*Michael D. Cohen, James G. March, and Johan P. Olsen*

# A Garbage Can Model of Organizational Choice

*Organized anarchies are organizations characterized by problematic preferences, unclear technology, and fluid participation. Recent studies of universities, a familiar form of organized anarchy, suggest that such organizations can be viewed for some purposes as collections of choices looking for problems, issues and feelings looking for decision situations in which they might be aired, solutions looking for issues to which they might be an answer, and decision makers looking for work. These ideas are translated into an explicit computer simulation model of a garbage can decision process. The general implications of such a model are described in terms of five major measures on the process. Possible applications of the model to more narrow predictions are illustrated by an examination of the model's predictions with respect to the effect of adversity on university decision making.*

Consider organized anarchies. These are organizations—or decision situations—characterized by three general properties.[1] The first is problematic preferences. In the organization it is difficult to impute a set of preferences to the decision situation that satisfies the standard consistency requirements for a theory of choice. The organization operates on the basis of a variety of inconsistent and ill-defined preferences. It can be described better as a loose collection of ideas than as a coherent structure; it discovers preferences through action more than it acts on the basis of preferences.

The second property is unclear technology. Although the organization manages to survive and even produce, its own processes are not understood by its members. It operates on the basis of simple trial-and-error procedures, the residue of learning from the accidents of past experience, and pragmatic inventions of necessity. The third property is fluid participation. Participants vary in the amount of time and effort they devote to different domains; involvement varies from one time to another. As a result, the boundaries of the organization are uncertain and changing; the audiences and decision makers for any particular kind of choice change capriciously.

These properties of organized anarchy have been identified often in studies of organizations. They are characteristic of any organization in part—part of the time. They are particularly conspicuous in public, educational, and illegitimate organizations. A theory of organized anarchy will describe a portion of almost any organization's activities, but will not describe all of them.

To build on current behavioral theories of organizations in order to accomodate the concept of organized anarchy, two major phenomena critical to an understanding of anarchy must be investigated. The first is the manner in which organizations make choices without consistent, shared goals. Situations of decision making under goal ambiguity are common in complex organizations. Often problems are resolved without recourse to explicit bargaining or to an explicit price system market—two common processes for decision making in the absence of consensus. The second phenomenon is the way members

[1] We are indebted to Nancy Block, Hilary Cohen, and James Glenn for computational, editorial, and intellectual help; to the Institute of Sociology, University of Bergen, and the Institute of Organization and Industrial Sociology, Copenhagen School of Economics, for institutional hospitality and useful discussions of organizational behavior; and to the Ford Foundation for the financial support that made our collaboration feasible. We also wish to acknowledge the helpful comments and suggestions of Søren Christensen, James S. Coleman, Harald Enderud, Kåre Rommetveit, and William H. Starbuck.

of an organization are activated. This entails the question of how occasional members become active and how attention is directed toward, or away from, a decision. It is important to understand the attention patterns within an organization, since not everyone is attending to everything all of the time.

Additional concepts are also needed in a normative theory of organizations dealing with organized anarchies. First, a normative theory of intelligent decision making under ambiguous circumstances (namely, in situations in which goals are unclear or unknown) should be developed. Can we provide some meaning for intelligence which does not depend on relating current action to known goals? Second, a normative theory of attention is needed. Participants within an organization are constrained by the amount of time they can devote to the various things demanding attention. Since variations in behavior in organized anarchies are due largely to questions of who is attending to what, decisions concerning the allocation of attention are prime ones. Third, organized anarchies require a revised theory of management. Significant parts of contemporary theories of management introduce mechanisms for control and coordination which assume the existence of well-defined goals and a well-defined technology, as well as substantial participant involvement in the affairs of the organization. Where goals and technology are hazy and participation is fluid, many of the axioms and standard procedures of management collapse.

This article is directed to a behavioral theory of organized anarchy. On the basis of several recent studies, some elaborations and modifications of existing theories of choice are proposed. A model for describing decision making within organized anarchies is developed, and the impact of some aspects of organizational structure on the process of choice within such a model is examined.

## THE BASIC IDEAS

Decision opportunities are fundamentally ambiguous stimuli. This theme runs through several recent studies of organizational choice.[2] Although organizations can often be viewed conveniently as vehicles for solving well-defined problems or structures within which conflict is resolved through bargaining, they also provide sets of procedures through which participants arrive at an interpretation of what they are doing and what they have done while in the process of doing it. From this point of view, an organization is a collection of choices looking for problems, issues and feelings looking for decision situations in which they might be aired, solutions looking for issues to which they might be the answer, and decision makers looking for work.

Such a view of organizational choice focuses attention on the way the meaning of a choice changes over time. It calls attention to the strategic effects of timing, through the introduction of choices and problems, the time pattern of available energy, and the impact of organizational structure.

To understand processes within organizations, one can view a choice opportunity as a garbage can into which various kinds of problems and solutions are dumped by participants as they are generated. The mix of garbage in a single can depends on the mix of cans available, on the labels attached to the alternative cans, on what garbage is currently being produced, and on the speed with which garbage is collected and removed from the scene.

Such a theory of organizational decision making must concern itself with a relatively complicated interplay among the generation of problems in an organization, the deployment of personnel, the production of solutions, and the opportunities for choice. Although it may be convenient to imagine that choice opportunities lead first to the generation of decision alternatives, then to an examination of their consequences, then to an evaluation of those consequences in terms of objectives, and finally to a decision, this type of model is often a poor description of what actually happens. In the garbage can model, on the other hand, a decision is an outcome

[2] We have based the model heavily on seven recent studies of universities: Christensen (1971), Cohen and March (1972), Enderud (1971), Mood (1971), Olsen (1970, 1971), and Rommetveit (1971). The ideas, however, have a broader parentage. In particular, they obviously owe a debt to Allison (1969), Coleman (1957), Cyert and March (1963), Lindblom (1965), Long (1958), March and Simon (1958), Schilling (1968), Thompson (1967), and Vickers (1965).

or interpretation of several relatively independent streams within an organization.

Attention is limited here to interrelations among four such streams.

*Problems.* Problems are the concern of people inside and outside the organization. They might arise over issues of lifestyle; family; frustrations of work; careers; group relations within the organization; distribution of status, jobs, and money; ideology; or current crises of mankind as interpreted by the mass media or the nextdoor neighbor. All of these require attention.

*Solutions.* A solution is somebody's product. A computer is not just a solution to a problem in payroll management, discovered when needed. It is an answer actively looking for a question. The creation of need is not a curiosity of the market in consumer products; it is a general phenomenon of processes of choice. Despite the dictum that you cannot find the answer until you have formulated the question well, you often do not know what the question is in organizational problem solving until you know the answer.

*Participants.* Participants come and go. Since every entrance is an exit somewhere else, the distribution of "entrances" depends on the attributes of the choice being left as much as it does on the attributes of the new choice. Substantial variation in participation stems from other demands on the participants' time (rather than from features of the decision under study).

*Choice opportunities.* These are occasions when an organization is expected to produce behavior that can be called a decision. Opportunities arise regularly and any organization has ways of declaring an occasion for choice. Contracts must be signed; people hired, promoted, or fired; money spent; and responsibilities allocated.

Although not completely independent of each other, each of the streams can be viewed as independent and exogenous to the system. Attention will be concentrated here on examining the consequences of different rates and patterns of flows in each of the streams and different procedures for relating them.

## THE GARBAGE CAN

A simple simulation model can be specified in terms of the four streams and a set of garbage processing assumptions.

Four basic variables are considered; each is a function of time.

*A stream of choices.* Some fixed number, m, of choices is assumed. Each choice is characterized by (a) an entry time, the calendar time at which that choice is activated for decision, and (b) a decision structure, a list of participants eligible to participate in making that choice.

*A stream of problems.* Some number, w, of problems is assumed. Each problem is characterized by (a) an entry time, the calendar time at which the problem becomes visible, (b) an energy requirement, the energy required to resolve a choice to which the problem is attached (if the solution stream is as high as possible), and (c) an access structure, a list of choices to which the problem has access.

*A rate of flow of solutions.* The verbal theory assumes a stream of solutions and a matching of specific solutions with specific problems and choices. A simpler set of assumptions is made and focus is on the rate at which solutions are flowing into the system. It is assumed that either because of variations in the stream of solutions or because of variations in the efficiency of search procedures within the organization, different energies are required to solve the same problem at different times. It is further assumed that these variations are consistent for different problems. Thus, a solution coefficient, ranging between 0 and 1, which operates on the potential decision energies to determine the problem solving output (effective energy) actually realized during any given time period is specified.

*A stream of energy from participants.* It is assumed that there is some number, v, of participants. Each participant is characterized by a time series of energy available for organizational decision making. Thus, in each time period, each participant can provide some specified amount of potential energy to the organization.

