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This article posits that military decision makers have come to rely too much on analytical decision making processes, contributing to a reduction in the effectiveness of training and decision support systems. The author examines the strengths and weaknesses of competing decision making processes, and offers a "recognitional model" for use in most combat or field situations. His recommendations have impact on training and decision aid development.

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Strategies of Decision Making

Gary A. Klein

This article posits that military decision makers have come to rely too heavily on analytical decision-making processes, contributing to a reduction in the effectiveness of training and decision support systems. The author examines the strengths and weaknesses of competing decision-making processes and offers a "recognitional model" for use in most combat or field situations. His recommendations have impact on training and decision-aid development.

IT IS TIME to admit that the theories and ideals of decision making we have held over the past 25 years are inadequate and misleading, having produced unused decision aids, ineffective decision training programs and inappropriate doctrine. The Department of Defense (DOD) often follows the lead of behavioral scientists, so it is important to alert DOD policy makers to new developments in models of decision making.[1]

The culprit is an ideal of analytical decision making which asserts that we must always generate options systematically, identify criteria for evaluating these options, assign weights to the evaluation criteria, rate each option on each criterion and tabulate the scores to find the best option. We call this a model of concurrent option comparison, the idea being that the decision maker deliberates about several options concurrently. The technical term is multiattribute utility analysis.

Another analytical ideal is decision analysis, a technique for evaluating an option as in a chess game. The decision maker looks at a branching tree of responses and counterresponses and estimates the probability and utility of each possible future state in order to calculate maximum and minimum outcomes. Both of these methods, multiattribute utility analysis and decision analysis, have been used to build decision training programs and automated decision aids.[2]

These strategies sound good, but in practice they are often disappointing. They do not work under time pressure because they take too long. Even when there is enough time, they require much work and lack flexibility for handling rapidly changing field conditions.

Imagine this situation (which we actually observed): An Army brigade planning staff engages in a 5-hour command and control exercise. One requirement is to delay the enemy advance in a specific sector. The operations

and training officer (S3) pinpoints a location that seems ideal for planting mines. It is a choke point in a wooded area where the road can be destroyed. A plan develops to crater the road, mine the sides off the road and direct the artillery on the enemy as he either halts or slows his advance to work around the obstacles. During the planning session, there are objections that it is impossible to have forward observers call in the artillery, and that without artillery support to take advantage of the enemy slowdown, the mines would do no good. Someone suggests using FASCAM (family of scatterable mines), but another person notes that FASCAM will not work in trees, only in open areas. Only after this thorough consideration and subsequent rejection of his initial choice, does the S3 consider an open area also favorable for an artillery attack and select it as the point of the action.

Suppose the planners had tried to list each and every available option, every possible site all over the map, and then evaluate the strengths and weaknesses of each? There was simply not enough time in the session to do this for each possible decision. We counted 27 decisions made during the 5 hours, an average of one every 12 minutes. Even this is misleading, since it does not take into account time taken by interruptions and communications. We estimate that about 20 of the decisions took less than 1 minute, five took less than 5 minutes and perhaps only two were examined for more than 5 minutes. Obviously, there is not enough time for each decision, using analytical concurrent option comparisons. And if we try to approach only a few choices in this way, which ones? It is even more complicated to screen decisions for deliberation. Analytical strategies just will not work in this type of setting.

I am not saying that people should never deliberate about several options. Clearly, there are times to use such analytical strategies. We have watched DOD design engineers wrestle with problems such as how to apply a new technology to an existing task. Here it *did* make sense to carefully list all the options for input devices and displays and to systematically analyze strengths and weaknesses to get down to a small number of configurations for testing.

The point . . . is that there are different ways to make decisions, analytical ways and recognitional ways, and that we must understand the strengths and limits of both in order to improve military decision making.

The point for this article is that there are different ways to make decisions, analytical ways and recognitional ways, and that we must understand the strengths and limits of both in order to improve military decision making. Too many people say that the ideal is for soldiers to think more systematically, to lay out all their options and to become, in effect, miniature operations researchers. This attitude is even built into military doctrine. For example, US Army Field Manual 101—5, *Staff Organization and Operations*, advises decision makers to go through the steps of multiattribute utility analysis.[3] Such advice may often be unworkable and sometimes may be dangerous. To understand why, we must get a clear idea of what skilled decision makers do.

