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THE CONCEPT OF SYSTEM.

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THE AUTHOR REVIEWS ONE OF THE BASIC SOCIAL SCIENCE CONCEPTS AS IT IS UTILIZED BY PROFESSIONAL SOCIAL SCIENTISTS, MAKING A CONCEPTUAL CLARIFICATION OF THE TERM "SYSTEM" AS IT RELATES TO THE FIELD OF SCHOOL ADMINISTRATION. INCLUDED IN THE ANALYSIS ARE KEY IDEAS EXPRESSED BY THE TERM, DISTINCTIONS THAT SERVE AS VALUABLE GUIDES IN FORMULATING PROBLEMS FOR EMPIRICAL RESEARCH, AND MISUSES OF THE TERM THAT DENY IT UTILITY IN SCIENTIFIC DISCOURSE. THIS DOCUMENT IS A REVISION OF A PAPER PRESENTED AT THE ANNUAL MEETING OF THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION (NEW YORK, FEBRUARY 16, 1967), AND IS ALSO AVAILABLE FROM PUBLICATIONS DEPARTMENT, CENTER FOR THE ADVANCED STUDY OF EDUCATIONAL ADMINISTRATION, HENDRICKS HALL, UNIVERSITY OF OREGON, EUGENE, OREGON 97403, FOR $1.00. (JK)

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FOREWORD

The language of a science is its life blood. Theories, empirical findings, hypotheses, generalizations--all are couched in the concepts of the discipline. The knowledge produced by a field of science can never be more meaningful than the linguistic terms in which it is stated. For this reason, the language of a field requires painstaking nurturance and cultivation. To the layman the scientists's concern for words often appears to be a mark of pedantry, but the fact remains that conceptual analysis can be one of the scientist's most important contributions to knowledge. To make this contribution requires serious, sophisticated scholarship as well as long periods of time devoted to what, on the surface, seems to be unproductive study.

The field of school administration has not been especially concerned with the precision of its language. Loose and careless usage of words abounds. This has been especially notable with respect to those terms imported in recent years from the neighboring social sciences. Such concepts are not always perfectly clear in the parent discipline, and yet they have often been the object of penetrating conceptual analyses undertaken by leading scientists of the discipline in order to reduce their ambiguity. Too readily these gains in precision and clarity are lost as the terms become appropriated by educational researchers.

So it is with the concept of <u>social system</u>. In this short monograph, Dr. Hills brings to the interested professional and to the student of school administration the essential ingredients of its meaning. He draws out the key ideas expressed by the concept, introduces distinctions that serve as valuable guides in formulating problems for empirical research, and points to the misuses of the term that deny it utility in scientific discourse. It is no mean feat to do this as successfully and succinctly as Dr. Hills has. When philosophers of science, general systems theorists, and other progenitors expound on the concept of social system, it quickly becomes obscured in technicalities and in terminology so abstruse that the concept seems nowhere to connect with the real world. Dr. Hills' success attests to the importance of a work setting where single-minded, enduring study is possible and, above all, to his own serious, patient scholarship.

R. Jean Hills received his Ph. D. in Educational Administration at the University of Chicago in 1961, where he was also a Staff Associate in the Midwest Administration Center. After two years at Cornell University, Dr. Hills joined the School of Education faculty at the University of Oregon in 1964 and has held an appointment as Research Associate in the Center for the Advanced Study of Educational Administration since that time.

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UNIVERSITY OF OREGON, EUGENE, OREGON

CONTENTS

INTRODUCTION

The vocabulary of educational administration has grown tremendously in the past decade and a half. The literature of the field is now heavily laden with such terms as, "power structure," "bureaucracy," "informal organization," "theory," "model," and "system," to mention only a few prominent examples. In the process of rapid change in the subject-matter of the field, two related problems seem to have arisen. The first is the failure on the part of writers in the field to distinguish between two different kinds of terms: (1) those utilized in discourse concerning substantive problems of one or more disciplines and; (2) those utilized in discourse concerning methodological problems which cut across disciplines. The former category includes such terms as "formal organization," "power structure," and "bureaucracy." The latter, with which this paper is concerned, includes such terms as "theory," "model," and "system."