Two varieties of organizational segmentation are reflected in the model. The first is the mapping of choices onto decision makers, the decision structure. The decision structure of the organization is described by D, a v-by-m array in which $d_{ij}$ is 1 if the ith participant is eligible to participate in the making of the jth choice. Otherwise, $d_{ij}$ is 0. The second is the mapping of problems onto choices, the access structure. The access structure of the organization is described by A, a w-by-m array in which $a_{ij}$ is 1 if the jth choice is accessible to the ith problem. Otherwise, $a_{ij}$ is 0.

In order to connect these variables, three key behavioral assumptions are specified. The first is an assumption about the additivity of energy requirements, the second specifies the way in which energy is allocated to choices, and the third describes the way in which problems are attached to choices.

*Energy additivity assumption.* In order to be made, each choice requires as much effective energy as the sum of all requirements of the several problems attached to it. The effective energy devoted to a choice is the sum of the energies of decision makers attached to that choice, deflated, in each time period, by the solution coefficient. As soon as the total effective energy that has been expended on a choice equals or exceeds the requirements at a particular point in time, a decision is made.

*Energy allocation assumption.* The energy of each participant is allocated to no more than one choice during each time period. Each participant allocates his energy among the choices for which he is eligible to the one closest to decision, that is the one with the smallest energy deficit at the end of the previous time period in terms of the energies contributed by other participants.

*Problem allocation assumption.* Each problem is attached to no more than one choice each time period, choosing from among those accessible by calculating the apparent energy deficits (in terms of the energy requirements of other problems) at the end of the previous time period and selecting the choice closest to decision. Except to the extent that priorities enter in the organizational structure, there is no priority ranking of problems.

These assumptions capture key features of the processes observed. They might be modified in a number of ways without doing violence to the empirical observations on which they are based. The consequences of these modifications, however, are not pursued here. Rather, attention is focused on the implications of the simple version described. The interaction of organizational structure and a garbage can form of choice will be examined.

## ORGANIZATIONAL STRUCTURE

Elements of organizational structure influence outcomes of a garbage can decision process (a) by affecting the time pattern of the arrival of problems choices, solutions, or decision makers, (b) by determining the allocation of energy by potential participants in the decision, and (c) by establishing linkages among the various streams.

The organizational factors to be considered are some that have real-world interpretations and implications and are applicable to the theory of organized anarchy. They are familiar features of organizations, resulting from a mixture of deliberate managerial planning, individual and collective learning, and imitation. Organizational structure changes as a response to such factors as market demand for personnel and the heterogeneity of values, which are external to the model presented here. Attention will be limited to the comparative statics of the model, rather than to the dynamics produced by organizational learning.

To exercise the model, the following are specified: (a) a set of fixed parameters which do not change from one variation to another, (b) the entry times for choices, (c) the entry times for problems, (d) the net energy load on the organization, (e) the access structure of the organization, (f) the decision structure of the organization, and (g) the energy distribution among decision makers in the organization.

Some relatively pure structural variations will be identified in each and examples of how variations in such structures might be related systematically to key exogenous variables will be given. It will then be shown how such factors of organizational structure affect important characteristics of the decisions in a garbage can decision process.

### Fixed Parameters

Within the variations reported, the following are fixed: (a) number of time periods—twenty, (b) number of choice opportunities—ten, (c) number of decision makers—ten, (d) number of problems—twenty, and (e) the solution coefficients for the 20 time periods—0.6 for each period.[3]

### Entry Times

Two different randomly generated sequences of entry times for choices are considered. It is assumed that one choice enters per time period over the first ten time periods in one of the following orders: (a) 10, 7, 9, 5, 2, 3, 4, 1, 6, 8, or (b) 6, 5, 2, 10, 8, 9, 7, 4, 1, 3.

Similarly, two different randomly generated sequences of entry times for problems are considered. It is assumed that two problems enter per time period over the first ten time periods in one of the following orders: (a) 8, 20, 14, 16, 6, 7, 15, 17, 2, 13, 11, 19, 4, 9, 3, 12, 1, 10, 5, 18, or (b) 4, 14, 11, 20, 3, 5, 2, 12, 1, 6, 8, 19, 7, 15, 16, 17, 10, 18, 9, 13.

### Net Energy Load

The total energy available to the organization in each time period is 5.5 units. Thus, the total energy available over twenty time periods is $20 \times 5.5 = 110$. This is reduced by the solution coefficients to 66. These figures hold across all other variations of the model. The net energy load on the organization is defined as the difference between the total energy required to solve all problems and the total effective energy available to the organization over all time periods. When this is negative, there is, in principle, enough energy available. Since the total effective energy available is fixed at 66, the net load is varied by varying the total energy requirements for problems. It is assumed that each problem has the same energy requirement under a given load. Three different energy load situations are considered.

*Net energy load 0: light load.* Under this condition the energy required to make a choice is 1.1 times the number of problems attached to that choice. That is, the energy required for each problem is 1.1. Thus, the minimum total effective energy required to resolve all problems is 22, and the net energy load is $22 - 66 = -44$.

*Net energy load 1: moderate load.* Under this condition, the energy required for each problem is 2.2. Thus, the energy required to make a choice is 2.2 times the number of problems attached to that choice, and the minimum effective energy required to resolve all problems is 44. The net energy load is $44 - 66 = -22$.

*Net energy load 2: heavy load.* Under this condition, each problem requires energy of 3.3. The energy required to make a choice is 3.3 times the number of problems attached to that choice. The minimum effective energy required to resolve all problems is 66, and the net energy load is $66 - 66 = 0$.

Although it is possible from the total energy point of view for all problems to be resolved in any load condition, the difficulty of accomplishing that result where the net energy load is zero—a heavy load—is obviously substantial.

### Access Structure

Three pure types of organizational arrangements are considered in the access structure (the relation between problems and choices).

*Access structure 0: unsegmented access.* This structure is represented by an access array in which any active problem has access to any active choice.

$$A_0 = \begin{array}{c} 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \end{array}$$

*Access structure 1: hierarchical access.* In this structure both choices and problems are

[3] The model has also been exercised under conditions of a set of solution coefficients that varies over the time periods. Specifically, the following series has been used: 1, 0.9, 0.7, 0.3, 0.1, 0.1, 0.3, 0.7, 0.9, 1, 0.6, 0.6, 0.6, 0.6, 0.6, 0.6, 0.6, 0.6, 0.6, 0.6. This simulation, using only one combination of choice and problem entry times, gives results consistent with all of the conclusions reported in the present article.

arranged in a hierarchy such that important problems—those with relatively low numbers—have access to many choices, and important choices—those with relatively low numbers—are accessible only to important problems. The structure is represented by the following access array:

$$A_1 = \begin{array}{c} 1111111111 \\ 1111111111 \\ 0111111111 \\ 0111111111 \\ 0011111111 \\ 0011111111 \\ 0001111111 \\ 0001111111 \\ 0000111111 \\ 0000111111 \\ 0000011111 \\ 0000011111 \\ 0000001111 \\ 0000001111 \\ 0000000111 \\ 0000000111 \\ 0000000011 \\ 0000000011 \\ 0000000001 \\ 0000000001 \end{array}$$

*Access structure 2: specialized access.* In this structure each problem has access to only one choice and each choice is accessible to only two problems, that is, choices specialize in the kinds of problems that can be associated to them. The structure is represented by the following access array:

$$A_2 = \begin{array}{c} 1000000000 \\ 1000000000 \\ 0100000000 \\ 0100000000 \\ 0010000000 \\ 0010000000 \\ 0001000000 \\ 0001000000 \\ 0000100000 \\ 0000100000 \\ 0000010000 \\ 0000010000 \\ 0000001000 \\ 0000001000 \\ 0000000100 \\ 0000000100 \\ 0000000010 \\ 0000000010 \\ 0000000001 \\ 0000000001 \end{array}$$

Actual organizations will exhibit a more complex mix of access rules. Any such combination could be represented by an appropriate access array. The three pure structures considered here represent three classic alternative approaches to the problem of organizing the legitimate access of problems to decision situations.

## Decision Structure

Three similar pure types are considered in the decision structure (the relation between decision makers and choices).

*Decision structure 0: unsegmented decisions.* In this structure any decision maker can participate in any active choice opportunity. Thus, the structure is represented by the following array:

$$D_0 = \begin{array}{c} 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \\ 1111111111 \end{array}$$

*Decision structure 1: hierarchical decisions.* In this structure both decision makers and choices are arranged in a hierarchy such that important choices—low numbered choices—must be made by important decision makers—low numbered decision makers—and important decision makers can participate in many choices. The structure is represented by the following array:

$$D_1 = \begin{array}{c} 1111111111 \\ 0111111111 \\ 0011111111 \\ 0001111111 \\ 0000111111 \\ 0000011111 \\ 0000001111 \\ 0000000111 \\ 0000000011 \\ 0000000001 \end{array}$$

*Decision structure 2: specialized decisions.* In this structure each decision maker is associated with a single choice and each choice has a single decision maker. Decision makers specialize in the choices to which they attend. Thus, we have the following array:

$$D_2 = \begin{matrix} 1000000000 \\ 0100000000 \\ 0010000000 \\ 0001000000 \\ 0000100000 \\ 0000010000 \\ 0000001000 \\ 0000000100 \\ 0000000010 \\ 0000000001 \end{matrix}$$

As in the case of the access structure, actual decision structures will require a more complicated array. Most organizations have a mix of rules for defining the legitimacy of participation in decisions. The three pure cases are, however, familiar models of such rules and can be used to understand some consequences of decision structure for decision processes.

