# INSTITUTIONALIZED DECISION MAKING AND VALID COMPUTER SIMULATIONS

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ABSTRACT

A major drawback of simulations is their debatable validity, and therefore usefulness. The present paper argues that this need not be the case for certain social processes. Routine and institutionalized decision making is a case in point. Specifically, the fact that such decisions are both complex and hierarchically delegated makes the design of valid computer simulations theoretically and practically feasible. A review of the literature shows that for such processes a very high degree of modeling validity can be expected to be reached. Some theoretical considerations are offered to help guide future work with the type of simulations advocated.

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The argument that I shall attempt to develop in this paper is based on three premises.

The first is that many disappointing results with computer simulations of social processes may be due to an improper choice of perspective.

The second is that some important and widespread processes of social decision making could demonstrably be modeled with very high degrees of validity.

The implications of these considerations are that the preconditions for a theoretically well-grounded and empirically useful paradigm of social simulations may have emerged.

I shall address the premises first, and then elaborate the argument.

## Social Simulations: Natural and Artificial Referent Structures

The disappointment felt by many of us with simulations for decision making can be traced in most cases to their debatable validity. This is probably not true in economics and for some aspects of voting behavior. As a rule, however, few people, including the designers themselves, would feel comfortable if many of the presently available simulations were used for consequential social decision making. This attitude is probably very wise. I would argue that it calls attention to possibly misdirected efforts, and upon reflection, to what might be a basic misconception.

To understand the nature of this misconception, it is useful to review briefly the rationale behind simulations for decision making. In essence, the rationale involves the notions of complexity and convenience. Beginning with the notion of complexity, it is held to justify three types of simulations that I would call calculating simulations, mirroring simulations, and dynamic formalizations.

The usual justification for calculating simulations is that the implications of complex processes may be difficult or impossible to work out. In such a case, the function of a simulation is to compute outcomes under specific conditions. The observation that a simulation is not better than the assumptions built into it does not constitute a criticism for this type of simulation. The reason is that those who run them are usually very confident in all the details of the theory simulated. Simulations of pure or derived physical processes, for instance, lunar flights, are examples in point.

The rationale for mirroring simulations is quite different and runs somewhat as follows: social phenomena are extremely complex. To study them it is essential to simplify and extract the main characteristics of social processes. Indeed, as Zelditch and Evan (1962) put it, "there are always more relevant variables than any observer or any theory could conceivably take into account at any time. Through simulations, the processes may be simplified, measured, and manipulated, so that....extraneous disturbances [may be] eliminated, and the process observed comprehensively, precisely and more or less at the will of the investigator." Here, therefore, simulations are seen as simplifying devices and as useful means for overcoming the confusing complexity of social processes.

Finally, some simulation efforts--what I labelled earlier dynamic formalizations--stress less the simulation as a finished product, than the activity per se of building a model. In such a case, the main benefit is held to be the sharpening of one's formulations which necessarily occurs during the process of designing a simulation. As Guetzkow (1962) puts it, "Although it is but one of alternative ways of building models about the operation of social systems, its operating character demands a greater clarity in formulation than is often necessary in literary and mathematical formulations. To construct an operable representation one must specify variables with some precision and then interlock the variables with some exactitude." Thus, for instance, it is one thing to say that, theoretically, problem solving involves such stages as preparation, incubation, illumination, and verification, and quite another thing to specify exactly what is involved in each stage, so that the computer can simulate the process (c.f. Hovland, 1962). Here, then, the perplexing complexity of social processes is seen as usefully tackled by the activity of designing a simulation, whatever its ultimate value as a product may be.

Turning now to the convenience argument, it rests primarily on the observation that simulations allow to experiment at will with alternative courses of action. In particular, such experiments do not have to depend on rare events, or on considerations of safety, morality, or practical feasibility, which often constrain real experiments.

Quite clearly, these advantages accrue only to the extent that one has succeeded in building a valid simulation, that is, in the case of calculating simulations. Experimenting with simulations on whose theoretical structure and details we have less than complete confidence, i.e., with mirroring simulations or dynamic formalizations, entails the above advantages only insofar as the result of the runs are viewed as having heuristic or insight value.

