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THEORY AND METHOD IN THE EXPLORATION OF HUMAN DECISION BEHAVIOR

Geoffrey P. E. Clarkson and William F. Pounds

For any one of a variety of purposes which might range from predicting the behavior of an individual to discovering the critical elements in the behavior of an organization, it is important to be able to discuss and describe human decision processes. In order to do this we need a theoretical structure around which to organize our thinking as well as a set of terms or vocabulary with which to label the data. The object of this paper is to provide a guide to such a theory and to describe an experimental method by which useful models of decision behavior can be specified.

We shall begin by describing the theory of human decision making on which this method is based. Employing this theoretical structure we shall then go on to a brief analysis of some basic decision processes and to an examination of how the theory is able to provide explanations of decision-making behavior. Although this section of the paper may appear somewhat abstract, the theory we describe is based upon observed behavior and several models of the theory have already been subjected to a number of empirical tests. To illustrate the data gathering process we shall describe several methods used to help isolate and identify specific decision mechanisms. Since the testing of a model is an especially important part of the research process we also provide a discussion with an example of the principal methods used to confront the model with observed behavior.

By providing only an outline of the theory and method we have been forced to ignore some items and mention others very briefly. For those who wish to pursue this research in greater depth the final part of the paper provides some suggestions for future research and the references, a list of further readings in the exploration of human decision behavior.

Theory of Human Decision Behavior

The theory of human decision-making that is basic to the understanding of decision processes was developed by Newell, Shaw and Simon[1/] to explain and predict the performance of an individual problem solver handling various specified tasks. The object of the theory is to explain the process of human thought by identifying the types of decision processes that humans employ while solving a variety of problems. Although questions about decision-making could be answered at various levels and in varying amounts of detail, this theory explains decision behavior in terms of a set of basic information processes. These processes are in part defined by the theory's three basic postulates which state that each decision-maker has:[2/]

1) A central control system that consists of a number of memories which contain various sorts of symbolized information. The information in these memories is interconnected by various ordering or associative relations.

2) A number of basic information processes which are used to operate on the information stored in the memories.

3) A perfectly definite set of rules for combining the basic information processes into whole programs of processing.

1/ Newell, Shaw and Simon, [5].

2/ Ibid., [5], p. 151.

It is apparent from these postulates that it is a basic assumption of this theory that decision processes can be isolated as well as identified. Indeed, it is also assumed that they can be represented by a series of straight forward mechanical processes. This does not imply that all decision processes are necessarily either simple or easy to represent. What is being asserted is that they can be broken down into their elemental parts, e.g. the memory, the basic information processes, and the rules for combining these processes into whole programs, which in turn consist of collections of simple mechanisms.

To clarify what is meant by these postulates consider the following application of the theory to the decision process of an investor of trust funds in a bank.[3/] This theory of investment behavior was developed to explain and predict the portfolio selection process of a particular trust investor. Consequently the basic postulates state that the trust investor has:

1) A memory which contains information associated with the general economy, industries and individual companies. The information is ordered in associated lists. While not all investors may associate identical companies with a given industry, the process of classification by industry is the primary basis for listing companies in the memory. In a similar manner the information associated with each company may vary among investors, but each company may be represented as having a list of attributes with their values stored in memory, e.g. growth rate, price earnings ratio, dividend rate, etc.

2) Basic information processes which perform the task of searching the lists of information in memory, selecting those items that have the required attributes, regrouping the selected pieces into new lists, and performing algebraic operations when necessary.

[3/] For a complete statement of the theory see: Clarkson [2].

3) A set of rules or criteria which guide the decision-making process by stipulating when and how each process is to be used. The set of rules constitutes the structure of the decision process for an individual investor.

As a further example of the application of these postulates consider the more general theory of human problem solving which has been proposed under the name of General Problem Solver.[4] This theory was developed to explain the problem solving behavior of individuals involved in the solution of tasks for which means-ends analysis is an appropriate method of solution. Consequently, although GPS cannot solve all problems stated in this form, it is possible to delimit the class of problems to which this theory of human problem solving applies.