**Energy Distribution**

The distribution of energy among decision makers reflects possible variations in the amount of time spent on organizational problems by different decision makers. The solution coefficients and variations in the energy requirement for problems affect the overall relation between energy available and energy required. Three different variations in the distribution of energy are considered.

*Energy distribution 0: important people—less energy.* In this distribution important people, that is people defined as important in a hierarchial decision structure, have less energy. This might reflect variations in the combination of outside demands and motivation to participate within the organization. The specific energy distribution is indicated as follows:

| Decision maker | Energy | |
|---|---|---|
| 1 | 0.1 | |
| 2 | 0.2 | |
| 3 | 0.3 | |
| 4 | 0.4 | |
| 5 | 0.5 | $= E_0$ |
| 6 | 0.6 | |
| 7 | 0.7 | |
| 8 | 0.8 | |
| 9 | 0.9 | |
| 10 | 1.0 | |

The total energy available to the organization each time period (before deflation by the solution coefficients) is 5.5.

*Energy distribution 1: equal energy.* In this distribution there is no internal differentiation among decision makers with respect to energy. Each decision maker has the same energy (0.55) each time period. Thus, there is the following distribution:

| Decision maker | Energy | |
|---|---|---|
| 1 | 0.55 | |
| 2 | 0.55 | |
| 3 | 0.55 | |
| 4 | 0.55 | |
| 5 | 0.55 | $= E_1$ |
| 6 | 0.55 | |
| 7 | 0.55 | |
| 8 | 0.55 | |
| 9 | 0.55 | |
| 10 | 0.55 | |

The total energy available to the organization each time period (before deflation by the solution coefficients) is 5.5.

*Energy distribution 2: important people—more energy.* In this distribution energy is distributed unequally but in a direction opposite to that in $E_0$. Here the people defined as important by the hierarchical decision structure have more energy. The distribution is indicated by the following:

| Decision maker | Energy | |
|---|---|---|
| 1 | 1.0 | |
| 2 | 0.9 | |
| 3 | 0.8 | |
| 4 | 0.7 | |
| 5 | 0.6 | $= E_2$ |
| 6 | 0.5 | |
| 7 | 0.4 | |
| 8 | 0.3 | |
| 9 | 0.2 | |
| 10 | 0.1 | |

As in the previous organizations, the total energy available to the organization each time period (before deflation by the solution coefficients) is 5.5.

Where the organization has a hierarchical decision structure, the distinction between important and unimportant decision makers is clear. Where the decision structure is unsegmented or specialized, the variations in energy distribution are defined in terms of the same numbered decision makers (lower numbers are more important than higher numbers) to reflect possible status differences which are not necessarily captured by the decision structure.

### Simulation Design

The simulation design is simple. A Fortran version of the garbage can model is given in the appendix, along with documentation and an explanation. The $3^4 = 81$ types of organizational situations obtained by taking the possible combinations of the values of the four dimensions of an organization (access structure, decision structure, energy distribution, and net energy load) are studied here under the four combinations of choice and problem entry times. The result is 324 simulation situations.

## SUMMARY STATISTICS

The garbage can model operates under each of the possible organizational structures to assign problems and decision makers to choices, to determine the energy required and effective energy applied to choices, to make such choices and resolve such problems as the assignments and energies indicate are feasible. It does this for each of the twenty time periods in a twenty-period simulation of organizational decision making.

For each of the 324 situations, some set of simple summary statistics on the process is required. These are limited to five.

### Decision Style

Within the kind of organization postulated, decisions are made in three different ways.

*By resolution.* Some choices resolve problems after some period of working on them. The length of time may vary, depending on the number of problems. This is the familiar case that is implicit in most discussions of choice within organizations.

*By oversight.* If a choice is activated when problems are attached to other choices and if there is energy available to make the new choice quickly, it will be made without any attention to existing problems and with a minimum of time and energy.

*By flight.* In some cases choices are associated with problems (unsuccessfully) for some time until a choice more attractive to the problems comes along. The problems leave the choice, and thus it is now possible to make the decision. The decision resolves no problems; they having now attached themselves to a new choice.

Some choices involve both flight and resolution—some problems leave, the remainder are solved. These have been defined as resolution, thus slightly exaggerating the importance of that style. As a result of that convention, the three styles are mutually exclusive and exhaustive with respect to any one choice. The same organization, however, may use any one of them in different choices. Thus, the decision style of any particular variation of the model can be described by specifying the proportion of completed choices which are made in each of these three ways.

### Problem Activity

Any measure of the degree to which problems are active within the organization should reflect the degree of conflict within the organization or the degree of articulation of problems. Three closely related statistics of problem activity are considered. The first is the total number of problems not solved at the end of the twenty time periods; the second is the total number of times that any problem shifts from one choice to another, while the third is the total number of time periods that a problem is active and attached to some choice, summed over all problems. These measures are strongly correlated with each other. The third is used as the measure of problem activity primarily because it has a relatively large variance; essentially the same results would have been obtained with either of the other two measures.

### Problem Latency

A problem may be active, but not attached to any choice. The situation is one in which a problem is recognized and accepted by some part of the organization, but is not considered germane to any available choice. Presumably, an organization with relatively high problem latency will exhibit somewhat different symptoms from one with low latency. Problem latency has been measured by the total number of periods a problem is active, but not attached to a choice, summed over all problems.

## Decision Maker Activity

To measure the degree of decision maker activity in the system, some measure which reflects decision maker energy expenditure, movement, and persistence is required. Four are considered: (a) the total number of time periods a decision maker is attached to a choice, summed over all decision makers, (b) the total number of times that any decision maker shifts from one choice to another, (c) the total amount of effective energy available and used, and (d) the total effective energy used on choices in excess of that required to make them at the time they are made. These four measures are highly intercorrelated. The second was used primarily because of its relatively large variance; any of the others would have served as well.

## Decision Difficulty

Because of the way in which decisions can be made in the system, decision difficulty is not the same as the level of problem activity. Two alternative measures are considered: the total number of choices not made by the end of the twenty time periods and the total number of periods that a choice is active, summed over all choices. These are highly correlated. The second is used, primarily because of its higher variance; the conclusions would be unchanged if the first were used.

# IMPLICATIONS OF THE MODEL

An analysis of the individual histories of the simulations shows eight major properties of garbage can decision processes.

First, resolution of problems as a style for making decisions is not the most common style, except under conditions where flight is severely restricted (for instance, specialized access) or a few conditions under light load. Decision making by flight and oversight is a major feature of the process in general. In each of the simulation trials there were twenty problems and ten choices. Although the mean number of choices not made was 1.0, the mean number of problems not solved was 12.3. The results are detailed in Table 1. The behavioral and normative implications of a decision process which appears to make choices in large part by flight or by oversight must be examined. A possible explanation of the behavior of organizations that seem to make decisions without apparently making progress in resolving the problems that appear to be related to the decisions may be emerging.

Second, the process is quite thoroughly and quite generally sensitive to variations in load. As Table 2 shows, an increase in the net energy load on the system generally increases problem activity, decision maker activity, decision difficulty, and the uses of flight and oversight. Problems are less likely to be solved, decision makers are likely to shift from one problem to another more frequently, choices are likely to take longer to make and are less likely to resolve problems. Although it is possible to specify an organization that is relatively stable with changes in load, it is not possible to have an organization that is stable in behavior and also has other desirable attributes. As load changes, an organization that has an unsegmented access structure with a specialized decision structure stays quite stable. It exhibits relatively low decision difficulty and decision maker activity, very low problem latency, and maximum problem activity. It makes virtually all decisions placed before it, uses little energy from decision makers, and solves virtually no problems.