It is worth noting that in most reports on simulations, an explicit or implicit assumption is that their ultimate goal is to achieve the status of calculating simulations, so as to give policy or decision makers the advantages of convenience just discussed. As a result, mirroring simulations--which probably best characterize most present-day simulations--and attempts at dynamic formalizations, are presented as stages towards this goal, remote as it may be acknowledged to be.

This hierarchical view, with calculating simulations as an ideal, implies an ultimate criterion of validity and usefulness which is related to the two-entity nature of calculating simulations. The two entities are the referent structure being modeled, and its representation--the simulation; the criterion of validity in such a case is quite naturally the referent structure itself.

A moment's thought, however, suggests that this conceptualization is imperfect. Indeed, in practice, a third element is always involved: this third element being the designer, and his image of the referent structure or process he wishes to simulate. The two situations are diagrammed in Figure 1.

An important implication of Figure 1 is that while situation 1.A allows and requires only one type of validation--the referent structure validation just mentioned--Figure 1.B points to the existence of several criteria of validation, according to the goals or combination of goals which were sought. These include: the objectivization of a researcher's or decision maker's subjective representation, in order to follow its implications; the objectivization of this representation to examine its fit with reality; or an attempt to represent adequately the real referent system--in effect the situation discussed in reference to Figure 1.B.

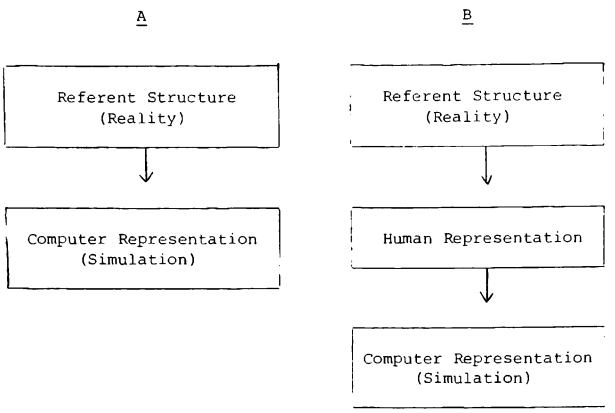


FIGURE 1

Two Models of Simulation

It would seem that the overlap between man's representation of a referent structure, and the structure itself (which must be assumed to transform Figure 1.B into Figure 1.A) is presently an unrealistic assumption in most social science disciplines. Should this be the case, most social simulations cannot be expected to be valid, as indeed they are not, for there is nothing in the methodology to help bridge an ignorance gap. Such a view suggests two useful approaches for modeling efforts.

The first is to explicitly conceive of simulation as an experimental activity, whose heuristic value rests in the process of feedback which it affords between the designer, the environment, and the simulation. For such work, a legitimate criterion of usefulness is the improved representation of man's view of the referent system that modeling affords. The ultimate goal of this process is properly the construction of simulations as perfectly validated in terms of the referent structure as possible. Presently, however, the case for such simulations would seem to rest first and foremost on the progress of man's representations that they afford. Should it be the case that, for a particular topic or substantive area, imperfect simulations are not useful or efficient for bettering man's representations, a rationale for building simulations for decision making in such areas would seem to be largely lacking. Indeed, few people would presently consider using most available simulations for serious decision making, and mediocre claims of validity are not likely to salvage the situation; rather, they are likely to blur the picture, and cast a general discredit upon the value of all simulation efforts.

The second useful approach is to simulate social processes for which human representations are demonstrably valid, or for which such representations are in themselves the legitimate data of interest. The latter condition is often met in research, and I shall not discuss it in the present paper. With regard to the former, however, I would argue that in the social sciences this condition already holds in the case of institutionalized systems of rules. The reasons are many, but are reducible to the observation that such systems are man-made for man-conceived purposes. Conceptually, therefore, any discrepancy between the operation of a simulation and the actual system of rules becomes manageable, in principle at least. This follows from the fact that in the case of artificial and purposeful systems, people, rather than nature, are the anchor and ultimate locus of control of the system. As a result, discrepancies between a simulation based on limited human knowledge--in this case the knowledge of the responsible persons in charge of the systems--and the actual mode of operation of the system itself, do not necessarily invalidate the model.