In order to operate within the context of a specific problem the basic postulates of GPS require that the following information be provided:

For the memory:

1) "A vocabulary, for talking about the task environment, containing terms like: object, operation, difference, feature....

2) A vocabulary, dealing with the organization of the problem solving processes, containing terms like: goal type, method, evaluation...."

For the processes and programs:

3) "A set of programs defining the terms of the problem solving vocabulary by terms in the vocabulary for describing the task environment.

4) A set of programs (correlative definitions) applying the terms of the task-environment vocabulary to a particular environment...."[5]

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[4] Newell, Shaw and Simon, [6].

[5] Ibid., [6], pp. 11-12.

Accordingly within the context of a particular problem GPS is a theory of human problem solving which essentially consists of a collection of general but powerful rules for solving problems. Because these processing rules are largely independent of the subject matter of the problem, GPS is more than a theory of one individual's decision-making processes. It is in fact the beginnings of a general theory which when suitably interpreted can be used to explain the decision processes of a variety of individuals.

As can be seen from these two examples, decision processes of individuals can be analysed and described in terms of the basic operations outlined in the theory of human problem solving. When these operations are collected into a set of statements that describe the decision behavior of the individual under investigation, this set of rules becomes the theory of the individual's decision-making process.

That such a set of rules can be considered to be an empirically testable theory can be determined by subjecting the theory to a series of empirical tests. To perform a particular test the theory would be amended by specifying, where necessary, the particular parameter values and decision rules that pertain to the specific context in which the theory is to be tested. The theory, i.e. the statements and decision rules that describe the behavior under investigation, and the statements containing the appropriate initial conditions are translated into a suitable computer language. The computer is then activated and, as in the more familiar case of scientific theories, the logical consequences are derived by performing the particular operations according to the specified rules.

In an actual test the behavior generated by the theory is compared with the observed decision behavior of the individual under investigation. When the rules

for processing the information yield results that are consistent with those obtained from the individual, the theory is said to be sufficient to account for the observed behavior. Hence, the theory of human problem solving establishes a theory of decision behavior by providing a basic set of postulates and hypotheses that when appropriately interpreted are sufficient to explain observable behavior.[6/]

Goals and the Structure of Decision Processes

Having briefly described the theory of decision-making we can now discuss how observed behavior is to be classified and structured in the context of the theory. According to the theory all decision behavior can be analysed and described by a set of processing rules operating on a specific collection of information available to the decision maker. This information is available either in his memory or in his environment. But before the theory can be usefully applied to a particular situation we need to be able to isolate and identify the principal decision processes as well as the structure by which they are related.

Most descriptions of human behavior refer to the purpose or goal toward which, it is argued, the behavior is directed. While disputes may arise over which goal the behavior is supposed to serve, many people feel that behavior can be usefully described using these terms.

Under the theory of human decision behavior a specific stream of behavior is described and explained by identifying a particular set of decision rules and the information upon which they operate. Within this theory a goal or

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[6/] A proposal of how this theory can be employed to explain the decision behavior of groups and organizations can be found in: Clarkson, [3].

purpose is not relevant to our understanding of behavior except as it may constitute a part of the decision process itself.[7]

For example, when choosing a portfolio of securities for a particular client an investor must first determine the investment policy for that account. Once the policy is selected, then this policy can be applied to a suitable list of stocks to determine which securities are to be included in the portfolio. If the policy is "Growth," then a process is needed which will select a specific set of growth stocks from the total list of such stocks available at the time. Such a selection process must discriminate among a variety of securities and choose those issues appropriate to the individual portfolio. We might describe this process as one which seeks to select a growth portfolio or one which has growth as its goal. Since the actual growth rate of the resulting portfolio is largely independent of the process by which it is selected it is clear that the term growth can be more accurately considered to be a name for the process which acts as the selection mechanism.

While there are a variety of ways in which the term goal can be used, the point to note is that the behavior of a set of mechanisms operating in a particular environment determine the consequences or final output. Behavior is selected by specific processes operating on items obtained from the memory or the environment. Some of these items are called goals because they help to determine the output of the decision process in which they are used. In most cases, however, goals are merely names of decision processes and it is the structure of these processes which we shall examine next.