Third, a typical feature of the model is the tendency of decision makers and prob-

TABLE 1. PROPORTION OF CHOICES THAT RESOLVE PROBLEMS UNDER FOUR CONDITIONS OF CHOICE AND PROBLEM ENTRY TIMES, BY LOAD AND ACCESS STRUCTURE

| | | Access structure | | | |
|---|---|---|---|---|---|
| | | All | Unsegmented | Hierarchical | Specialized |
| Load | Light | 0.55 | 0.38 | 0.61 | 0.65 |
| | Moderate | 0.30 | 0.04 | 0.27 | 0.60 |
| | Heavy | 0.36 | 0.35 | 0.23 | 0.50 |
| | All | 0.40 | 0.26 | 0.37 | 0.58 |

TABLE 2. EFFECTS OF VARIATIONS IN LOAD UNDER FOUR CONDITIONS OF CHOICE AND PROBLEM ENTRY TIMES

| | | Mean problem activity | Mean decision maker activity | Mean decision difficulty | Proportion of choices by flight or oversight |
|---|---|---|---|---|---|
| Load | Light | 114.9 | 60.9 | 19.5 | .45 |
| | Moderate | 204.3 | 63.8 | 32.9 | .70 |
| | Heavy | 211.1 | 76.6 | 46.1 | .64 |

lems to track each other through choices. Subject to structural restrictions on the tracking, decision makers work on active problems in connection with active choices; both decision makers and problems tend to move together from choice to choice. Thus, one would expect decision makers who have a feeling that they are always working on the same problems in somewhat different contexts, mostly without results. Problems, in a similar fashion, meet the same people wherever they go with the same result.

Fourth, there are some important interconnections among three key aspects of the efficiency of the decision processes specified. The first is problem activity, the amount of time unresolved problems are actively attached to choice situations. Problem activity is a rough measure of the potential for decision conflict in the organization. The second aspect is problem latency, the amount of time problems spend activated but not linked to choices. The third aspect is decision time, the persistence of choices. Presumably, a good organizational structure would keep both problem activity and problem latency low through rapid problem solution in its choices. In the garbage can process such a result was never observed. Segmentation of the access structure tends to reduce the number of unresolved problems active in the organization but at the cost of increasing the latency period of problems and, in most cases the time devoted to reaching decisions. On the other hand, segmentation of the decision structure tends to result in decreasing problem latency, but at the cost of increasing problem activity and decision time.

Fifth, the process is frequently sharply interactive. Although some phenomena associated with the garbage can are regular and flow through nearly all of the cases, for example, the effect of overall load, other phenomena are much more dependent on the particular combination of structures involved. Although high segmentation of access structure generally produces slow decision time, for instance, a specialized access structure, in combination with an unsegmented decision structure, produces quick decisions.

Sixth, important problems are more likely to be solved than unimportant ones. Problems which appear early are more likely to be resolved than later ones. Considering only those cases involving access hierarchy where importance is defined for problems, the relation between problem importance and order of arrival is shown in Table 3. The system, in effect, produces a queue of problems in terms of their importance, to the disadvantage of late-arriving, relatively unimportant problems, and particularly so when load is heavy. This queue is the result of the operation of the model. It was not imposed as a direct assumption.

TABLE 3. PROPORTION OF PROBLEMS RESOLVED UNDER FOUR CONDITIONS OF CHOICE AND PROBLEM ENTRY TIMES, BY IMPORTANCE OF PROBLEM AND ORDER OF ARRIVAL OF PROBLEM (FOR HIERARCHICAL ACCESS)

| | | Time of arrival of problem: Early, first 10 | Time of arrival of problem: Late, last 10 |
|---|---|---|---|
| Importance of problem | High, first 10 | 0.46 | 0.44 |
| | Low, last 10 | 0.48 | 0.25 |

Seventh, important choices are less likely to resolve problems than unimportant choices. Important choices are made by oversight and flight. Unimportant choices are made by resolution. These differences are observed under both of the choice entry sequences but are sharpest where important choices enter relatively early. Table 4 shows the results. This property of important choices in a garbage can decision process can be naturally and directly related to the phenomenon in complex organizations of important choices which often appear to just happen.

TABLE 4. PROPORTION OF CHOICES THAT ARE MADE BY FLIGHT OR OVERSIGHT UNDER FOUR CONDITIONS OF CHOICE AND PROBLEM ENTRY TIMES, BY TIME OF ARRIVAL AND IMPORTANCE OF CHOICE (FOR HIERARCHICAL ACCESS OR DECISION STRUCTURE)

| | | Time of arrival of choice | |
|---|---|---|---|
| | | Early, first 5 | Late, last 5 |
| Importance of choice | High, first 5 | 0.86 | 0.65 |
| | Low, last 5 | 0.54 | 0.60 |

Eighth, although a large proportion of the choices are made, the choice failures that do occur are concentrated among the most important and least important choices. Choices of intermediate importance are virtually always made. The proportion of choice failures, under conditions of hierarchical access or decision structures is as follows:

| | |
|---|---|
| Three most important choices | 0.14 |
| Four middle choices | 0.05 |
| Three least important choices | 0.12 |

In a broad sense, these features of the process provide some clues to how organizations survive when they do not know what they are doing. Much of the process violates standard notions of how decisions ought to be made. But most of those notions are built on assumptions which cannot be met under the conditions specified. When objectives and technologies are unclear, organizations are charged to discover some alternative decision procedures which permit them to proceed without doing extraordinary violence to the domains of participants or to their model of what an organization should be. It is a hard charge, to which the process described is a partial response.

At the same time, the details of the outcomes clearly depend on features of the organizational structure. The same garbage can operation results in different behavioral symptoms under different levels of load on the system or different designs of the structure of the organization. Such differences raise the possibility of predicting variations in decision behavior in different organizations. One possible example of such use remains to be considered.

## GARBAGE CANS AND UNIVERSITIES

One class of organization which faces decision situations involving unclear goals, unclear technology, and fluid participants is the modern college or university. If the implications of the model are applicable anywhere, they are applicable to a university. Although there is great variation among colleges and universities, both between countries and within any country, the model has general relevance to decision making in higher education.

### General Implications

University decision making frequently does not resolve problems. Choices are often made by flight or oversight. University decision processes are sensitive to increases in load. Active decision makers and problems track one another through a series of choices without appreciable progress in solving problems. Important choices are not likely to solve problems.

Decisions whose interpretations continually change during the process of resolution appear both in the model and in actual observations of universities. Problems, choices, and decision makers arrange and rearrange themselves. In the course of these arrangements the meaning of a choice can change several times, if this meaning is understood as the mix of problems discussed in the context of that choice.

Problems are often solved, but rarely by the choice to which they are first attached. A choice that might, under some circumstances, be made with little effort becomes an arena for many problems. The choice becomes almost impossible to make, until the problems drift off to another arena. The matching of problems, choices, and decision makers is partly controlled by attributes of content, relevance, and competence; but it is also quite sensitive to attributes of timing, the particular combinations of current garbage cans, and the overall load on the system.

## Universities and Adversity

In establishing connections between the hypothetical attributes of organizational structure in the model and some features of contemporary universities, the more detailed implications of the model can be used to explore features of university decision making. In particular, the model can examine the events associated with one kind of adversity within organizations, the reduction of organizational slack.

Slack is the difference between the resources of the organization and the combination of demands made on it. Thus, it is sensitive to two major factors: (a) money and other resources provided to the organization by the external environment, and (b) the internal consistency of the demands made on the organization by participants. It is commonly believed that organizational slack has been reduced substantially within American colleges and universities over the past few years. The consequences of slack reduction in a garbage can decision process can be shown by establishing possible relations between changes in organizational slack and the key structural variables within the model.

*Net energy load.* The net energy load is the difference between the energy required within an organization and the effective energy available. It is affected by anything that alters either the amount of energy available to the organization or the amount required to find or generate problem solutions. The energy available to the organization is partly a function of the overall strength of exit opportunities for decision makers. For example, when there is a shortage of faculty, administrators, or students in the market for participants, the net energy load on a university is heavier than it would be when there is no shortage. The energy required to find solutions depends on the flow of possible problem solutions. For example, when the environment of the organization is relatively rich, solutions are easier to find and the net energy is reduced. Finally, the comparative attractiveness and permeability of the organization to problems affects the energy demands on it. The more attractive, the more demands. The more permeable, the more demands. Universities with slack and with relatively easy access, compared to other alternative arenas for problem carriers, will attract a relatively large number of problems.

*Access structure.* The access structure in an organization would be expected to be affected by deliberate efforts to derive the advantages of delegation and specialization. Those efforts, in turn, depend on some general characteristics of the organizational situation, task, and personnel. For example, the access structure would be expected to be systematically related to two features of the organization: (a) the degree of technical and value heterogeneity, and (b) the amount of organizational slack. Slack, by providing resource buffers between parts of the organization, is essentially a substitute for technical and value homogeneity. As heterogeneity increases, holding slack constant, the access structure shifts from an unsegmented to a specialized to a hierarchical structure. Similarly, as slack decreases, holding heterogeneity constant, the access structure shifts from an unsegmented to a specialized to a hierarchical structure. The combined picture is shown in Figure 1.

