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 for decision situations, characterized by three general properties. 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 accommodate 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...
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. 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 the 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 (1971), Olsen (1970, 1971), and Rommetveit (1971). The ideas, however, have a broader perspective. In particular, they obviously owe a debt to Allison (1965), Coleman (1957), Cyert and March (1963), Lindblom (1965), Long (1965), 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 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 × 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. Thus, 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.

A₀ =

1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1

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

\[ A_1 = \]

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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, those that specialize in the kinds of problems that can be associated with them. The structure is represented by the following access array:

\[ A_2 = \]

<table>
<thead>
<tr>
<th>1</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

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:

\[ D_0 = \]

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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:

\[ D_1 = \]

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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:
\[ D_2 = \\
\begin{array}{cccc}
1000000000 \\
0100000000 \\
0010000000 \\
0001000000 \\
0000100000 \\
0000010000 \\
0000001000 \\
0000000100 \\
0000000010 \\
0000000001
\end{array}
\]

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 hierarchical 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:

<table>
<thead>
<tr>
<th>Decision maker</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>5</td>
<td>0.5 (= E_0)</td>
</tr>
<tr>
<td>6</td>
<td>0.6</td>
</tr>
<tr>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>9</td>
<td>0.9</td>
</tr>
<tr>
<td>10</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Decision maker</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.55</td>
</tr>
<tr>
<td>2</td>
<td>0.55</td>
</tr>
<tr>
<td>3</td>
<td>0.55</td>
</tr>
<tr>
<td>4</td>
<td>0.55</td>
</tr>
<tr>
<td>5</td>
<td>0.55 (= E_1)</td>
</tr>
<tr>
<td>6</td>
<td>0.55</td>
</tr>
<tr>
<td>7</td>
<td>0.55</td>
</tr>
<tr>
<td>8</td>
<td>0.55</td>
</tr>
<tr>
<td>9</td>
<td>0.55</td>
</tr>
<tr>
<td>10</td>
<td>0.55</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Decision maker</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>5</td>
<td>0.6 (= E_2)</td>
</tr>
<tr>
<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>7</td>
<td>0.4</td>
</tr>
<tr>
<td>8</td>
<td>0.3</td>
</tr>
<tr>
<td>9</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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 differ-
ences 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 orga-
nizational situations obtained by taking the
possible combinations of the values of the
four dimensions of an organization (access
structure, decision structure, energy distribu-
tion, and net energy load) are studied here
under the four combinations of choice and
problem entry times. The result is 324 simula-
tion 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 prob-
lems 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 asso-
ciated 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 them-
selves to a new choice.

Some choices involve both flight and reso-
lution—some problems leave, the remainder
are solved. These have been defined as reso-
lution, thus slightly exaggerating the impor-
tance 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 prob-
lems are active within the organization should
reflect the degree of conflict within the organi-
zation or the degree of articulation of prob-
lems. 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 sec-
ond 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 la-
tency. 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>
<thead>
<tr>
<th>Load</th>
<th>Access structure</th>
<th>All</th>
<th>Unsegmented</th>
<th>Hierarchical</th>
<th>Specialized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td></td>
<td>0.55</td>
<td>0.38</td>
<td>0.61</td>
<td>0.65</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td>0.30</td>
<td>0.04</td>
<td>0.27</td>
<td>0.69</td>
</tr>
<tr>
<td>Heavy</td>
<td></td>
<td>0.36</td>
<td>0.35</td>
<td>0.23</td>
<td>0.50</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>0.40</td>
<td>0.26</td>
<td>0.37</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Table 2. Effects of variations in load under four conditions of choice and problem entry times

<table>
<thead>
<tr>
<th>Load</th>
<th>Mean problem activity</th>
<th>Mean decision maker activity</th>
<th>Mean decision difficulty</th>
<th>Proportion of choices by flight or oversight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>114.9</td>
<td>60.9</td>
<td>19.5</td>
<td>.45</td>
</tr>
<tr>
<td>Moderate</td>
<td>204.3</td>
<td>63.8</td>
<td>32.9</td>
<td>.70</td>
</tr>
<tr>
<td>Heavy</td>
<td>211.1</td>
<td>76.6</td>
<td>46.1</td>
<td>.64</td>
</tr>
</tbody>
</table>