For the past four years, my colleagues and I have been studying experienced decision makers, faced with real tasks that often have life and death consequences. We have studied tank platoon leaders, battle commanders engaged in operational planning at Fort Leavenworth, Fort Riley, Fort Hood, Fort Stewart and the National Training Center at Fort Irwin. (Prior to that, we observed Air Force and Army battle commanders at *BLUE FLAG*.) We studied urban fireground com-

manders and wildland fireground commanders (with over 20 years of experience) as they conducted actual operations. We also studied computer programmers, paramedics, maintenance officers and design engineers. Many of the decisions we examined were made under extreme time pressure. In some domains more than 85 percent of the decisions were made in less than 1 minute.

We found that concurrent option comparison hardly ever occurred. That is, experienced decision makers rarely thought about two or more options and tried to figure out which was better. In this article, I will describe the recognitional decision strategies we did find, differentiate between the situations that call for analytical or recognitional strategies and examine some of the implications for military decision making.

Recognitional Decision Making

When we told one commander that we were studying decision making, he replied that he never made any decisions! What he meant was that he never constructed two or more options and then struggled to choose the best one. After interviewing him, we learned that he did handle decisions all the time. After studying over 150 experienced decision makers and 450 decisions, we concluded that his approach to decision making is typical of people with years of experience and we have derived a model of this typical strategy.

Basically, proficient decision makers are able to use their experience to recognize a situation as familiar, which gives them a sense of what goals are feasible, what cues are important, what to expect next and what actions are typical in that situation. The ability to recognize the typical action means that experienced decision makers do not have to do any concurrent deliberation about options. They do not, however, just blindly carry out the actions. They first consider whether there are any potential problems and only if everything seems reasonable, do they go ahead.

A recognitional approach can save time and effort for more important concerns. An experienced brigade commander looked at a map and selected a site for an engagement area (a place to set up artillery and air attacks on an enemy advance). Other sites were then proposed that he had not even bothered to consider, although they seemed plausible to his less-experienced subordinate. He was able to explain why each alternative was defective and seemed surprised that anyone would even think about them. In other words, his skill enabled him to generate only plausible options so that he did not have to bother with computing advantages and disadvantages. He could use all of his experience to judge what was needed for the situation. He could generate a workable first option, so there was no reason for him to generate many more options and then have to perform a painstaking evaluation of them.

We call this a "recognition-primed decision (RPD)." The officer used experience to recognize the key aspects of the situation, enabling a rapid reaction. Once a decision maker identifies the typical action, there is usually a step of imagining what will happen if the ac-

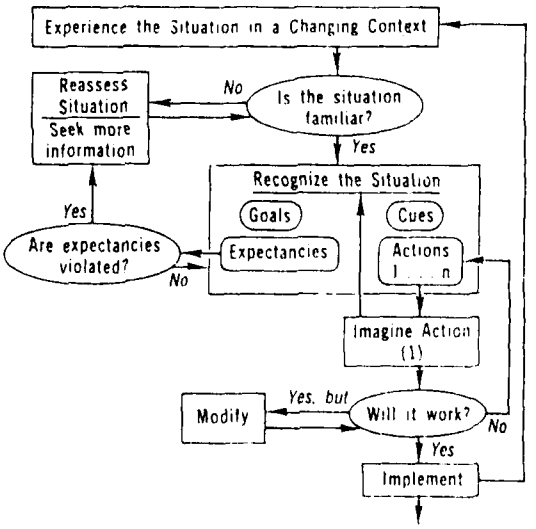

Figure 1. Recognition-Primed Decision (RPD) model

tion is carried out in *this* situation. If any pitfalls are imagined, then the decision maker will try to modify the action. If that does not work, the officer jettisons it and thinks about the next most typical action.