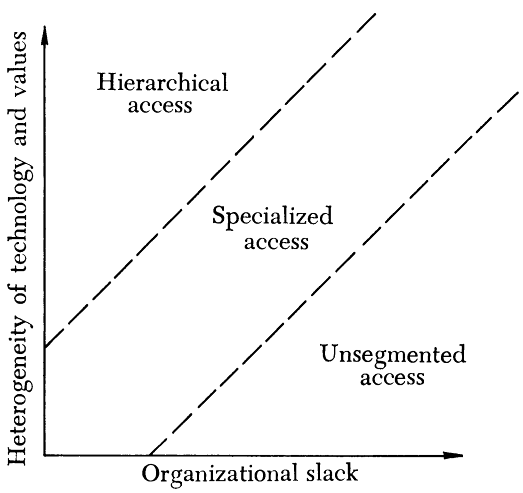



FIGURE 1. HYPOTHESIZED RELATIONSHIP BETWEEN SLACK, HETEROGENEITY, AND THE ACCESS STRUCTURE OF AN ORGANIZATION

*Decision structure.* Like the access structure, the decision structure is partly a planned system for the organization and partly a result of learning and negotiation within the organization. It could be expected to be systematically related to the technology, to attributes of participants and problems, and to the external conditions under which the organization operates. For example, there are joint effects of two factors: (a) relative administrative power within the system, the extent to which the formal administrators are conceded substantial authority, and (b) the average degree of perceived interrelation among problems. It is assumed that high administrative power or high interrelation of problems will lead to hierarchical decision structure, that moderate power and low interrelation of problems leads to specialized decision structures, and that relatively low administrative power, combined with moderate problem interrelation, leads to unsegmented decision structures. The hypothetical relations are shown in Figure 2.

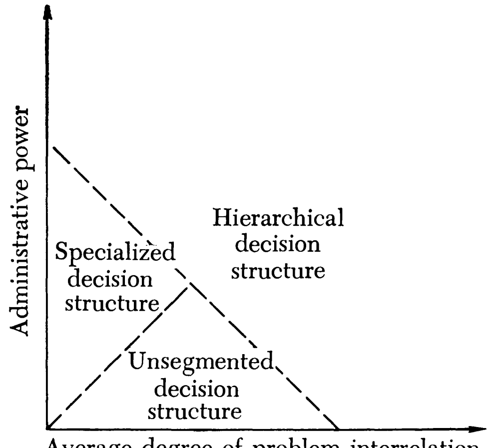



FIGURE 2. HYPOTHESIZED RELATIONSHIP BETWEEN ADMINISTRATIVE POWER, INTERRELATION OF PROBLEMS, AND THE DECISION STRUCTURE OF AN ORGANIZATION

*Energy distribution.* Some of the key factors affecting the energy distribution within an organization are associated with the alternative opportunities decision makers have for investing their time. The extent to which there is an active external demand for attention affects the extent to which decision makers will have energy available for use within the organization. The stronger the relative outside demand on important people in the organization, the less time they will spend within the organization relative to others. Note that the energy distribution refers only to the relation between the energy available from important people and less important people. Thus, the energy distribution variable is a function of the relative strength of the outside demand for different people, as shown in Figure 3.

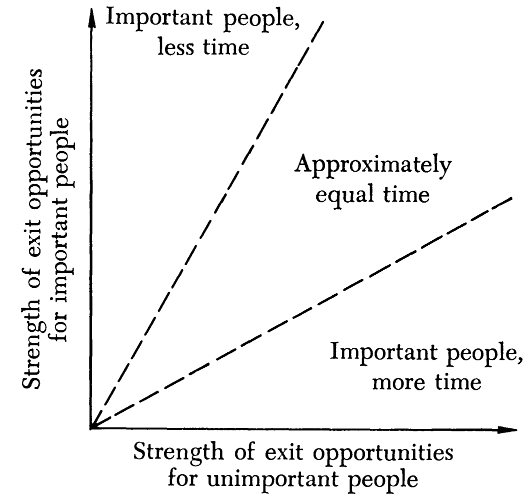



FIGURE 3. HYPOTHESIZED RELATIONSHIP BETWEEN EXIT OPPORTUNITIES AND THE DISTRIBUTION OF ENERGY WITHIN AN ORGANIZATION

Within a university setting it is not hard to imagine circumstances in which exit opportunities are different for different decision makers. Tenure, for example, strengthens the exit opportunities for older faculty members. Money strengthens the exit opportunities for students and faculty members, though more for the former than the latter. A rapidly changing technology tends to strengthen the exit opportunities for young faculty members.

Against this background four types of colleges and universities are considered: (a) large, rich universities, (b) large, poor universities, (c) small, rich colleges, and (d) small, poor colleges.

Important variations in the organizational variables among these schools can be expected. Much of that variation is likely to be within-class variation. Assumptions about these variables, however, can be used to generate some assumptions about the predominant attributes of the four classes, under conditions of prosperity.

Under such conditions a relatively rich school would be expected to have a light energy load, a relatively poor school a moderate energy load. With respect to access structure, decision structure, and the internal distribution of energy, the appropriate position of each of the four types of schools is marked with a circular symbol on Figures 4, 5, and 6. The result is the pattern of variations indicated below:

| | *Load* | *Access structure* | *Decision structure* | *Energy distribution* |
|---|---|---|---|---|
| Large, rich | Light<br>0 | Specialized<br>2 | Unsegmented<br>0 | Less<br>0 |
| Large, poor | Moderate<br>1 | Hierarchical<br>1 | Hierarchical<br>1 | More<br>2 |
| Small, rich | Light<br>0 | Unsegmented<br>0 | Unsegmented<br>0 | More<br>2 |
| Small, poor | Moderate<br>1 | Specialized<br>2 | Specialized<br>2 | Equal<br>1 |

With this specification, the garbage can model can be used to predict the differences expected among the several types of school. The results are found in Table 5. They suggest that under conditions of prosperity, overt conflict (problem activity) will be substantially higher in poor schools than in rich ones, and decision time will be substantially longer. Large, rich schools will be characterized by a high degree of problem latency. Most decisions will resolve some problems.

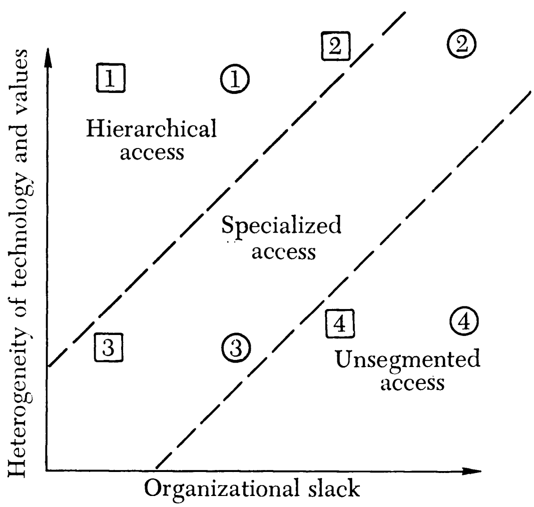
What happens to this group of schools under conditions of adversity—when slack is reduced? According to earlier arguments, slack could be expected to affect each of the organizational variables. It first increases net energy load, as resources become shorter and thus problems require a larger share of available energy to solve, but this effect is later compensated by the reduction in market demand for personnel and in the relative attractiveness of the school as an arena for problems. The market effects also reduce the differences in market demand for important and unimportant people. The expected results of these shifts are shown by the positions of the square symbols in Figure 6.

At the same time, adversity affects both access structure and decision structure. Adversity can be expected to bring a reduction in slack and an increase in the average interrelation among problems. The resulting hypothesized shifts in access and decision structures are shown in Figures 4 and 5.

Table 5 shows the effects of adversity on the four types of schools according to the previous assumptions and the garbage can model. By examining the first stage of adversity, some possible reasons for discontent among presidents of large, rich schools can be seen. In relation to other schools they are not seriously disadvantaged. The large, rich schools have a moderate level of problem activity, a moderate level of decision by resolution. In relation to their earlier state, however, large, rich schools are certainly deprived. Problem activity and decision time have increased greatly; the proportion of decisions which resolve problems has decreased from 68 percent to 21 percent; administrators are less able to move around from one decision to another. In all these terms, the relative deprivation of the presidents of large, rich schools is much greater, in the early stages of adversity, than that of administrators in other schools.

The large, poor schools are in the worst absolute position under adversity. They have a high level of problem activity, a substantial decision time, a low level of decision maker mobility, and a low proportion of decisions being made by resolution. But along most of these dimensions, the change has been less for them.