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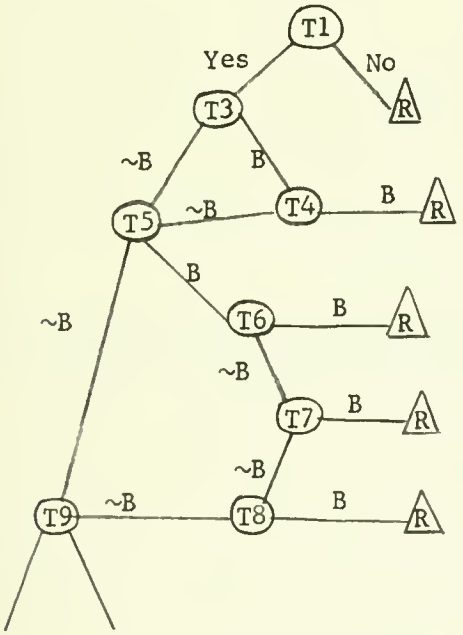
[7] For a detailed discussion of goals and their effect upon decision behavior see: Pounds, [8].

Decision processes that select or operate on the information in the memory are represented by nets. A net is an associated list of tests or filters through which the information passes. Each test or item in the net is the name of another process, and the behavior of the decision process itself is the result of the net selecting and operating upon the information.

For example, in the theory of investment behavior the decision process or discrimination net that selects the individual securities is represented as a collection of tests through which a security must pass if it is to be placed in the portfolio. Each of these tests may be simple or complex, but the discrimination net itself will only contain their names, and the order in which they are associated to one another.

In the following net, which is part of the Growth Portfolio discrimination net,[8] T1 - T9 represent a particular sequence of tests that are applied in turn to an appropriate list of securities.



Dictionary

T1 - Mean growth in price (past) $\geq$ 20%
T3 - Mean growth in earnings per share (past)
T4 - Mean growth in sales (past)
T5 - Forecasted growth in earnings per share (1 year)
T6 - Forecasted growth in sales (1 year)
T7 - Mean growth in cash flow per share (past)
T8 - Mean growth in profit margin (past)
T9 - (y) on Relative Value List
B - "Below" average for industry
~B - "Not Below" average for industry
R - Reject.

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[8] For a complete description of this net and the way in which it is employed see: Clarkson, [2], p. 50.

As can be seen from this segment of the flow chart the net commences processing with T1. If a security passes this test, T3 is then applied. From T3 the security will then go directly either to T4 or T5 depending on the outcome at T3. Note that these tests are arranged in hierarchies, so that if a specific security is "below average" on T5 it must pass through T6, T7, and T8 if it is not to be rejected and is to return to T9 and the remainder of the net.

Since all nets have this associative structure, and since all decision processes can be represented by a sequential list of operations, all decision processes can be represented by discrimination nets. Consequently, in order to identify a specific decision process it is necessary to know the contents of the tests or processes in the net as well as the manner in which they are interconnected. Once this information is known the behavior of the decision process is determined. Since the generated behavior is the result of the process acting on information stored in the memory or environment, a knowledge of the decision process is vital to the explanation of the behavior. Since all decision processes can be represented as discrimination nets, the key to the explanation of observed behavior lies in the ability to isolate and identify the contents of discrimination nets.

Understanding and Explaining Decision Behavior

In this discussion we have asserted that the theory of decision-making is able to explain decision behavior. Since all theories claim to explain something and not all theories do so, it is appropriate to examine for a moment what is meant by the word explain.

In order to provide a scientific explanation for the occurrence of an event three conditions must be met.[9] The first is that the occurrence of the event to be explained must be deducible as a direct consequence from the conjunction of the theory and the appropriate initial conditions. For this condition to be satisfied the theoretical system must conform to the general rules of logic that govern the formation and manipulation of deductive systems. Theories which are stated in verbal or mathematical form are able to meet these conditions as well as theories stated in terms of a computer program. In all cases the theory can be constructed so that the process of deducing the occurrence of an event will conform to the general rules governing deductive systems.