To clarify this point, consider the ways in which a simulation of the type considered can be invalid. The first is rather trivial. The designer may have poorly retrieved the formal rules and procedures which constitute the system. This, of course, is easy to remedy. The second assumes that the rules have already been properly retrieved, and are demonstrably incorporated into the model. In such a case a discrepancy between runs of the simulation and the operation of the actual system can have two sources. The first is that other or additional rules than those publicized are in fact applied. In such a case the formal rules and procedures are misleading, and two questions arise. One is related to who is being misled; another is whether or not this is intentional. Quite clearly these are significant issues, which can even raise problems of social control; an important contribution of simulations is that they can help to focus and clarify them.

Another source of possible discrepancies is related to the fact that rules and procedures are applied by people who might be inconsistent. This, however, is not a problem of validity, but rather of reliability. Furthermore, it is a problem located in the referent system, and one on which a simulation can cast valuable light.

With this last remark I have in effect begun discussing the main thesis of this paper. Before developing it further, however, it might be useful to pause a moment to give substance to the discussion by introducing a concrete example of the type of system which might usefully be modeled. I shall now describe such a system.

## Routinized Decision Making

Consider the nature of bureaucracies. They are systems where--by definition--problem solving and decision making have been routinized. Indeed, if such processes are not routinized, we are not dealing with a true bureaucracy. Excluding therefore the cases of crises--to which I shall return later--a property of bureaucracies is that the rules and procedures for the myriad of decisions that they daily make are institutionalized. Moreover, through the operation of the principle of hierarchical accountability, these rules and procedures are constantly made explicit, and often formalized. From these considerations, in particular the fact that decisions are routinized by the recurrent application of explicit rules and procedures, it follows, I would argue, that a bureaucracy operating under normal conditions may be conceived of as a program.

This remark has several implications. In the first place the logic of artificial purposeful systems suggests that, should a simulation be valid in terms of the formal rules and procedures incorporated in it, any discrepancy between its runs and actual decisions raises at best a problem of performance, and at worst one of social control. Secondly, the program structure of bureaucracies, at least for the decisions they were set up to make, suggests that computer simulations are a natural methodology for modeling and studying such institutions. In particular the data required to retrieve both the architecture and the specifics of the program structure of such institutions are readily and isomorphically available in the form of organizational charts, rules, procedures, and criteria.

It would appear, therefore, that most bureaucracies may have the characteristics required for making valid simulations both possible and useful. This is so, except for one difficulty. As every student of bureaucratic organizations knows, in many cases the formal procedures do not specify rules and criteria, but simply state who is entitled to make which decisions. This discretionary

aspect of the bureaucratic system raises a very fundamental problem. Quite clearly, it could even invalidate the whole argument developed to this point.

Before pursuing any further, therefore, we must confront this issue. I shall now attempt to do so by showing that, for recurrent tasks, the human information-processing characteristics do not make discretionary decisions a problem; rather, these characteristics suggest that the type of modeling advocated is both feasible, and also, perhaps, necessary. To make these points, a brief discussion of some findings related to human information processing and decision making is necessary.

Recurrent Decision Making

One finding of importance for the purpose at hand is that human information-processing capabilities are rather limited. A classical statement of this fact has long been the very title of Miller's famous paper, "The magical number seven, plus or minus two." (Miller, 1956). In particular, it appears that human information processing is constrained by time parameters of access to, and retrieval from memory; by the size of the short-term memory; and by the list-structure organization of stored information (Simon, 1969). As a consequence it can be shown that man may be expected to make judgments and decisions by means of heuristics, as in fact he does. Surprisingly, however, these heuristics appear to be extraordinarily simple (Tversky and Kahnman, 1974; Inbar, 1974). Nevertheless, and as one would expect, human information processing in general, and creative thinking in particular, are demonstrably very complex (Neisser, 1967). Paradoxically, therefore, the evidence is that normal daily problem solving and decision making are the results of greatly complex processes, while the heuristics by means of which they are carried out appear to be of a puzzling functional simplicity.

How puzzling these heuristics are, becomes evident when one considers the success achieved with simple linear models, in particular multiple regressions, for modeling the decision rules of individuals engaged in repetitive tasks of decision making. Although the fact is incidental to our discussion, it should be noted that originally the use of such models was apologetical; the reason is that while linear models have methodological advantages, they also have theoretical shortcomings. The obvious advantage of a regression analysis is that it yields in a straightforward manner a measure of the relationship existing between any single independent variable and a decision--the b's; it also yields an interpretable measure of the decision's predictability--the multiple R. The disadvantage of this type of analysis, however, is that it assumes that the independent variables are additively related to the predicted variable. If one takes into account that most people experience judgments as being contextual and configurative, the likely outcome is therefore that although easy to perform, regression analyses may not be very helpful.