The small rich schools experience a large increase in problem activity, an increase in




① Large, poor school, good times
② Large, rich school, good times
③ Small, poor school, good times
④ Small, rich school, good times

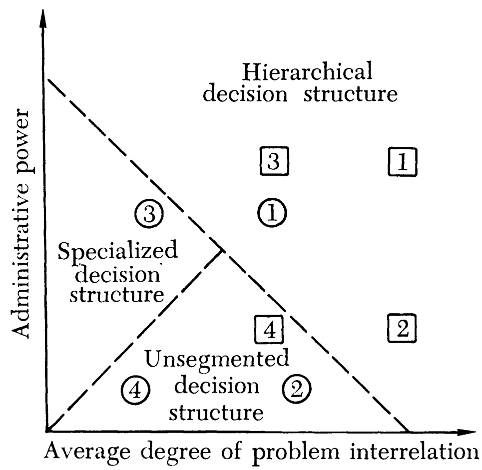
[1] Large, poor school, bad times
[2] Large, rich school, bad times
[3] Small, poor school, bad times
[4] Small, rich school, bad times

FIGURE 4. HYPOTHESIZED LOCATION OF DIFFERENT SCHOOLS IN TERMS OF SLACK AND HETEROGENEITY

decision time, and a decrease in the proportion of decisions by resolution as adversity begins. The small, poor schools seem to move in a direction counter to the trends in the other three groups. Decision style is little affected by the onset of slack reduction, problem activity, and decision time decline, and decision-maker mobility increases. Presidents of such organizations might feel a sense of success in their efforts to tighten up the organization in response to resource contraction.

The application of the model to this particular situation among American colleges and universities clearly depends upon a large number of assumptions. Other assumptions would lead to other interpretations of the impact of adversity within a garbage can decision process. Nevertheless, the derivations from the model have some face validity as a description of some aspects of recent life in American higher education.

The model also makes some predictions of future developments. As adversity continues, the model predicts that all schools, and particularly rich schools, will experience improvement in their position. Among large, rich schools decision by resolution triples, problem activity is cut by almost three-fourths, and decision time is cut more than one-half. If the model has validity, a series of articles in the magazines of the next decade detailing how President X assumed the presidency of large, rich university Y and guided it to "peace" and "progress" (short decision time, decisions without problems, low problem activity) can be expected.




① Large, poor school, good times
② Large, rich school, good times
③ Small, poor school, good times
④ Small, rich school, good times

[1] Large, poor school, bad times
[2] Large, rich school, bad times
[3] Small, poor school, bad times
[4] Small, rich school, bad times

FIGURE 5. HYPOTHESIZED LOCATION OF DIFFERENT SCHOOLS IN TERMS OF ADMINISTRATIVE POWER AND PERCEIVED INTERRELATION OF PROBLEMS

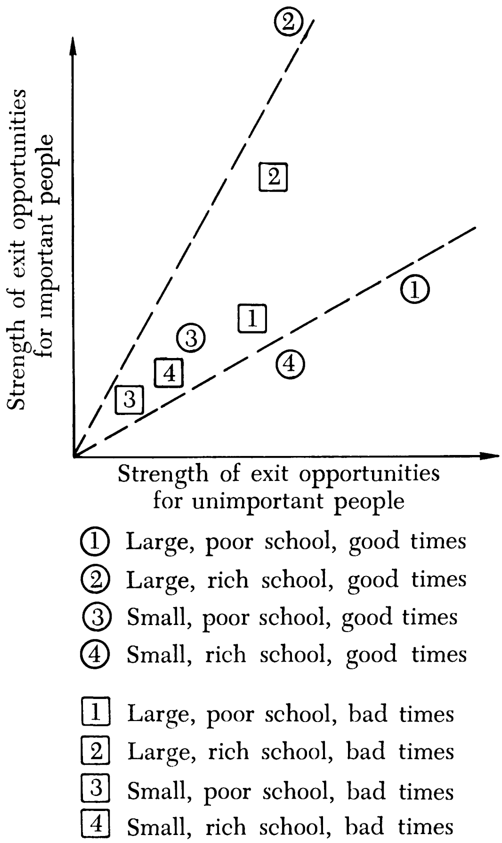



FIGURE 6. HYPOTHESIZED LOCATION OF DIFFERENT SCHOOLS IN TERMS OF EXIT OPPORTUNITIES

## CONCLUSION

A set of observations made in the study of some university organizations has been translated into a model of decision making in organized anarchies, that is, in situations which do not meet the conditions for more classical models of decision making in some or all of three important ways: preferences are problematic, technology is unclear, or participation is fluid. The garbage can process is one in which problems, solutions, and participants move from one choice opportunity to another in such a way that the nature of the choice, the time it takes, and the problems it solves all depend on a relatively complicated intermeshing of elements. These include the mix of choices available at any one time, the mix of problems that have access to the organization, the mix of solutions looking for problems, and the outside demands on the decision makers.

A major feature of the garbage can process is the partial uncoupling of problems and choices. Although decision making is thought of as a process for solving problems, that is often not what happens. Problems are worked upon in the context of some choice, but choices are made only when the shifting combinations of problems, solutions, and decision makers happen to make action possible. Quite commonly this is after problems have left a given choice arena or before they have discovered it (decisions by flight or oversight).

Four factors were specified which could be expected to have substantial effects on the operation of the garbage can process: the organization's net energy load and energy distribution, its decision structure, and problem access structure. Though the specifications are quite simple their interaction is extremely complex, so that investigation of the probable behavior of a system fully characterized by the garbage can process and previous specifications requires computer simulation. No real system can be fully characterized in this way. Nonetheless, the simulated organization exhibits behaviors which can be observed some of the time in almost all organizations and frequently in some, such as universities. The garbage can model is a first step toward seeing the systematic interrelatedness of organizational phenomena which are familiar, even common, but which have previously been regarded as isolated and pathological. Measured against a conventional normative model of rational choice, the garbage can process does appear pathological, but such standards are not really appropriate. The process occurs precisely when the preconditions of more normal rational models are not met.

It is clear that the garbage can process does not resolve problems well. But it does enable choices to be made and problems resolved, even when the organization is plagued with goal ambiguity and conflict, with poorly understood problems that wander in and out of the system, with a variable environment, and with decision makers who may have other things on their minds.

There is a large class of significant situa-

TABLE 5. EFFECT OF ADVERSITY ON FOUR TYPES OF COLLEGES AND UNIVERSITIES OPERATING WITHIN A GARBAGE CAN DECISION PROCESS

| | | Outcome | | | | |
|---|---|---|---|---|---|---|
| Type of school/ type of situation | Organizational type | Decision style proportion resolution | Problem activity | Problem latency | Decision maker activity | Decision time |
| *Large, rich universities* | | | | | | |
| Good times | 0200 | 0.68 | 0 | 154 | 100 | 0 |
| Bad times, early | 1110 | 0.21 | 210 | 23 | 58 | 34 |
| Bad times, late | 0111 | 0.65 | 57 | 60 | 66 | 14 |
| *Large, poor universities* | | | | | | |
| Good times | 1112 | 0.38 | 210 | 25 | 66 | 31 |
| Bad times, early | 2112 | 0.24 | 248 | 32 | 55 | 38 |
| Bad times, late | 1111 | 0.31 | 200 | 30 | 58 | 28 |
| *Small, rich colleges* | | | | | | |
| Good times | 0002 | 1.0 | 0 | 0 | 100 | 0 |
| Bad times, early | 1002 | 0 | 310 | 0 | 90 | 20 |
| Bad times, late | 0001 | 1.0 | 0 | 0 | 100 | 0 |
| *Small, poor colleges* | | | | | | |
| Good times | 1221 | 0.54 | 158 | 127 | 15 | 83 |
| Bad times, early | 2211 | 0.61 | 101 | 148 | 73 | 52 |
| Bad times, late | 1211 | 0.62 | 78 | 151 | 76 | 39 |

tions in which the preconditions of the garbage can process cannot be eliminated. In some, such as pure research, or the family, they should not be eliminated. The great advantage of trying to see garbage can phenomena together as a process is the possibility that that process can be understood, that organizational design and decision making can take account of its existence and that, to some extent, it can be managed.

## APPENDIX

Version five of the Fortran program for the garbage can model reads in entry times for choices, solution coefficients, entry times for problems, and two control variables, NA and IO. NA controls various combinations of freedom of movement for decision makers and problems. All results are based on runs in which NA is 1. Comment cards included in the program describe other possibilities. The latter variable, IO, controls output. At the value 1, only summary statistics are printed. At the value 2, full histories of the decision process are printed for each organizational variant.

The following are ten summary statistics:

1. (KT) Problem persistence, the total number of time periods a problem is activated and attached to a choice, summed over all problems.
2. (KU) Problem latency, the total number of time periods a problem is activated, but not attached to a choice, summed over all problems.
3. (KV) Problem velocity, the total number of times any problem shifts from one choice to another.
4. (KW) Problem failures, the total number of problems not solved at the end of the twenty time periods.
5. (KX) Decision maker velocity, the total number of times any decision maker shifts from one choice to another.
6. (KS) Decision maker inactivity, the total number of time periods a decision maker is not attached to a choice, summed over all decision makers.
7. (KY) Choice persistence, the total number of time periods a choice is activated, summed over all choices.

8. (KZ) Choice failures, the total number of choices not made by the end of the twenty time periods.

9. (XR) Energy reserve, the total amount of effective energy available to the system but not used because decision makers are not attached to any choice.

10. (XS) Energy wastage, the total effective energy used on choices in excess of that required to make them at the time they are made.