The second condition is that the theory itself must contain at least one general hypothesis or law that has been subjected to and survived a process of refutation by empirical test. Accordingly, at least one of the major hypotheses of a theory must be stated in such a manner that it can be corroborated or refuted by empirical test.

The third condition requires that the statements describing the initial conditions be empirically true.

Since an explanation is achieved by deducing the occurrence of an event from the conjunction of the initial conditions and the theoretical systems the second and third criteria must be met if the explanation is to have empirical content. As a result it is apparent that it is possible to determine whether a given explanation is a scientific one or not.

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[9] For a lucid and detailed analysis of the structure of a scientific explanation see: Carl G. Hempel and Paul Oppenheim, "The Logic of Explanation," in Feigl and Brodbeck, [4].

With the theory of decision-making an explanation of observed decision behavior is achieved by applying the processing rules to the initial conditions contained in the memory and by this process generating the required behavior. If the generated behavior matches the observed (in a manner to be discussed below) then that decision behavior has indeed been explained.

For example, if we wanted to explain the portfolio selection process of a particular investor, part of the observed behavior to be explained would be the actual portfolios selected for the particular accounts. Consequently, if after being provided with the appropriate initial data the processing rules select for the same accounts the same portfolios of securities, then we have a case where part of a particular decision process has been explained.

Theories, Models and Data

Given that the theory is capable of producing scientific explanations of observable behavior we now need to inquire into the question of how to develop theories or models of specific decision procedures and processes.

One theory is a 'model' of another theory only if their postulates and hypotheses are structurally similar.[9a/] Hence, a particular application of the theory to a specific set of decision processes is a model of those processes. For example, in the case where the general theory is employed to develop a theory of the trust investment process this application is in fact a model of the more general theory. Since it is usually difficult to find general data against which to test general theories, theories are normally submitted to empirical test by testing specific models against specific sets of data. Accordingly,

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[9a/] For a somewhat more detailed and more intensive examination of the relation between models and theories see: Brodbeck, [1].

when we talk about testing a theory what we are really talking about is the process of submitting a particular model of this theory to a specific set of tests.

In order to construct a theory of a given decision process it is clear that what we have to do is take the general structure provided by the theory of human decision-making behavior and by adding the appropriate information and decision rules develop a testable model of behavior. Consequently, the important part in constructing such a model is knowing how to discover, collect and fit into the general structure what we called the appropriate information and decision rules. While this may sound like a formidable task, the general theory provides the structure with which the data are to be sorted and arranged. At the same time the general theory provides the outline which guides the process of making observations. Thus, although the task of uncovering the components of specific decision rules requires careful observations, the job is made quite practicable by knowing what to look for.

Within this framework the problem of constructing a model of some specific decision behavior becomes a problem of uncovering the basic rules or operations employed by the decision maker to lead him to the particular decisions under consideration. To obtain these data a variety of interview and observational techniques can be used, and the following list is merely an outline of some possible and useful methods.

(a) Interview

One method of finding out the components of an individual's decision process is by the question and answer approach of a straight forward interview. If the decision process is one which is frequently employed by the individual questions

about the procedure followed, the records consulted, the information that is processed and the output that is produced can provide a rough picture of the more important parts of the decision process. These interviews are frequently more rewarding if there is one person to ask the questions while another takes notes. It must be noted, however, that this approach asks an individual to describe and in some sense justify why he behaves as he does. To the extent that many people are unable to describe how they reached a particular decision the information gathered in this manner must be regarded with some caution.

(b) Protocols

One way of forming a more reliable guide to the decision processes gathered by direct interviews is to make protocols of the individual's decision behavior. A protocol is a tape recorded transcript of the verbalized thoughts and actions of a subject when he has been instructed to think or problem solve aloud. The transcript is a record of the subject's thought processes while he is engaged in making a decision. Since a protocol is a detailed description of what a person does, it avoids some of the problems inherent in the interviews and questionnaire techniques.