Problems 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

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)

<table>
<thead>
<tr>
<th>Time of arrival of problem</th>
<th>Importance of problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early, first 10</td>
<td>High</td>
</tr>
<tr>
<td>Late, last 10</td>
<td>Low</td>
</tr>
</tbody>
</table>

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.

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

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)

<table>
<thead>
<tr>
<th>Importance of choice</th>
<th>Time of arrival of choice</th>
<th>Early, first 5</th>
<th>Late, last 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, first 5</td>
<td></td>
<td>0.86</td>
<td>0.65</td>
</tr>
<tr>
<td>Low, last 5</td>
<td></td>
<td>0.54</td>
<td>0.60</td>
</tr>
</tbody>
</table>

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.

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 al-
most 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.](image)

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.](image)

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:

<table>
<thead>
<tr>
<th></th>
<th>Load</th>
<th>Access structure</th>
<th>Decision structure</th>
<th>Energy distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large, rich</td>
<td>Light 0</td>
<td>Specialized 2</td>
<td>Unsegmented 0</td>
<td>Less 0</td>
</tr>
<tr>
<td>Large, poor</td>
<td>Moderate 1</td>
<td>Hierarchical 1</td>
<td>Hierarchical 1</td>
<td>More 2</td>
</tr>
<tr>
<td>Small, rich</td>
<td>Light 0</td>
<td>Unsegmented 0</td>
<td>Unsegmented 0</td>
<td>More 2</td>
</tr>
<tr>
<td>Small, poor</td>
<td>Moderate 1</td>
<td>Specialized 2</td>
<td>Specialized 2</td>
<td>Equal 1</td>
</tr>
</tbody>
</table>

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
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.

**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

**Figure 5. Hypothesized location of different schools in terms of administrative power and perceived interrelation of problems**

Copyright © 1972. All rights reserved.
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

<table>
<thead>
<tr>
<th>Type of school/ type of situation</th>
<th>Decision style proportion resolution</th>
<th>Problem activity</th>
<th>Problem latency</th>
<th>Decision maker activity</th>
<th>Decision time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large, rich universities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good times</td>
<td>2000</td>
<td>0.68</td>
<td>0</td>
<td>154</td>
<td>100</td>
</tr>
<tr>
<td>Bad times, early</td>
<td>1110</td>
<td>0.21</td>
<td>210</td>
<td>23</td>
<td>58</td>
</tr>
<tr>
<td>Bad times, late</td>
<td>0111</td>
<td>0.65</td>
<td>57</td>
<td>60</td>
<td>66</td>
</tr>
<tr>
<td><strong>Large, poor universities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good times</td>
<td>1112</td>
<td>0.38</td>
<td>210</td>
<td>25</td>
<td>66</td>
</tr>
<tr>
<td>Bad times, early</td>
<td>2112</td>
<td>0.24</td>
<td>248</td>
<td>32</td>
<td>55</td>
</tr>
<tr>
<td>Bad times, late</td>
<td>1111</td>
<td>0.31</td>
<td>200</td>
<td>30</td>
<td>58</td>
</tr>
<tr>
<td><strong>Small, rich colleges</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good times</td>
<td>0002</td>
<td>1.0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Bad times, early</td>
<td>1002</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Bad times, late</td>
<td>0001</td>
<td>1.0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td><strong>Small, poor colleges</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good times</td>
<td>1221</td>
<td>0.54</td>
<td>158</td>
<td>127</td>
<td>15</td>
</tr>
<tr>
<td>Bad times, early</td>
<td>2211</td>
<td>0.61</td>
<td>101</td>
<td>148</td>
<td>73</td>
</tr>
<tr>
<td>Bad times, late</td>
<td>1211</td>
<td>0.62</td>
<td>78</td>
<td>151</td>
<td>76</td>
</tr>
</tbody>
</table>

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.