Notice that the experienced decision makers are not searching for the best option. They only want to find one that works, a strategy called "satisficing." We have found many cases where decision makers examined several options, one after the other, without ever comparing one to another. Because there is no deliberated option comparison, experienced decision makers may feel that they are relying on something mysterious called "intuition" and they may be mildly defensive about it if they are questioned carefully. One implication of our work is that this is not a mysterious process. It is a recognitional, pattern-matching process that flows from experience. It should not be discounted just because all aspects of it are not open to conscious scrutiny.

Figure 1 shows a schematic drawing of the RPD model. It shows that if the events contradict expectancies, the experienced decision maker may reexamine the way the situation is being understood. The basic thrust of the model is that decision makers handle decision points, where there are several options, by recognizing what the situation calls for rather than by calculating the strengths and weaknesses of the different options. The concept of recognitional decision making has been developing only in the last few years.

We have found that even with nonroutine incidents, experienced decision makers handle approximately 50 to 80 percent of decisions using recognitional strategies without any effort to contrast two or more options. If we include all decision points, routine plus nonroutine, the proportion of RPDs goes much higher, more than 90 percent. For novices, however, the rate of RPDs can dip to 40 percent. We have also found that when there

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is deliberation, experienced decision makers deliberate more than novices about the nature of the *situation*, whereas novices deliberate more than experts about which *response* to select. In other words, it is more typical of people with lower levels of experience to focus on careful thinking about the best option.

What about team decision making? Since many decisions are made within a network of coordinating organizations and by several

The RPD model assumes that decision makers evaluate typical actions by imagining how they will be carried out in that situation. Such an evaluation lets the decision maker improve the option and also reject it, if necessary. Analytical models present strong methods for evaluating sets of options. These models make it inconvenient for the user to improve options since that would force the evaluation to begin again.

people at each node in the network, we have also examined distributed decision making.

Teams and networks demand more justification and conflict resolution, so we expect to find more examples of concurrent option comparison; that is, contrasting two or more options. However, in our studies, this has not occurred. Earlier I described a 5-hour command and control planning session in which we tabulated 27 decisions.[4] Only one of these showed any evidence of concurrent option comparison. My earlier example of the operations planning officer choosing a site to disrupt the enemy advance illustrates recognitional decision making by a team. Similarly, our other studies of team decision making found the team behaving much like individuals—generating a plausible option, evaluating it by imagining what could go wrong, trying to "satisfice," trying to improve the option to overcome its limitations and sometimes rejecting or tabling an option to move on in a more promising direction.

How is the RPD Model Different from Analytical Decision Making?

The RPD model describes how choices can be made without comparing options: by perceiving a situation as typical; perceiving the typical action in that type of situation; and evaluating potential barriers to carrying out the action. This recognitional approach contrasts to analytical decision making in several ways:

- The RPD model concentrates on "satisficing," whereas models of decision analysis and concurrent option comparison have emphasized optimizing (trying to find the *best* option).
- The RPD model asserts that experienced decision makers generate a good option as the first one they consider. However, concurrent option comparison assumes that generating options is a semirandom process, with some coarse screening to ensure that only relevant options are considered.
- The RPD model focuses on situation assessment. In contrast, concurrent option evaluation models have placed more of the emphasis on selecting among options than on recognizing situations.
- Another difference is the evaluation of options. The RPD model assumes that decision makers evaluate typical actions by imagining how they will be carried out in that situation. Such an evaluation lets the decision maker improve the option and also reject it, if necessary. Analytical models present strong methods for evaluating sets of options. These models make it inconvenient for the user to improve options since that would force the evaluation to begin again.
- The RPD model assumes that decision makers will usually have an option available regardless of how tight the time constraints are. Experienced decision makers usually start with a typical option. If time permits, this option will be evaluated; if defective, it will be replaced by the next most typical option. In contrast, analytical models provide no guidance until after options are generated, evaluation criteria and weights established, ratings accomplished and tabulations completed. If a reaction is needed before this process is fin-

ished, the decision maker is out of luck.

By contrasting recognitional and analytical decision making, we can see the strengths of each. Recognitional decision making is more important when experienced personnel are working under time pressure on concrete, contextually dependent tasks in changing environments and have a "satisficing" criterion of selecting the first option that looks like it will work. It comes into play when the unit is an individual or a cohesive team that does not reach deadlocks over conflicts. Recognitional decisions can ensure that the decision maker is poised to act. Its disadvantages are that it is hard to articulate the basis of a decision and it is difficult to reconcile conflicts. Furthermore, it cannot ensure "optimal" courses of action and this is especially important for anticipating the opponent's strategies in preparation for the worst case. Also, it is risky to let inexperienced personnel "shoot from the hip."