Contrary to this expectation, linear models turn out to be very efficient. To illustrate the results typically obtained, consider the clinical task of having to diagnose neurotic and psychotic patients by means of their MMPI profiles. The scale scores of the subparts of these personality inventories are conceptualized as being the independent variables of a multiple regression, and the decisions as being the dependent variable--these decisions being expressed as a dichotomy, 0 - 1, or as a scale value of estimated intensity of sickness, for instance 0 through 11. The data used in the study considered consist of 861 profiles of actual patients, diagnosed by 29 clinical psychologists. That is, for each of the 29 judges there are 861 judgments. These data, known as the Oregon Data Bank, have been submitted to numerous analyses which have been reported in the literature (see, for instance, Meehl, 1959; and Goldberg, 1968, 1970).

For our purpose, the major finding of interest is the degree to which clinical judgments are reproducible with linear assumptions. As it turns out, the decisions appear to be highly modelable. Indeed, despite the fact noted by Meehl (1959, p.104), that "differences between psychotic and neurotic profiles are considered in MMPI lore to be highly configural in character, so that an atomistic treatment by combining single scales linearly should theoretically be a very poor substitute for a configural approach," the fact is that after a decade or so of research and replications, the judgments seem to be almost completely reproducible. The overall conclusion which imposes itself is, in the words of a prominent student of the Oregon Data Bank, that "a simple linear model will normally permit the reproduction of 90% - 100% of the clinical judges' reliable judgmental variance." (Goldberg, 1968, p. 491). This finding may strike one as verging on the impossible. The fact is, however, that it has been replicated many times, and with different judges as well as tasks. Slovic and Lichtenstein (1971, pp.677-678), reviewing the empirical evidence to date, summarize the situation as follows:

> "Examination of more than 30 of these studies illustrates the tremendous diversity of judgmental tasks to which the model has been applied. The tasks include judgment about personality characteristics; performance in college or on the job; attractiveness of common stock and other types of gambles; physical and mental pathology; and legal matters.* In some cases, the stimuli were artificial and the judges were unfamiliar with the task. Typical of these is a study by Knox and Hoffman (1962), who asked college students to judge the intelligence of other students on the basis of grade point average, aptitude test scores, credit hours attempted, etc., and a study by Summers (1968), who asked students to rate the potential for achieving minority group equality as a function of legislated opportunities and educational opportunities. At the other extreme are studies of judgments made in complex but familiar situations by skilled decision makers, who had other cues available besides those included in the prediction equation. For example, Kort (1968) modeled judicial decisions in Workmen's Compensation Cases, using various facts from the cases as cues. Brown (1970) modeled caseworkers' suicide probability estimates for persons phoning a metropolitan suicide prevention center; the cues were variables such as sex, age, suicide plan, etc., obtained from the telephone interview. And Dawes (1971) used a linear model to predict the ratings given applicants for graduate school by members of the admissions committee. In all these situations the linear model has done a fairly good job of predicting the judgments, as indicated by Rs values in the .80's and .90's for the artificial tasks, and the .70's for the more complex real-world situations."

The evidence, then, is that for improvised or somewhat unstructured tasks of decision making, the multiple Rs we can expect to obtain are in the .70's. For either artificial or routinized decisions, on the other hand, the figure rises to an impressive .90, with a range of variation of only about 10%.

If so, an even more daring approach can be contemplated. Indeed, if a simple regression can act as a functional subrogate for what decision makers typically describe as a complex and interactive process, one might well begin wondering about how simple a regression analysis can afford to be before it becomes inefficient.

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*The sixteen references cited in the original in support of these statements have been omitted.