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.
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.
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 DETERMINING 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 OFCMKRS
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 NCH ENERGY EXPENDED
C XERC 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 CHANGES 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

Copyright © 1972. All rights reserved.
COL 10: XS: TOTAL AMOUNT OF WASTED ENERGY

INPUT BLOCK, READ-IN AND INITIALIZATIONS
DIMENSION ICH(20), JF(20), XERC(20), XEE(20), XSC(20), JFF(20), KERP(20)
   JET(20), JPS(20), JCS(20), KDC(20), KDCW(20), JIA(20, 20), IKA(20, 20),
   CKEA(20, 20), KABC(20, 20), KOB(C(20, 20), KCB(C(20, 20)

1001 FORMAT(5(13, 1X))
1002 FORMAT(10(I3, 1X))
1003 FORMAT(25(I1, 1X))
1004 FORMAT(10(F4.2)

NTP=20
NCH=10
NPR=20
NDM=10

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, 10
WRITE(6, 1050) NA

1050 FORMAT('1 DECISION MAKER MOVEMENT CONDITION (NA) IS '11/)
   DO 998 1L=1, 3
   IO=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
   XA=0, 0
   XS=0, 0
   KS=0
   DO 10 I=1, NCH
   XERC(I)=1, 1
   XEE(I)=0, 0
10  IC(S(I))=0
   DO 20 K=1, NDM
   KDC(K)=0
20  KDCW(K)=KDC(K)
   DO 40 J=1, NPR
   KERP(J)=IL*1, 1
   JFF(J)=0
   JPS(J)=0
40  SETTING UP THE DECISION MAKERS ACCESS TO CHOICES
   DO 520 I=1, NCH
   DO 510 J=1, NDM
   IKAI(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
   IKAI(I, J)=0
   GO TO 510
504  IF(J*EQ.1) GO TO 510
   IKAI(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
COHEN ET AL: A GARBAGE CAN MODEL