Concurrent option comparison has the opposite strengths and weaknesses. It is more helpful for novices who lack an experience base and for seasoned decision makers confronting novel conditions. It is apt to be used when there is ample time for the decision. It comes into play when the data are abstract, preventing decision makers from using concrete experiences. It makes it easy to break down new tasks and complex tasks that recognition cannot handle. It is especially important when there is a need to justify the decision to others, since justification usually requires us to list reasons and indicate their importance. Analytical decision making is more helpful when there is a conflict to be resolved, especially when the conflict involves people with different concerns. It is usually a better strategy to use when one needs an optimal solution. And finally, analytical decision making is needed when the problem involves so much computational complexity that recognitional processes are inadequate. However, its cost is more time and effort, and more of a disconnect with the experience of the decision maker. Figure 2 presents the conditions that increase a decision maker's tendency to use analytical strategies rather than rely on recognitional decision making.

I am not claiming that there is a right way

Factor	Effect on Using Analytical Decisions
Experience Level	*Decrease*
Time Pressure	*Decrease*
Dynamic Events	*Decrease*
Abstract Data	*Increase*
Justification	*Increase*
Conflict Resolution	*Increase*
Optimization	*Increase*
Computational Complexity	*Increase*

Figure 2. Factors affecting the use of recognitional and analytical decisions

Once a decision maker identifies the typical action, there is usually a step of imagining what will happen if the action is carried out in this situation. If any pitfalls are imagined, then the decision maker will try to modify the action. If that does not work, the officer jettisons it and thinks about the next most typical action . . . the experienced decision makers are not searching for the best option. They only want to find one that works.

Decision aids can interfere with and frustrate the performance of skilled operators. It is no wonder that field officers reject decision aids requiring them to use lengthy analytical processes when the time available is not adequate.

or a wrong way to make decisions. Different conditions call for different strategies. My goal is not to reject analytical decision making, but to make clear what its strengths and weaknesses are so that it can be applied more fruitfully.

For too long we have emphasized one strategy—the analytical one. That is the one required by doctrine. That is the one we have been teaching. That is the one we have been building decision aids to promote.

Problems with Analytical Decision Making

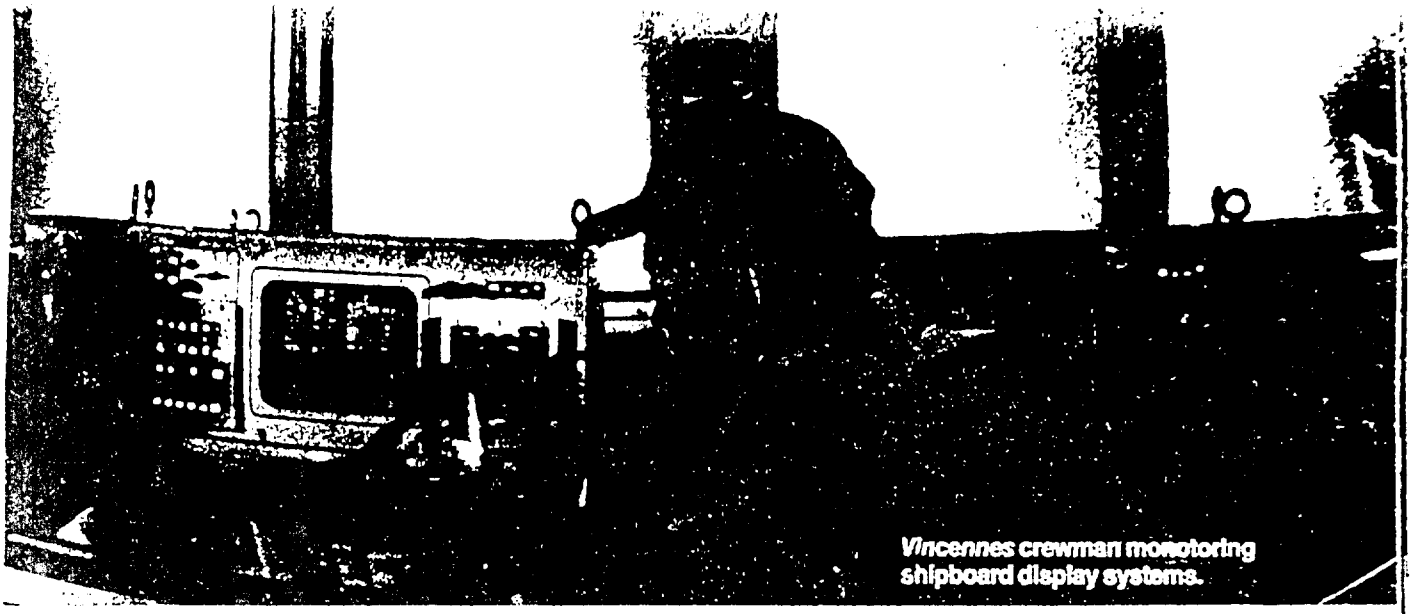
We create problems of *credibility* when we present doctrine about one right way to make decisions—the analytical strategy—and thereby force officers and soldiers to ignore doctrine in making the vast majority of time-pressured operational decisions during training exercises. It does not take them long to realize that doctrine is irrelevant in this area and to wonder whether it can be trusted in other areas.