(c) Constrained Problem Solving Interviews[10/]

A variant on the interview approach is to ask the individual under investigation to write out a decision routine which he thinks will accomplish the task at hand. By requesting him to construct routines of this type and then asking relevant questions, e.g. 'But what happens if.....?', he may be

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10/ For examples of this variant on interview techniques see: Pounds, op.cit.

led to expand and alter what he has written before. Such modifications provide useful information on what are the important and unimportant items in the decision process. Further data can be uncovered if it is possible to get the individual to use his written decision routine to make one or a series of actual decisions. If he is satisfied with the actual behavior of his routine then this is a good basis from which to develop a model to explain his behavior.

Throughout the data gathering process constant checks must be made to ensure that the relevant parts of the decision process are being discovered. One way of checking the data is to construct simple nets and groups of decision rules and by applying them to the relevant data determine whether they reproduce the behavior recorded, for example, in the protocols. If a record of past decisions is available, these nets and models should be tested against this record as well. The object of this testing is, of course, to identify the principal routines and data inputs which must be included if behavior is to be explained.

An Example

To illustrate this discussion we shall now consider the outline of a model that was constructed to explain the portfolio selection process of an investor of trust funds.[11/] Since we have argued that all decision processes can be analysed in terms of a set of decision routines plus a set of information or data, this model represents the investment process as consisting of three major sections: (a) processes concerned with the analysis and selection of, from a basic set of stocks, a list of securities which are suitable for current purchasing, (b) processes which determine the investment policy for each account,

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[11/] Clarkson, op. cit., [2].

and (c) the processes that perform the actual selection of securities for the individual portfolios. The basic information in the memory consists of data on particular economy and industry variables as well as all the data for a ten-year period on the relevant attributes of eighty companies and their securities.

Section (a) of the model uses this data to create various ratios and indices by which it can judge the relative performance and relative value of one company's stock against another. Expectations are also included in the data and are reduced to one scale so that patterns can be found and recognized. A pattern recognizing process is then employed to create the list of stocks that are suitable for current purchasing. This list is selected from the original set of stocks and its contents depend directly on the outputs of the relative performance, relative value, and expectational processes.

Section (b) of the model consists of a mechanism that formulates an investment policy for a particular account by processing the data taken from the bank's records and the instrument setting up the trust, concerning the nature of the client or the trust. This mechanism is merely a discrimination net which associates certain patterns of data with specific investment policies.

In section (c) the portfolios are selected by applying the selection mechanisms associated with each investment policy to the list of companies produced by section (a). At the same time mechanisms are employed which decide how many shares of each security to purchase and how to ensure that the portfolio is appropriately diversified. The end result is a portfolio chosen for a particular account where the portfolio specifies the name of the security, the number of shares to purchase, the price per share at that time, and the total amount expended for each issue.

From this brief description it is readily apparent that we are dealing with a fairly large and complex model. Even though each of the decision processes was built by observing and reviewing in some detail a particular investor's decision behavior, the construction of such a model is only the first part of the total experimental process. Once a model is built it must be tested, and it is toward this stage in the experimental procedure that we shall now turn our attention.

Testing the Decision Model

In order to subject this type of model to a series of empirical tests we need a set of tests that take into account the fact that we wish to predict the actual output of the decision-maker as well as determine the mechanisms by which this output was produced. In other words a set of tests are required which will discriminate between processes as well as between outputs.

One testing procedure that meets both of these requirements is an adaptation of a test which was designed by Turing to determine whether a machine could 'think.' He called his test an imitation game and it proceeds as follows:[12/]

The game is played by three players--a machine, a human and an interrogator--and there are two channels of communication (say teleprinters) which link the interrogator, separately, to the human and the machine. The object of the game for the interrogator is to identify which of the two players is the machine. Active questioning is allowed, and the machine's task is to fool the interrogator while the human is assumed to do his best to reveal his 'true' identity. The interrogator succeeds and the machine is declared unable to 'think,' if on a given number of trials he is able to identify which player is which on a better than chance basis.

[12/] Turing, [9], pp. 2099-2123.