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 ((-J)*GT*(1/2)) GO TO 550
JIA(I,J)=1
GO TO 550
534 IF(JA*NE.(12+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
XIA(I,J)=0*55
IF(JE*EQ.0) GO TO 580
XXA=1
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,13,2X,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 CONTINUE
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,1)*EQ.0) GO TO 121
IF(JF(J)*EQ.0) GO TO 122
IF(JF(J)*EQ.1) 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)=1
121 CONTINUE
GO TO 120
127 JFF(J)=JF(J)
120 CONTINUE
130 DO 130 J=1,NPR
131 CONTINUE
132 IF(JF(J).NE.0) GO TO 133
133 CONTINUE
134 LT=LT+1
135 IF(LT.EQ.11) LT=1
136 CONTINUE
137 FIND MOST ATTRACTIVE CHOICE FOR DMKR K
138 DO 140 K=1,NOM
139 IF(NA(K).EQ.0) GO TO 145
140 IF(NA(K).EQ.1) GO TO 145
141 CONTINUE
142 S=1000000
143 DO 143 I=1,NCH
144 CONTINUE
145 IF(I).NE.1) GO TO 146
146 IF(KA(I).EQ.0) GO TO 147
147 CONTINUE
148 IF(KD(K).EQ.1) GO TO 149
149 CONTINUE
150 S=1000000
151 DO 151 K=1,NCH
152 CONTINUE
153 IF(KD(K).NE.0) GO TO 154
154 CONTINUE
155 XR=K+XEA(K,LTT)*XSC(LTT)
156 CONTINUE
157 KS=KS+1
158 CONTINUE
159 E=ESTABLISHING THE ENERGY REQUIRED TO MAKE EACH CHOICE.
160 IF(ICS(I).NE.0) GO TO 161
161 CONTINUE
162 J=1,NPR
163 CONTINUE
164 J=1,NPR
165 XR=XAE(I)+XER(J)
166 CONTINUE
167 CONTINUE
168 CONTINUE
169 CONTINUE
170 CONTINUE
171 CONTINUE
172 CONTINUE
173 CONTINUE
174 CONTINUE
175 CONTINUE
176 CONTINUE
177 CONTINUE
178 CONTINUE
179 CONTINUE
180 CONTINUE
181 CONTINUE
182 CONTINUE
183 CONTINUE
184 CONTINUE
185 CONTINUE
186 CONTINUE
187 CONTINUE
188 CONTINUE
189 CONTINUE
190 CONTINUE
191 CONTINUE
192 CONTINUE
193 CONTINUE
194 CONTINUE
195 CONTINUE
196 CONTINUE
197 CONTINUE
198 CONTINUE
199 CONTINUE
200 CONTINUE
201 CONTINUE
202 CONTINUE
203 CONTINUE
204 CONTINUE
205 CONTINUE
206 CONTINUE
207 CONTINUE
208 CONTINUE
209 CONTINUE
210 CONTINUE
211 CONTINUE
212 CONTINUE
213 CONTINUE
214 CONTINUE
215 CONTINUE
216 CONTINUE
217 CONTINUE
218 CONTINUE
219 CONTINUE
220 CONTINUE
221 CONTINUE
222 CONTINUE
223 CONTINUE
224 CONTINUE
225 CONTINUE
226 CONTINUE
227 CONTINUE
228 CONTINUE
229 CONTINUE
230 CONTINUE
231 CONTINUE
232 CONTINUE
233 CONTINUE
234 CONTINUE
235 CONTINUE
236 CONTINUE
237 CONTINUE
238 CONTINUE
239 CONTINUE
240 CONTINUE
241 CONTINUE
242 CONTINUE
243 CONTINUE
244 CONTINUE
245 CONTINUE
246 CONTINUE
247 CONTINUE
248 CONTINUE
249 CONTINUE
250 CONTINUE
251 CONTINUE
252 CONTINUE
253 CONTINUE
254 CONTINUE
255 CONTINUE
256 CONTINUE
257 CONTINUE
258 CONTINUE
259 CONTINUE
260 CONTINUE
261 CONTINUE
262 CONTINUE
263 CONTINUE
264 CONTINUE
265 CONTINUE
266 CONTINUE
267 CONTINUE
268 CONTINUE
269 CONTINUE
270 CONTINUE
271 CONTINUE
272 CONTINUE
273 CONTINUE
274 CONTINUE
275 CONTINUE
276 CONTINUE
277 CONTINUE
278 CONTINUE
279 CONTINUE
280 CONTINUE
281 CONTINUE
282 CONTINUE
283 CONTINUE
284 CONTINUE
285 CONTINUE
286 CONTINUE
287 CONTINUE
288 CONTINUE
289 CONTINUE
290 CONTINUE
291 CONTINUE
292 CONTINUE
293 CONTINUE
294 CONTINUE
295 CONTINUE
296 CONTINUE
297 CONTINUE
298 CONTINUE
299 CONTINUE
300 CONTINUE
301 CONTINUE
302 CONTINUE
303 CONTINUE
304 CONTINUE
305 CONTINUE
306 CONTINUE
307 CONTINUE
308 CONTINUE
309 CONTINUE
310 CONTINUE
311 CONTINUE
312 CONTINUE
313 CONTINUE
314 CONTINUE
315 CONTINUE
316 CONTINUE
317 CONTINUE
318 CONTINUE
319 CONTINUE
320 CONTINUE
321 CONTINUE
322 CONTINUE
323 CONTINUE
324 CONTINUE
325 CONTINUE
326 CONTINUE
327 CONTINUE
328 CONTINUE
329 CONTINUE
330 CONTINUE
331 CONTINUE
332 CONTINUE
333 CONTINUE
334 CONTINUE
335 CONTINUE
336 CONTINUE
337 CONTINUE
338 CONTINUE
339 CONTINUE
340 CONTINUE
341 CONTINUE
IF(NA*EQ.3)GO TO 261
IF(INA*EQ.4)GO TO 261
GO TO 299