The second problem seems to follow from the first. Given the confusion concerning the universe of discourse to which terms apply, there appears to be a wide-spread tendency to utilize these terms either in an indiscriminate manner, or in a manner which emphasizes their honorific rather than their methodological and substantive value. Thus, various works are labeled "models" more for the erudition the use of the term connotes, and more for the stature which it confers upon the work to which it is applied, than for clearly designating the methodological nature of the work itself. Such practices, in and of themselves, warrant little attention. What does warrant some attention, however, is the fact that such use of some concepts tends to obscure certain important implications for research.

In the discussion which follows I propose to single out from the methodological universe of discourse the one concept which, more than any other, provides the fundamental basis for all scientific inquiry, that of <u>system</u>. After an exposition of the minimum essentials of the concept of system, I shall proceed to (1) a consideration of some refinements on the basic concept; (2) a consideration of general conclusions and implications. My thesis throughout is this: the concept of system, as used by self-conscious methodologists, is a fundamental notion, which, in spite of the complexities it involves, has important implications for the kind of research that one does.

THE CONCEPT OF SYSTEM

Given the complexities involved in its application to social phenomena, it is not at all surprising to find that the term system is bandied about in rather meaningless ways. What on first examination appears to be a simple, straightforward idea, with direct and profound implications for research, turns out to be a highly complex set of ideas, the implications of which are by no means direct or obvious. Moreover, I find that I know far less about these ideas than I thought I did. Consequently, what follows is certainly not an authoratative statement. It is advanced, and should be received, tentatively and with reservations, questions, and doubts.

By way of introducing the idea, let me cite what one author considers to be the minimum requirements for a scientific account of a system.

A scientific account of a system must include at least the following:

1. An identification of the components or elements of the system.

2. A specification of the aspects or characteristics of the components, relative to which <u>states</u> of the system are to be provided.

3. A specification of the set of laws in conformity with which states of the system succeed or precede each other, or with which elements of the system interact as regards the characteristics of the [components] specified in 2.[1]

The concise statement just cited involves a set of conceptions which require a good deal of "unpacking" to get at the content of the concept of system. First, however, it seems worthwhile to call attention to what may be a misleading aspect of the above characterization. The use of the definite article "the" in the phrase "the system" suggests that the referent of the concept system is a thing, which may consist of a number of parts or smaller things. While this interpretation may be appropriate as a particular instance, the more general interpretation would seem to hold that the referent of the concept is simple order, regularity, interdependence, or relatedness. Although this will have to be qualified below, it seems more useful to speak of system as a state of affairs holding among things, events, variables, phenomena, etc. (precisely what it is that is related will be considered below).

Another way of saying this is to point out that the term system seems to be used most frequently as a proper name the referent of which is a collection of entities. It seems more useful to me to treat the term initially as a predicate which is synonymous with the term order. One may then use the term in either of the following illustrative ways: (1) "There is system (order) in social behavior;" and (2) "The system (order) in social behavior is temporal." In short, it is important both to be clear about the referent of the term system, and about the distinction between (1) the use of the term as a predicate, and (2) the use of the term as a proper name.

Reduced to its minimum essentials, then, the referent of the concept of system is interdependence or order among phenomena. The only meaningful distinction that I can find between this elementary notion of system and that of "general system" is level of generality. All scientific investigation is based either implicitly or explicitly on the idea of system. There is no science without it. The physicist searches for order in one area, the chemist in an adjoining one, the biologist in another, and the sociologist in still another. What the "general systems" movement seems to be all about is that there are those who hold that it is fruitful to examine the several orders discovered in the separate disciplines to discover what order there is in order itself.

In addition to the element of order, three other components of the concept of system stand out. These are selectivity, abstraction, and system state. Let us take up each in turn, beginning with system, or order, itself.

System, or order, concerns the relations among the properties, or variables utilized to characterize empirical entities and phenomena.[2] At least three kinds of system may be identified:

1. System among the several variables utilized to characterize a given entity.

2. System among the variables utilized to characterize a given entity, and the variables utilized to character-

ize another entity with which it interacts.