We can create problems in *efficiency* when we teach analytical decision techniques to military personnel who will have little or no opportunity to use them. Worse yet, we create problems in *effectiveness* for personnel who try to apply these techniques and fail.

We create problems of *competence* when we build decision aids and decision support systems that assume analytical decision strategies. These systems are likely to reduce inputs to the form of abstract alphanumeric data and to restrict the operator's job to that of assessing probabilities, entering subjective utilities, providing context-free ratings and so forth. This misses the skilled operator's ability to size up situations, to notice incongruities and to think up ways to improve options. In other words, these decision aids can interfere with and frustrate the performance of skilled operators. It is no wonder that field officers reject decision aids requiring them to use lengthy analytical processes when the time available is not adequate.

Human error is often explained in terms of decision bias.[5] The concept of decision bias is that people are predisposed to make poor decisions because of several inherent tendencies, such as inaccurate use of base rates, overreliance on those data that are more readily available or appear more representative, low ability to take sample size into account and difficulty in deducing logical conclusions. This argument is often made by scientists who want to convince us that human decision makers (other than themselves) cannot be trusted, and we therefore need these scientists to develop decision aids to keep the rest of us from making grievous errors.

However, the decision bias argument has been recently attacked as unjustified and self-serving.[6] The evidence that humans are inherently biased decision makers comes from experiments run under artificial laboratory conditions. Furthermore, judgment biases appear to have a very small impact outside laboratory conditions. It is easy to use the benefit of hindsight to label each accident an example of decision bias that can best be controlled by more rigorous analytical procedures. For example, expert testimony was given by some psychologists about the Vincennes episode. With the benefit of hindsight, it was clear that something had gone wrong and there was an assumption that human error was to blame. One piece of testimony suggested that the crew was guilty of expectancy bias. They were expecting an F-14 attack and focused on cues that fit that expectation.



Vincennes crewman monitoring shipboard display systems.

Expert testimony was given by some psychologists about the Vincennes *episode. With the benefit of hindsight, it was clear that something had gone wrong and there was an assumption that human error was to blame. One piece of testimony suggested that the crew was guilty of expectancy bias. They were expecting an F-14 attack and focused on cues that fit that expectation.*

However, if the error had been in the other direction, an F-14 attack that was missed, then the blame would have been placed on base-rate bias, failure to take base rates and prior expectancies into account. My impression is that with hindsight, every error can be explained as a bias, but this may not be telling us much. I am more in agreement with the testimony showing how the *Vincennes*' control room failed to provide the crew with the cues and information that would have enabled them to take advantage of their expertise. They were prevented from using recognitional decision strategies.

