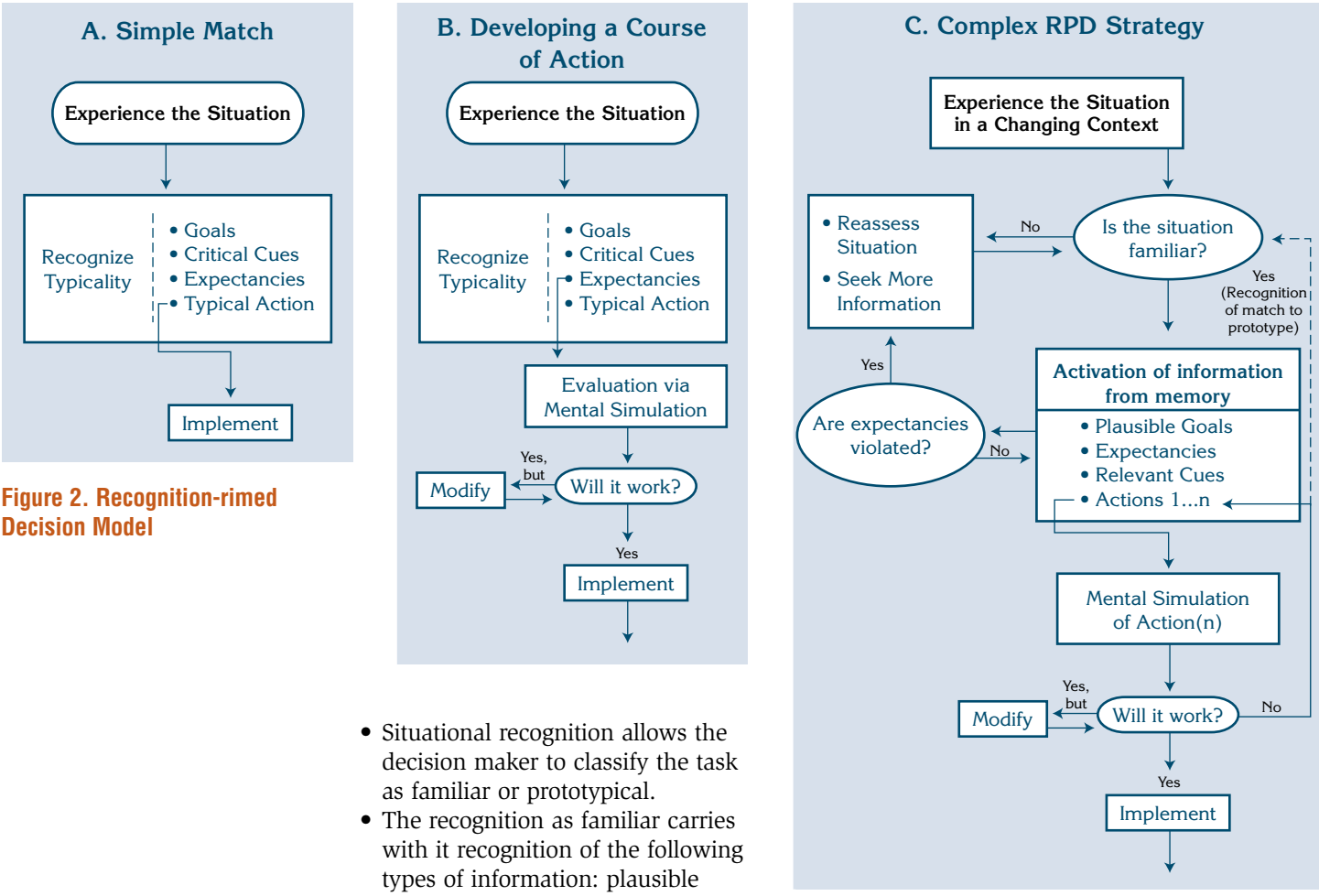

Figure 2. Recognition-rimed Decision Model

- Situational recognition allows the decision maker to classify the task as familiar or prototypical.
- The recognition as familiar carries with it recognition of the following types of information: plausible goals, cues to monitor, expectancies about the unfolding of the situation, and typical reactions.
- Options are generated serially, with a very typical course of action as the first one considered.
- Option evaluation is also performed serially to test the adequacy of the option, and to identify weaknesses and find ways to overcome them.
- The RPD model includes aspects of problem solving and judgment along with decision making.
- Experienced decision makers are able to respond quickly, by using experience to identify a plausible course of action as the first one considered rather than having to generate and evaluate a large set of options.
- Under time pressure, the decision maker is poised to act while evaluating a promising course of action, rather than paralyzed while waiting to complete an evaluation of different options. The focus is on acting rather than analyzing.

We do not propose the RPD model as an alternative to analytic approaches. Rather, we postulate that recognitional and analytical decision strategies occupy opposite ends of a decision continuum similar to the cognitive continuum described by Hammond et al. (1987). At one extreme are the conscious, deliberated, highly analytic strategies such as MAUA and Decision Analysis. Slightly less analytic are noncompensatory strategies such as elimination-by-aspects. At the alternate end of the continuum are Recognition-Primed Decisions (RPD), which involve non-optimizing and non-compensatory strategies and require little conscious deliberation. RPDs are marked by an absence of comparison among options. They are induced by a starting point that involves recognitional matches that in turn evoke generation of the most likely action.

We have tested applications of the model in a variety of tasks and domains, including fireground

Table 2. Key Features of Recognition-Primed Decision (RPD) Model

1. First option is usually workable NOT random generation and selective retention
2. Serial generation/evaluation of options NOT concurrent evaluation
3. Satisficing NOT optimizing
4. Evaluation through mental simulation NOT MAUA, Decision Analysis, or Bayesian statistics
5. Focus on elaborating and improving options NOT choosing between options
6. Focus on situation assessment NOT decision events
7. Decision Maker primed to act NOT waiting for complete analyses

command, battle planning, critical care nursing, corporate information management, and chess tournament play. These studies have shown good support for the validity and utility of the model presented in Figure 2 as it applies to individual decision makers. Our coding was evaluated as having 87% to 94% inter-rater reliability.

What are the implications of the naturalistic decision-making approach? A workshop in Dayton, Ohio, in Fall 1989, took stock of the current state of knowledge and explored implication and future research directions. Attending were researchers who had been active in naturalistic decision making, including 31 professionals who represented decision research being conducted by the military, NASA, private firms, and academic institutions The domains studied spanned tactical operations, medical decision making, weather forecasting, nuclear power plant control, and executive planning among others. This workshop was sponsored by the Army Research Institute (ARI) which began a research program in 1985 on Planning, Problem Solving, and Decision Making. The goal of this program is to make decision research more relevant to the needs of the applied community.

The Dayton workshop enabled researchers, working with different domains and paradigms, to find commonalities and to identify remaining questions. The workshop succeeded in identifying the favors of greatest interest for generalizing to operational settings. The participants documented limitations of classical decision theory, and explored opportunities for using nonanalytical models to develop better training programs and decision support systems. The participants also contributed to a book, *Decision making in action: Models and methods*, edited by Gary Klein, Judith Orasanu, and Roberta Calderwood (expected date of publication, 1991). It will be available through Ablex Publishing Corporation, 355 Chestnut Street, Norwood, NJ, 07648.■

Gary Klein, Ph.D., is the Chief Scientist for Klein Associates, Fairborn, OH. David Klinger is the Director of Development for Klein Associates.

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