3. System between the variables utilized to characterize a given entity at a given time, and the values of one or more of these same variables for the same entity at a subsequent time. (If variables involving time, e.g., velocity and momentum, are viewed as properties of the entity, then types 1 and 3 are the same.)

Selectivity. Anything capable of being investigated embodies, or may have ascribed to it, an infinite number of properties from among which a limited number must be selected on the basis of their relevance to a given interest. Thus, for example, the properties that might be ascribed to a pendulum include the chemical composition of the bob, the reflecting power of its surface, its temperature, shape, electrical conductivity, degree of bacterial contamination, color, and so on.[3] If, however, one is interested in predicting the motion of the pendulum, only two properties are relevant: the angular deviation of the pendulum from the vertical, and the angular velocity of the pendulum.

Abstraction. The notion of abstraction is too obvious to require more than a brief mention. It implies that entities are treated in terms of their common rather than their unique properties.

System States. The conception of system state may be illustrated by returning to the example of the pendulum. One may regard the order in the relation between the values of angular velocity and angular deviation as an order the state of which changes over time (the order does not change). These variables are termed variables of state, or variables defining the state of the system. A state description of a system is provided by giving specific values to the variables. If we have two variables x and y with orderly, or systematic relations between them, then if the value of x is known, y can be specified. If the variables are continuous, then there is an infinite number of possible combinations of the two values. A state description simply specifies the particular combination of these values which exists at a given time. Another example is the motion of a planet. In this case the variables of state are the position and momentum of the planet in its solar orbit. Common to both these examples is the implication that the variables of state change in time according to mathematical equations such that knowing the values of the variables of state at a given time enables one to predict the value of the position variable at a subsequent time. A state of a system, then, is a particular configuration of values of the variables of state. Systems described in terms of variables that represent properties ascribed to individual elements, or a set of such elements taken distributively, are commonly termed mechanical systems.

A different approach to the identification of state conditions is that illustrated by the description of the state of a body of gas in terms of its temperature, pressure and volume. Here the state description is provided in terms of values of variables that represent statistical properties of classes of elements rather than properties that can be predicated of individual elements. Thus, in statistical mechanics, the temperature of a gas can be interpreted as the average value of the mechanical state variables which, theoretically, characterize the condition of the molecular elements.[4] Temperature and pressure are properties of aggregates and refer to individual units only through theoretical interpretation.

The references to system (or order), selectivity, abstraction, and system states should now be clear. The investigator selects from a concrete situation capable of characterization in terms of an infinite number of properties, a limited set of properties common to a plurality of entities, the values of which are related systematically to one another, or to other values of the same variables at a subsequent time. In the classic illustration of celestial motion, the astronomer selects from the infinite number of available properties of the planets and the sun the two properties position and momentum. Considering the degree of selectivity involved, no one in his right mind would suggest that the astronomer's characterization says all that is worth saying about the entities under consideration. Yet, for the specific purpose of predicting motion, it is all that needs to be said.

At this point we might pause to consider briefly the manner in which the concept of system appears to be used in the literature of educational administration. It seems quite clear that the applications of the term do not involve any conception of a set of interdependent variables selected in terms of their relevance for making predictions either about changes in these variables, or about the values of unknown variables. More often than not, the term seems to be used, with some appropriate adjective such as "social," to refer to a total entity such as the school.

Even with the addition of a conception of roles as units of a social system, such a view is seriously misleading for it suggests that a social system is a system of entities of some sort rather than a system of relations among properties of entities. This point can be illustrated with a familiar example from the field of geometry. Consider a triangle, in which lines are the units, and in which the relevant properties of the units are length and spatial arrangement. Certain properties of the several lines are systematically related. For example, it can be asserted that, given lines A and B perpendicular to one another, with respective lengths x and y, the square of the length of line H, connecting lines A and B, will be equal to the sum of the squares of x and y. The important distinction, and it seems to be a difficult one to maintain, is that the order that we seek to identify, and to which the concept of system refers, is not order among concrete units as such, but order among properties of units. Units are carriers of properties, and nothing more. As Kuhn has put it,