In the MMPI task just discussed, the clinical judges were presented in each case with eleven subscores of the subparts of the MMPI. If decision makers so grossly misperceive the functional simplicity of their judgments, one intriguing possibility is, indeed, that they also misperceive the number of variables they actually take into consideration in a decision. Operationally this amounts to the question of the number of independent variables--or cues, as they are often referred to in this tradition of research--which are really necessary to reproduce the judges' decisions. Such a question can be addressed in two ways. First directly, by using in the regression equation less cues than were available to the decision maker. Second, in a somewhat experimental manner, by asking the judges to list at the end of the task the cues they believe to have taken into consideration, and also the relative weights they feel that they have attached to them. Both types of studies have been carried out, and Slovic and Lichtenstein (1971, p.684), summarize the findings as follows:

> "Across a number of studies, varying in the number of cues that were available, three cues usually sufficed to account for more than 80% of the predictable variance in the judges' responses....One type of error in self-insight has emerged in all of these studies. Judges strongly overestimate the importance they place on minor cues (i.e., their subjective weights greatly exceed the computed weights for these cues) and they underestimate their reliance on a few major variables. Subjects apparently are quite unaware of the extent to which their judgments can be predicted by only a few cues."

Not surprisingly, this discrepancy between common sense and actual findings has given rise to a search for explanations; discussing them, however, would take us too far afield. An hypothesis advanced by Shepard will illustrate one type of explanation which has some favor in the literature:

> "Possibly our feelings that we can take into account a host of different factors comes about because, although we remember that at some time or other we have attended to each of the different factors, we fail to notice that it is seldom more than one or two that we consider at any one time." (Shepard, 1964, p.266).

Whatever the case may be, it seems fair to hold that two conclusions stand out from the study of man as an information processor. The first is rather noncontroversial and holds that the human thinking process is still much of a mystery. The second is much more surprising, and points to the fact that man's decision-making activities, in particular routinized decision making, can be modeled with an extraordinary degree of accuracy, whether decision makers are aware of it or not.

## Elements of a Paradigm

We can now resume the argument previously interrupted. As will be recalled, and disregarding momentarily human variability and discretionary prerogatives, the purely artificial and instrumental logic and raison d'etre of bureaucracies indicate that they should be modelable with as data their rules, procedures and criteria. Indeed, whenever this is not the case there would seem to be room for either social control or improved efficiency.

The conditions under which social control are needed are rather obvious and need not be elaborated here. The problem of improved efficiency, on the other hand, may benefit from our discussion of the characteristics of repetitive human decision making.

As we have seen, human information-processing capabilities are both limited and misperceived. It stands to reason, therefore, that complex systems involving thousands of delegated tasks--in particular of decision making--might also be misperceived by any of a number of its participants, clients, and above all, by those persons who are in charge of, and responsible for, the purposeful operation of the system. Simulating it might therefore be a useful, perhaps even a necessary means for bridging the ignorance gap which is likely to exist in and out most bureaucracies. It is noteworthy that an important reason which makes this task potentially useful is that both in form and logic the referent structure and the type of simulation advocated are similar in ways which are not captured by probabilistic models. In particular, an information-processing simulation of a bureaucracy, itself conceived as a programmed information processor, can be expected to help locating and interpreting both the sources and levels of mismatches, in ways in which probabilistic conceptualizations cannot.

Of no less importance is the contribution that simulations can make to the problem created by man's unreliability. As already noted, the source of this problem lies in the referent structure itself, rather than in the model. A direct outcome of modeling, therefore, is that it should help cast light on the process of error diffusion, a problem of central importance in any system, but one which has largely gone unstudied in human systems.

Turning now to discretionary decisions, it is useful to distinguish between two cases. One occurs when discretionary decisions are recurrently made, as for instance in the case of rulings, judgments, diagnoses, etc. The other obtains when unique or nearly unique decisions are made, as happens in times of crises.

By definition, unique decisions are boundary cases for bureaucracies, and if consequential they are likely to be associated with social or functional changes in the system, rather than with its normal mode of operation. I shall therefore focus on normal and recurrent discretionary decisions, and return later to the boundary cases.

From the perspective taken in this paper, discretionary role decision making has two characteristics of interest. The first is that from an objective point of view the term is probably a misnomer. Indeed, as we have seen, under conditions of repetitive decision making, man develops stable decision rules which are relatively easy to model. In other words, while decisions may be discretionary in terms of role prerogatives, the likelihood is that they become rapidly stereotyped; as a consequence, and within the limits of human reliability, and at times of explorative behaviors, such decisions are far from being indeterminate; rather, they are likely to be predictable, as most people dealing with role incumbents intuitively know, and as we have seen it to be indeed the case.