261 DO 262 K=1,NDM
IF(KDC(K)*NE.*1)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
KBB(LT,K)=KDC(K)
IF(KDC(K)*NE.*0)GO TO 210
KDC(K)=0

210 KDCW(K)=0
DO 220 J=1,NPR
KBC(LT,J)=JF(J)
IF(JP(J)*NE.*0)GO TO 230
IF(JP(J)*NE.*1)GO TO 220
KBC(LT,J)=1000
GO TO 220

220 CONTINUE

994 CONTINUE

C FINISH TIME PERIOD LOOP. BEGIN ACCUMULATION OF 10 SUMMARY STATISTICS.
KZ=0
KY=0
KX=0
KW=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,NCH
IF(KBBC(I,J)*EQ.*KBB(I-1,J))GO TO 340
KX=KX+1

340 CONTINUE

330 CONTINUE

DO 350 I=1,NTP
DO 360 J=1,NPR
IF(KCB(J,J)*EQ.*0)GO TO 351
IF(KCB(J,J)*EQ.*-1)GO TO 360
IF(KCB(J,J)*EQ.*1000)GO TO 352
KT=KT+1

GOTO 360

351 KU=KU+1
GOTO 360

352 IF(I*NE.*NTP)GO TO 360
KW=KW+1

360 CONTINUE

350 CONTINUE
KW=NP=KW

Copyright © 1972. All rights reserved.
DO 370 I=2,NTP
DO 380 J=1,NPR
IF(KCBC(I,J))EQ*KCBC(1-I,J))GO TO 380
KV=KV+1
380 CONTINUE
370 CONTINUE
C BEGIN WRITEOUT OF MATERIALS FOR THIS ORGANIZATIONAL VARIANT.
1000 FORMAT(IHI)
          BI1,2X,*STATS 1=10!,3X,B15,1X,2F6.2/)
WRITE(6,1010)1B,JA,J0,JE,KZ,KX,KV,KU,KT,KS,XR,XS
IF((10,F4.4))GO TO 999
2000 FORMAT(*5X,*CHOICE ACTIVATION HISTORY*,33X,*DEC*MAKER ACTIVITY HISTOR
          BY*,/20 TIME PERIODS,10 CHOICES*,33X,*120 TIME PERIODS,10 DEC* MAKE
          CRs*,/0=INACTIVE,1=ACTIVE,2=MADE*,33X,*0=INACTIVE,X=WORNING 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,12,3X,1012,25X,12,3X,1012)
WRITE(6,2001)KABC(LT,LT,J),J=1,NCH,LT,( KBBC(LT,LT),J=1,NDM),
B LT=1,NTP )
2002 FORMAT(*5X,*PROBLEM HISTORY:ROWS=TIME,COLS=PROBS**, -1=NOT ENTERED**,
          80=UNATTACHED,X=ATTENDED,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,12,3X,20(1X,12)/))
WRITE(6,2003)(LT,(KCBC(LT,LT),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
123456789012345678901234567890123456789012345678901234567890
000.005.006.007.004.009.002.010.003.001
1.000.990.700.300.100.100.300.700.901.60
0.600.600.600.600.600.600.600.600.600.60
009.005.008.007.010.003.003.001.007.009
006.008.005.002.004.002.002.010.006.001
1 2

Copyright © 1972. All rights reserved.
Michael D. Cohen is an NSF-SSRC postdoctoral 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.

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

Cohen, Michael D., and James G. March

Coleman, James S.

Cyert, Richard M., and James G. March

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

Lindblom, Charles E.

Long, Norton

March, James G., and Herbert A. Simon

Mood, Alexander (ed.)

Olsen, Johan P.


Rønnsetveit, Kåre

Schilling, Warner R.

Thompson, James D.

Vickers, Geoffrey