In its current form the program generates both the problem access structure and the decision structure internally. In order to examine the performance of the model under other structures, modification of the code or its elimination in favor of Read statements to take the structures from cards will be necessary.

Under IO = 2, total output will be about ninety pages. Running time is about two minutes under a Watfor compiler.

APPENDIX TABLE: FORTRAN PROGRAM FOR GARBAGE CAN MODEL, VERSION FIVE

```
C      THE GARBAGE CAN MODEL. VERSION 5
C      ***
C      IO IS 1 FOR SUMMARY STATISTICS ONLY
C      IO IS 2 FOR SUMMARY STATISTICS PLUS HISTORIES
C      ***
C      NA IS 1 WHEN PROBS AND DMKRS BOTH MOVE
C      NA IS 2 WHEN DMKRS ONLY MOVE
C      NA IS 3 WHEN PROBS ONLY MOVE
C      NA IS 4 WHEN NEITHER PROBS NOR DMKRS MOVE
C      ***
C      IL IS A FACTOR DETFRMINING PROB ENERGY REQ
C      ***
C      VARIABLES
C         ***
C         NUMBERS
C              COUNTERS  UPPER LIMITS     NAME
C              ***
C                 I           NCH         CHOICES
C                 J           NPR         PROBLEM
C                 K           NDM         DECMKRS
C                 LT          NTP         TIME
C         ***
C         ARRAYS
C              CODE           DIMEN       NAME
C              ***
C              ICH            NCH         CHOICE ENTRY TIME
C              ICS            NCH         CHOICE STATUS
C              JET            NPR         PROB. ENTRY TIME
C              JF             NPR         PROB. ATT. CHOICE
C              JFF            NPR         WORKING COPY JF
C              JPS            NPR         PROB. STATUS
C              KDC            NDM         DMKR. ATT. CHOICE
C              KDCW           NDM         WORKING COPY KDC
C              XEF            MCH         FNERGY EXPENDED
C              XFRC           NCH         CHOICE EN. REQT.
C              XERP           NPR         PROB. EN. REQT.
C              XSC            NTP         SOLUTION COEFFICIENT
C         ***
C         2-DIMENSIONAL ARRAYS
C              ***
C              CODE           DIMEN       NAME
C              ***
C              IKA            NCH,NDM     DECISION STRUCTURE
C              JIA            NPR,NCH     ACCESS STRUCTURE
C              XEA            NDM,NTP     ENERGY MATRIX
C         ***
C         ***
C         ***
C      ***
C      SUMMARY STATISTICS FOR EACH VARIANT
C              COL 1: KZ: TOTAL DECISIONS NOT MADE
C              COL 2: KY: TOTAL NUMBER ACTIVE CHOICE PERIODS
C              COL 3: KX: TOTAL NUMBER CHANGES BY DECISION MAKERS
C              COL 4: KW: TOTAL PROBLEMS NOT SOLVED
C              COL 5: KV: TOTAL NUMBER CHANGFS BY PROBLEMS
C              COL 6: KU: TOTAL NUMBER LATENT PROBLEM PERIODS
C              COL 7: KT: TOTAL NUMBER ATTACHED PROBLEM PERIODS
C              COL 8: KS: TOTAL NUMBER PERIODS DMKRS RESTING
C              COL 9: XR: TOTAL AMOUNT OF UNUSED ENERGY
```

```
C             COL 10:XS: TOTAL AMOUNT OF WASTED ENERGY
C       ***
C       INPUT BLOCK. READ-IN AND INITIALIZATIONS.
        DIMENSION ICH(20),JF(20),XERC(20),XEE(20),XSC(20),JFF(20),XERP(20
       *),JET(20),JPS(20),ICS(20),KDC(20),KDCW(20),JIA(20,20),IKA(20,20),
       CXEA(20,20),KABC(20,20),KBBC(20,20),KCBC(20,20)
1001    FORMAT(5(I3,1X))
1002    FORMAT(10(I3,1X))
1003    FORMAT(25(I1,1X))
1004    FORMAT(10F4.2)
        NTP=20
        NCH=10
        NPR=20
        NDM=10
 8      READ(5,1002)(ICH(I),I=1,NCH)
        READ(5,1004)(XSC(LT),LT=1,NTP)
        READ(5,1002)(JET(J),J=1,NPR)
        READ(5,1003) NA,IO
        WRITE(6,1050) NA
 1050 FORMAT('1       DEC.MAKER MOVEMENT CONDITION (NA) IS   ',I1/)
        DO 998 IL=1,3
        IB=IL-1
        DO 997 JAB=1,3
        JA=JAB-1
        DO 996 JDB=1,3
        JD=JDB-1
        DO 995 JEB=1,3
        JE=JEB-1
        XR=0.0
        XS=0.0
        KS=0
        DO 10 I=1,NCH
        XERC(I)=1.1
        XEE(I)=0.0
10      ICS(I)=0
        DO 20 K=1,NDM
        KDC(K)=0
20      KDCW(K)=KDC(K)
        DO 40 J=1,NPR
        XERP(J)=IL*1.1
        JF(J)=0
        JFF(J)=0
40      JPS(J)=0
C       SETTING UP THE DECISION MAKERS ACCESS TO CHOICES.
        DO 520 I=1,NCH
        DO 510 J=1,NDM
        IKA(I,J)=1
        IF(JD.EQ.1) GO TO 502
        IF(JD.EQ.2) GO TO 504
        GO TO 510
 502    IF(I.GE.J) GO TO 510
        IKA(I,J)=0
        GO TO 510
 504    IF(J.EQ.I) GO TO 510
        IKA(I,J)=0
 510    CONTINUE
 520    CONTINUE
C       SETTING UP THE PROBLEMS ACCESS TO CHOICES.
        DO 560 I=1,NPR
        DO 550 J=1,NCH
```

```
      JIA(I,J)=0
      IF(JA.EQ.1) GO TO 532
      IF(JA.EQ.2) GO TO 534
      JIA(I,J)=1
      GO TO 550
 532  IF ((I-J).GT.(I/2)) GO TO 550
      JIA(I,J)=1
      GO TO 550
 534  IF(I.NE.(2*J))  GO TO 550
      JIA(I,J)=1
      JIA(I-1,J)=1
 550  CONTINUE
 560  CONTINUE
      DO 590 I=1,NDM
      DO 580 J=1,NTP
      XEA(I,J)=0.55
      IF(JF.EQ.1)GO TO 580
      XXA=I
      IF(JE.EQ.0)GO TO 570
      XEA(I,J)=(11.0-XXA)/10.0
      GO TO 580
  570 XEA(I,J)=XXA/10.0
 580  CONTINUE
 590  CONTINUE
C     *** FINISH READ   INITIALIZATION
      DO 994 LT=1,NTP
 1006 FORMAT(2X,6HCHOICE,2X,I3,2X,6HACTIVE )
C     CHOICE ACTIVATION
      DO 101  I=1,NCH
      IF(ICH(I).NE.LT)GO TO 101
      ICS(I)=1
 101  CONTINUE
C     PROB. ACTIVATION
      DO 110 J=1,NPR
      IF(JET(J).NE.LT)GO TO 110
      JPS(J)=1
 110  CONTINUF
C     FIND MOST ATTRACTIVE CHOICE FOR PROBLEM J
      DO 120 J=1,NPR
      IF (JPS(J).NE.1) GO TO 120
      IF(NA.EQ.2)GO TO 125
      IF(NA.EQ.4)GO TO 125
      GO TO 126
 125  IF(JF(J).NE.0)GO TO 127
 126  S=1000000
      DO 121 I=1,NCH
      IF (ICS(I).NE.1) GO TO 121
      IF(JIA(J,I).EQ.0)GO TO 121
      IF(JF(J).EQ.0)GO TO 122
      IF(JF(J).EQ.I)GO TO 122
      IF((XERP(J)+XERC(I)-XEE(I)).GE.S)GO TO 121
      GO TO 123
122   IF((XERC(I)-XEE(I)).GE.S)GO TO 121
       S=XERC(I)-XEE(I)
      GO TO 124
 123  S=XERP(J)+XERC(I)-XEE(I)
124   JFF(J)=I
121   CONTINUE
      GO TO 120
 127  JFF(J)=JF(J)
```

```
120   CONTINUE
      DO 130 J=1,NPR
131   JF(J)=JFF(J)
130   JFF(J)=0
      LTT=LT-1
      IF(LT.EQ.1)LTT=1
C     FIND MOST ATTRACTIVE CHOICE FOR DMKR K
      DO 140 K=1,NDM
      IF(NA.EQ.3)GO TO 145
      IF(NA.EQ.4) GO TO 145
      GO TO 146
 145  IF(KDC(K).NE.0)GO TO 147
 146  S=1000000
      DO 141 I=1,NCH
      IF (ICS(I).NE.1) GO TO 141
      IF(IKA(I,K).EQ.0)GO TO 141
      IF(KDC(K).EQ.0)GO TO 142
      IF(KDC(K).EQ.I)GO TO 142
148   IF((XERC(I)-XEE(I)-(XEA(K,LTT)*XSC(LTT))).GE.S)GO TO 141
      GO TO 143
142   IF((XERC(I)-XEE(I)).GE.S)GO TO 141
      S=XERC(I)-XEE(I)
      GO TO 144
143   S=XERC(I)-XEE(I)-XEA(K,LTT)*XSC(LTT)
 144  KDCW(K)=I
141   CONTINUE
      GO TO 140
 147  KDCW(K)=KDC(K)
140   CONTINUF
      DO 150 K=1,NDM
151   KDC(K)=KDCW(K)
      IF(KDC(K).NE.0)GO TO 150
      XR=XR+(XEA(K,LT)*XSC(LT))
      KS=KS+1
  150 KDCW(K)=0
C     ESTABLISHING THE ENERGY REQUIRED TO MAKE EACH CHOICE.
      DO 199 I=1,NCH
      IF(ICS(I).EQ.0)GO TO 199
      XERC(I)=0.0
      DO 160 J=1,NPR
      IF (JPS(J).NE.1) GO TO 160
      IF(JF(J).NE.I)GO TO 160
      XERC(I)=XERC(I)+XERP(J)
160   CONTINUE
      DO 170 K=1,NDM
      IF(IKA(I,K).EQ.0)GO TO 170
      IF(KDC(K).NE.I)GO TO 170
      XEE(I)=XEE(I)+XSC(LT)*XEA(K,LT)
170   CONTINUE
199   CONTINUE
C     MAKING DECISIONS
      DO 299 I=1,NCH
      IF (ICS(I).NE.1) GO TO 299
      IF(XERC(I).GT.XEE(I))GO TO 299
      XS=XS+XEE(I)-XERC(I)
      ICS(I)=2
      DO 250 J=1,NPR
      IF(JF(J).NE.I)GO TO 250
      JPS(J)=2
250   CONTINUE
```

```
      IF(NA.EQ.3)GO TO 261
      IF(NA.EQ.4)GO TO 261
      GO TO 299
  261 DO 262 K=1,NDM
      IF(KDC(K).NE.I)GO TO 262
      KDCW(K)=1
  262 CONTINUE
 299  CONTINUE
      DO 200 I=1,NCH
  200 KABC(LT,I)=ICS(I)
      DO 210 K=1,NDM
      KBBC(LT,K)=KDC(K)
      IF(KDCW(K).EQ.0)GO TO 210
      KDC(K)=0
  210 KDCW(K)=0
      DO 220 J=1,NPR
      KCBC(LT,J)=JF(J)
      IF(JPS(J).EQ.0) GO TO 230
      IF(JPS(J).EQ.1) GO TO 220
      KCBC(LT,J)=1000
      GO TO 220
  230 KCBC(LT,J)=-1
  220 CONTINUE
  994 CONTINUE
C     FINISH TIME PERIOD LOOP. BEGIN ACCUMULATION OF 10 SUMMARY STATISTICS.
      KZ=0
      KY=0
      KX=0
      KW=0
      KV=0
      KU=0
      KT=0
      DO 310 I=1,NTP
      DO 320 J=1,NCH
      IF(KABC(I,J).NE.1)GO TO 320
      KY=KY+1
      IF(I.NE.NTP)GO TO 320
      KZ=KZ+1
  320 CONTINUE
  310 CONTINUE
      DO 330 I=2,NTP
      DO 340 J=1,NDM
      IF(KBBC(I,J).EQ.KBBC(I-1,J))GO TO 340
      KX=KX+1
  340 CONTINUE
  330 CONTINUE
      DO 350 I=1,NTP
      DO 360 J=1,NPR
      IF(KCBC(I,J).EQ.0)GO TO 351
      IF(KCBC(I,J).EQ.-1) GO TO 360
      IF(KCBC(I,J).EQ.1000) GO TO 352
      KT=KT+1
      GO TO 360
  351 KU=KU+1
      GO TO 360
  352 IF(I.NE.NTP)GO TO 360
      KW=KW+1
  360 CONTINUE
  350 CONTINUE
      KW=NPR-KW
```

```
      DO 370 I=2,NTP
      DO 380 J=1,NPR
      IF(KCBC(I,J).EQ.KCBC(I-1,J))GO TO 380
      KV=KV+1
 380  CONTINUE
 370  CONTINUE
C     BEGIN WRITEOUT OF MATERIALS FOR THIS ORGANIZATIONAL VARIANT.
 1000 FORMAT(1H1)
 1019 FORMAT(2X,'LOAD=',I1,' PR.ACC.=',I1,' DEC.STR.=',I1,' EN.DIST.=',
     BI1,2X,'STATS 1-10',3X,8I5,1X,2F6.2/)
      WRITE(6,1019)IB,JA,JD,JE,KZ,KY,KX,KW,KV,KU,KT,KS,XR,XS
      IF(IO.EQ.1) GO TO 995
 2000 FORMAT(' CHOICE ACTIVATION HISTORY',34X,'DEC.MAKER ACTIVITY HISTOR
     BY'/' 20 TIME PERIODS,10 CHOICES',33X,'20 TIME PERIODS,10 DEC. MAKE
     CRS'/' 0=INACTIVE,1=ACTIVE,2=MADE',33X,'0=INACTIVE,X=WORHING ON CHO
     DICE X'//9X,'  1 2 3 4 5 6 7 8 9 10',30X,'1 2 3 4 5 6 7 8 9 10'/)
      WRITE(6,2000)
 2001 FORMAT( 5X,I2,3X,10I2,25X,I2,3X,10I2)
      WRITE(6,2001)(LT,(KABC(LT,J),J=1,NCH),LT,( KBBC(LT,J),J=1,NDM),
     B LT=1,NTP  )
 2002 FORMAT(/' PROBLEM HISTORY:ROWS=TIME,COLS=PROBS., -1=NOT ENTERED.,
     B0=UNATTACHED,X=ATT.TO CH.X,**=SOLVED'/10X,
     C'  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20'/)
      WRITE(6,2002)
 2003 FORMAT(20(5X,I2,3X,20(1X,I2)/))
      WRITE(6,2003)(LT,(KCBC(LT,J),J=1,NPR),LT=1,NTP)
      WRITE(6,1000)
 995  CONTINUE
 996  CONTINUE
 997  CONTINUE
  998 CONTINUE
      STOP
      END

*******    DATA AS FOLLOWS  (AFTER GUIDE CARDS)    ***********


0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

008,005,006,007,004,009,002,010,003,001
1.000.900.700.300.100.100.300.700.901.00
0.600.600.600.600.600.600.600.600.600.60
009,005,008,007,010,003,003,001,007,009
006,008,005,002,004,002,004,010,006,001
1 2
```