The second characteristic of discretionary decisions is that they are incongruent with the philosophy underlying most purposeful systems of rules. As Weber has pointed out, such systems partake and express a social trend toward the rationalization of social action. A concomitant of this trend, he argues, is the division of labor, the hierarchization, and the principle of accountability, by means of which these rules are carried out. In systems of this kind, however, discretion is obviously an incongruence. Historically, therefore, it is not surprising to find a trend toward the reduction of bureaucratic discretion, both within bureaucracies as well as within society at large.*

Returning to our concern, I would argue that simulations are in a unique position to contribute to the trend toward social rationalization, at least for certain subprocesses of institutionalized decision making. To illustrate, it would seem that such topics as clients' eligibil-

*This trend takes sometimes a form which expresses the innermost logic of many bureaucratic decisions--replacing an employee with computerized rules.

ity for benetits, administrative and legal rulings and judgments, and more generally the process of institutionalized selection and promotion of personnel, may present very real modeling opportunities.

Should I have made my case, one could wonder why simulations of the kind advocated have not yet been designed. The fact is that some have; furthermore, these simulations bear out the expectations of validity and usefulness suggested by our theoretical discussion. To take but one example, Davis and Rueter designed a computer simulation of municipal zoning in Pittsburgh.* As the authors show, the simulation is able to predict correctly over 90% of the actual decisions; moreover, the theoretical and practical usefulness of this endeavor is demonstrated by the analysis of the effect of public opinion, as well as by the analysis of the discrepant results, afforded by the simulation. The reader interested in the details of these analyses is invited to consult the original report.

The problem with this and similar information processing simulations, however, is that they are conceived more as exercises and illustrations, than as ongoing activities. This, I would argue, is due to two causes. The first is that the concept of power, and more particularly the focus on the power structures within which decisions are made, as well as the salience of crisis situations, exert a fascination that routine decisions do not. As a consequence these perspectives also mobilize much, if not most, of the research and modeling efforts. The fact is, however, that while power struggles sometimes induce consequential changes, between such changes institutionalized decision making is carried out within relatively stable power structures. It would seem therefore that, between crises, institutionalized and routinized decisions may even be a more consequential topic. At least it is presently a more researchable and more modelable topic; for simulation endeavors,therefore, it is likely to provide a strategically advantageous approach to the study of social decision making.

The second cause for the paucity of simulations of institutionalized decision making within a framework of information processing is, I believe, the lack of awareness of the strong practical and theoretical reasons for designing such simulations. The foregoing discussion suggests, however, that such reasons might not only exist, but in addition be anchored in a theoretical and methodological paradigm.

This has been suggested with particular force by Newell and Simon (1971); in particular, they have proposed that computers as systems may constitute for human information processing and decision making an analytical tool as powerful and useful as the number system and differential equations are for physical processes. I would argue that while the parallel is intriguing at the individual level, at which and for which it was originally formulated, it becomes almost compelling in the case of institutions. The reason is that at the individual level the retrieval of decision rules requires the use of a rather artificial procedure--the generation of a protocol (inferring decision rules rather than retrieving them--as in the case of multiple regression modeling--is of course a different matter). The logic of institutional decision making, on the other hand, implies that the data required to model this process are exactly those which are naturally generated (e.g., rules, directives, procedures, criteria).**

Furthermore, the social perspective leads to the realization that both computers and bureaucratized institutions can be genuinely viewed as being programmed decision makers; this in turn immediately suggests that debugging--in an isomorphic rather than in an analogical sense--might be essential in one case as it is in the other. Similarly, and going now from social information processors to computers, it appears likely that some problem-solving strategies developed in bureaucracies may be found to provide important insights for the development of heuristics, a task on which progress in designing systems endowed with artificial intelligence depends.

The point, then, is that there are important similarities between computer and human information processing. Of perhaps greater importance is the fact that, when the latter process is blown up and objectivized by the requirements of orderly social intercourse, it might even become legitimate to talk about partial isomorphisms. Should this be the case, computer simulations of institutionalized decision making may have uses which have hardly begun to be tapped; they have also a theoretical rationale whose power may not have been yet fully recognized.

*It is a relatively complex simulation which involves a fourteen-page flow-chart.

**More generally, the prerequisites for human interaction suggest that social settings, in particular group problem solving, might cast light on human information processing in natural ways which cannot be matched by the protocol procedure.

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