The adaptation of Turing's Test to the problem of discriminating between the output of a particular model of human behavior and the decision behavior of the human proceeds as follows: Data are gathered on the human's decision processes by collecting protocols or other records of his decision behavior. The output generated by the model is also collected and can now be directly compared with that of the human. This comparison can be carried out at many levels. The only restriction is the level of detail of the data that can be gathered on the human's decision processes. When the model generates decision behavior that meets the criterion of Turing's Test, the model is said to be sufficient to account for the human's decision-making behavior.[13/]

Clearly, this test can be applied to the output of the model as a whole as well as to the behavior of the individual decision mechanisms. In the former case the test might be considered to be quite weak, since there presumably are a variety of decision rules that will yield a specified output. But, by carrying the matching process down to the level of the individual decision processes the tests become more and more discriminating. Consequently, the strength of the test can be determined by the experimenter; and our confidence in the empirical validity of the model is manifestly a function of the levels of detail at which the matching process is carried out.

For example, in order to determine the investment model's ability to reproduce the portfolio selection process of the trust investor the model was required to select a series of portfolios for a specific set of trust accounts. In particular, the model was tested by requiring it during the first and third

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[13/] For further discussion of this method of testing as well as the evidence from a specific application see: Newell and Simon, [7].

quarters of 1960 to select portfolios for four accounts that the trust investor had dealt with during the same period. The first test consisted of comparing against each other the two sets of portfolios for the four different accounts. To achieve a perfect score the model not only had to select the correct number of securities for each portfolio, but it also had to select the same securities and the same number of shares of each security as was purchased by the trust investor.

To illustrate this part of the testing procedure consider the two portfolios presented below where the model's selections are listed on the left hand side and the trust investor's on the right.[14/]

Account 1, selected January 8, 1960.

Investment Policy: High growth with little concern for dividend income, total funds: $22,000

Trust Model Selected				Trust Officer Selected			
Shares	Stock	Price	Total	Shares	Stock	Price	Total
60	General American Transport Co.	$ 65	$ 4,200	30	Corning Glass	$145	$ 4,350
50	Dow Chemical	99	4,950	50	Dow Chemical	98	4,900
10	IBM	440	4,400	10	IBM	440	4,400
60	Merck & Co.	79	4,740	50	Merck & Co.	80	4,000
45	Owens Corning Fiberglass	88	3,960	50	Owens Corning Fiberglass	89	4,450
			$22,250				$22,100
	Estimated yield 1.6%				Estimated yield 1.3%		

14/ These portfolios are taken directly from the results presented in G. P. E. Clarkson, op. cit. pp. 62-63.

Account 2, selected June 10, 1960.

Investment Policy: High income with possibility of price appreciation, total funds: $37,500

Trust Model Selected				Trust Officer Selected			
Shares	Stock	Price	Total	Shares	Stock	Price	Total
100	American Can Co.	$37	$ 3,700	100	American Can Co.	$38	$ 3,800
100	Continential Ins.	51	5,100	100	Continental Ins.	51	5,100
100	Equitable Gas Co.	36	3,600	100	Equitable Gas Co.	35	3,500
100	Dugnesne Light Co.	24	2,400	100	General Public Utilities	24	2,400
100	Libbey Owens Ford	50	5,000	100	Libbey Owens Ford	51	5,100
100	International Harvester	44	4,400	50	National Lead	91	4,550
100	Philadelphia Electric	49	4,900	100	Philadelphia Electric	49	4,900
100	Phillips Petroleum	43	4,300	100	Phillips Petroleum	43	4,300
100	Socony Mobil Co.	37	3,700	100	Socony Mobil Co.	36	3,600
			$37,100				$37,250
	Estimated yield 4.8%				Estimated yield 4.6%		

Since there are a variety of models that could generate the same portfolios, the next test was concerned with determining whether the model's decision rules were consistent with the investor's recorded decision behavior. To conduct this test a record was made of the problem solving behavior of the model which was then compared to the statements contained in the trust investor's protocols. To succeed in this test the model's decision behavior had to be sufficiently similar to the investor's so that a direct examination of the two streams of

behavior would not provide a basis for deciding which was produced by the human and which by the model. As a further check, outputs of some individual decision processes were compared in a similar manner to the appropriate portions of the investor's protocols.