My own impression is that experienced decision makers do an excellent job of coping with time pressure and dynamic conditions. Rather than trying to change the way they think, we should be finding ways to help them. We should be developing techniques for broadening their experience base through training, so they can gain situation assessment more quickly and accurately.

If we can give up our old single-theory analytical perspectives and appreciate the fact that there are a variety of decision strategies, we can improve operational decision making in a number of ways.

One opportunity is to improve strategies for effective team decision making. Staff exercises are too often a charade, where subordinates present options to a commander who then picks the best one. Usually, however, the subordinates know which option they prefer. They present, as other options, ones that had been rejected to round out the field. This procedure can be inefficient because it divorces the situation assessment activities from the response selection step and it gives the subordinates the more demanding job of assessing the situation. It asks the commander to make a choice rather than working with the team to modify and improve options. There may be times when it is more effective to have the commander work with the staff to examine the situation and then turn over to them the job of preparing implementation plans. If alternative viewpoints and criticisms are wanted, they should come during the assessment and initial planning, so as to strengthen the option to be implemented.

A second opportunity is to understand how

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commanders can present their strategic intent so that subordinates are able to improvise effectively. It is dangerous to have subordinates ignoring direction and carrying out their own plans, but it is also dangerous to have subordinates carrying out plans that no longer make sense. Improvisation arises when there is recognition that the situation has functionally changed. We need to understand how commanders can communicate their situation assessment so that their subordinates can recognize and exploit changed conditions.

A third opportunity is to revise training procedures. Certain specialties need training and analytical decision strategies. But generally, training can be more productive by focusing on situation assessment. Along with teaching principles and rules, we should present actual cases to develop sharper discriminations and improve ability to anticipate the pitfalls of various options. The goal of analytical decision training is to teach procedures that are so abstract and powerful that they will apply to a wide variety of cases. If this had been successful, it would have been quite efficient. However, we have learned that such rules do not exist. Instead, we need to enhance expertise by presenting trainees with a wide variety of situations and outcomes, and letting them improve their recognitional abilities. At the team level, we can be using after-action reviews to present feedback about the *process* of the decision making and not just on the *content* of the options that should have been selected.

A fourth opportunity is to improve decision support systems. We must insist that the designers of these systems have appropriate respect for the expertise of proficient operators and ensure that their systems and interfaces do not compromise this expertise.[7] We must find ways to present operators with displays that will make situation assessment easier and more accurate. We also want displays that will make it easier for operators to assess options in order to discover potential problems. In other words, we want to build decision support systems that enhance recognitional as well as analytical decision strategies. ⁂

NOTES

1. For a fuller view, see G. A. Klein (in press), "Recognition-Primed Decisions," *Advances in Man-Machine Systems Research*, ed. W. Rouse, (Greenwich, CT: JAI Press), 5.

2. For the purposes of this article, the term "analytical decision making" will be used to refer to these two methods, and particularly to concurrent option comparison.

3. US Department of the Army Field Manual 101-5, *Staff Organization and Operations* (Washington, DC: US Government Printing Office, May 1984), 5-9 to 5-10.

4. M. Thordsen, J. Galushka, S. Young, G. A. Klein and C. P. Brezovic, *Distributed Decision Making in a Command and Control Planning Environment* (KATR-863(C)-87-08F) (Yellow Springs, OH: Klein Associates Inc., 1987). Prepared under contract MDA903-86-C-0170 for the US Army Research Institute, Alexandria, VA.

5. D. Kahneman and A. Tversky, "Intuitive Predictions: Biases and Corrective Procedures," *TIMS Studies in Management Science*, 12, 1979, 313-27.

6. L. L. Lopes, *The Rhetoric of Irrationality*, paper presented at Colloquium in Mass Communication, Madison, WI, November 1986 (currently under revision). J. J. J. Christensen-Szalanski, "Improving the Practical Utility of Judgment Research," *New Directions in Research on Decision Making*, ed. B. Brehmer, H. Jungerman, P. Lourens and G. Sevon (North Holland: Elsevier, 1986).

7. I have made some suggestions in an earlier paper, see G. A. Klein, "Automated Aids for the Proficient Decision Maker," *IEEE Proceedings*, (1980), 301-4.

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