*Michael D. Cohen is an NSF-SSRC post-doctoral fellow at Stanford University; James G. March is David Jacks Professor of Higher Education, Political Science, and Sociology at Stanford University; and Johan P. Olsen is an assistant professor of Political Science at the University of Bergen.*

## BIBLIOGRAPHY

Allison, Graham T.
1969 "Conceptual models and the Cuban missile crises." American Political Science Review, 63: 689–718.

Christensen, Søren
1971 Institut og laboratorieorganisation på Danmarks tekniske Højskole. Copenhagen: Copenhagen School of Economics.

Cohen, Michael D., and James G. March
1972 The American College President. New York: McGraw-Hill, Carnegie Commission on the Future of Higher Education.

Coleman, James S.
1957 Community Conflict. Glencoe: Free Press.

Cyert, Richard M., and James G. March
1963 Behavioral Theory of the Firm. Englewood Cliffs: Prentice-Hall.

Enderud, Harald
1971 Rektoratet og den centrale administration på Danmarks tekniske Højskole. Copenhagen: Copenhagen School of Economics.

Lindblom, Charles E.
1965 The Intelligence of Democracy. New York: Macmillan.

Long, Norton
1958 "The local community as an ecology of games." American Journal of Sociology, 44: 251–261.

March, James G., and Herbert A. Simon
1958 Organizations. New York: John Wiley.

Mood, Alexander (ed.)
1971 More Scholars for the Dollar. New York: McGraw-Hill, Carnegie Commission on the Future of Higher Education.

Olsen, Johan P.
1970 A Study of Choice in an Academic Organization. Bergen: University of Bergen.
1971 The Reorganization of Authority in an Academic Organization. Bergen: University of Bergen.

Rommetveit, Kåre
1971 Framveksten av det medisinske fakultet ved Universitetet i Tromsø. Bergen: University of Bergen.

Schilling, Warner R.
1968 "The H-bomb decision: how to decide without actually choosing." In W. R. Nelson (ed.), The Politics of Science. London: Oxford University Press.

Thompson, James D.
1967 Organizations in Action. New York: McGraw-Hill.

Vickers, Geoffrey
1965 The Art of Judgment. New York: Basic Books.