As an example of this adaptation of Turing's Test consider the following excerpts taken from the trust officer's protocols and the trace of the trust model's decision process.[15] While these two sets of decision behavior are not both concerned with selecting securities for the same account at the same period of time, the accounts do have a similar investment policy, i.e. high income with possible price appreciation. Hence, although different companies are being considered by man and model it is the similarity of decision process that is being held up for examination.

Trace of Model's Decision Process	Trace of Trust Officer's Decision Process
Ingersoll Rand	Libbey Owens Ford
1. No defensive characteristics	1. Good prospects this year
2. Yield is well above 4%	2. But stock is up in price
3. Earnings are quite stable	3. And it yields less than 4%
4. But there is very little growth in earnings	4. Unless we can offset this by a stock paying more than 4% we shall have to forget it for the moment.
5. Earnings are expected to rise this year	5. If we pick up a stock paying $4\frac{1}{2}$% we could then use Libbey Owens Ford and average out.
6. But growth in working capital is very low	6. Place it to one side for the moment.
7. Place to one side for the moment.	

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[15] These excerpts are taken from the data recorded in G. P. E. Clarkson, op. cit., pp. 83-85.

Borg Warner

1. Has no defensive characteristics
2. Yield is well above 4%
3. But earnings are cyclical
4. And dividends are unstable
5. Place it to one side for the moment.

* * * * * * *

International Harvester

1. No defensive characteristics
2. Yield is well above 4%
3. Earnings are cyclical
4. But dividends are stable
5. Moderate growth in earnings
6. And dividends are expected to increase this year.
7. Accept and mark down: 100 shares @ $44 or $4,400

* * * * * * *

National Biscuit

1. Has defensive characteristics
2. Yield is better than 4%
3. But there is very little growth there
4. Place it to one side for the moment.

International Harvester

1. This stock has a good yield, well over 4%
2. Earnings are somewhat cyclical
3. Not too much growth
4. But let's mark that down: 100 shares @ $43 would be $4,300.

* * * * * * *

When comparing these two sets of decision behavior the reader must remember that the model processes each company with a fixed sequence of tests. But it is quite possible to incorporate mechanisms into the model which will alter the sequence of testing without in any way affecting the portfolio selections. Hence, the regularity of sequence should not be used as a basis upon which to discriminate the model's decision procedure from that of the trust investor.

It is apparent, therefore, that decision models of this sort can be subjected to a series of empirical tests, and that these tests can be applied to the model

as a whole as well as to the individual decision processes of which the model is composed. Consequently, Turing's Test is a powerful method for determining the empirical validity of models whose object is to explain human decision-making behavior.

Suggestions for Future Research

Progress in science is achieved by many individuals working separately or together on various aspects of one main theory. In a similar fashion the depth of our understanding of decision behavior is a direct function of the number of researchers who are willing to observe, test, re-check, and elaborate the theory of human decision-making behavior.

One of the principal ways by which scientific findings are tested is by replication. Until recently many social scientists were convinced that it was not possible to perform the vital task of replicating studies of human behavior. With the theory of human decision-making it is possible to do so, since decision processes, like humans, can be required to behave under a variety of circumstances. As a result, one obvious and major piece of research that needs to be done is another investigation of the decision processes of a trust or other type of institutional investor. If the findings of one case are to be generalized then further instances must be found to compare favorably with the existing theory. All theories contain errors and progress is achieved by research that seeks to find and eliminate the errors.

Since our principal objective is to be able to explain all decision-making behavior, all decision processes are admirably suited for investigation. Since the theory of human decision-making has already been subjected to a variety of empirical tests each new investigation does not start a fresh. For example, if

one wished to explain the decision rules governing the pricing, reordering, forecasting, or production scheduling processes with in a firm, to mention but a few of the total number of possibilities, the task, as outlined above, is chiefly that of discovering the data and decision rules used and placing them within the structure of the theory so that their empirical validity can be checked. Some decision processes are on a higher level of generality than others, some pertain to low order detail. But all can be described, tested and explained by the methods outlined above. Hence, it is up to the researcher to select that process for investigation which suits his management or research interests.

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