> The elements, or components of a system are <u>not</u> the entities in the system, but qualities or states of those entities. In the thermostatic system, it is not the air in the room, but its temperature, which is the element in the system. It is not the thermostat, but the position of its switch. It is not the furnace, but its state of being on or off. Similarly, the environment is not the outside air, but the temperature of the outside air, along with the properties of the wall which will determine how fast heat will move between system and environment.[5]

REFINEMENTS ON THE CONCEPT OF SYSTEM

<u>Structural</u> <u>System</u>. Given the preceding preliminary exposition of the concept of system, a number of refinements can be added. The first of these is the distinction between <u>structural</u> <u>system</u> (or order) and <u>process</u> <u>system</u> (or order). The notion of structural system seems applicable only when the order of reference is that which holds among the relational properties of two or more entities, or units. Thus,

while it does not seem particularly useful to speak of structural order with respect to the variables position and momentum, it does seem useful to apply that term when considering the relative positions of the several planets. Within the concept of structure, then, a distinction may be made between (1) units (parts, or components, with given properties) on the one hand, and (2) relations among the properties of these units, on the other. The structural units of the solar system are the sun and the nine planets. The units of a physiological system may be the peripheral blood vessels, the thyroid gland, and the adrenal gland. The units of a social system may be roles and collectivities. And the units of a word may be its component letters. Strictly speaking, however, the focus of interest is not the unit such as the planet or role in its undifferentiated wholeness. Science does not proceed on the basis of descriptions of whole things, but rather on the basis of descriptions of properties of things. Thus, to be accurate we should say that the unit of classical mechanics is the mass-point. In the physiological example it is not the concrete blood vessel that is the thing of interest, but one of its properties, e.g., its degree of dilation.

The above remarks must be further qualified by noting that the notion of unit or entity seems to reduce to a cluster of variables the values of which remain relatively constant over time, and which have some permanence as a cluster. Thus, Kuhn's thermostat can be viewed as an entity because it can be "constructed" out of a cluster of observable properties which will, in all probability, still be observable when one looks again. Units, then, consist of clusters of stable properties with which are associated additional variable properties, e.g., the position of the thermostat switch.

But units alone do not constitute a structure. Structure consists in stable unit, or character, properties and also relational properties. Without adding or subtracting any units, and without changing any of their character properties, we may completely change structural system by changing the relations among them. For example, consider the names "Ronald," "Roland," and "Arnold."[6] They contain exactly the same letters, but the relative positions of these letters, i.e., their mutual relations of before and after, are different in each case. Similarly, the units of both a university and a public school might be said to be roles which have very similar character properties, but the relational properties of these units in the two settings are sufficiently different from one another so that no one with more than superficial acquaintance with them mistakes the one for the other.

Process System.[7] Structural system, then, may be treated as consisting of (1) units, such as the particle, or the role, with selected character properties, and (2) patterned relations among unit properties, such as the law of gravitation, the laws of contract, property, etc.[8] Both these aspects of structural system may be distinguished from process system. There are cases of scientific inquiry in which the sole concern of an investigation is structure. Descriptive physical geography, for example, simply delineates the location and spatial relations of mountains, plains, rivers and oceans. Structural order, however, usually provides the basis for investigations of processes which go on within structures, and through which structures either change or are maintained. Implicit in the preceding statement is a three-fold distinction within the concept of process:

1. Stable processes, as illustrated by motion in classical mechanics, which involve neither structural change or structural maintenance processes.

2. Compensatory, or equilibrium maintenance processes which tend to maintain a given structure in the face of external variability.

3. Processes through which structural system undergoes change.

The classic illustration of stable process is that of motion in classical mechanics. Here the processes of motion are stable and involve neither changes in the character properties of the units (mass) nor changes in the relations among units (relative distances from a point of reference). Although the values of the process variables undergo continuous change, the orderly relation between structural units remains stable. One can conceive of equilibrium maintenance processes in this context by imagining the introduction of an external force which tended to disturb the orbit of a planet, counter-acted by a tendency toward the re-establishment of the original orbit. Similarly, one can conceive of structural change in the same context by considering what might happen if an explosion dispersed the mass of a given planet into several widely separated pieces. In addition to the change in the mass of the original planet, changes would occur in the relative locations of other planets and a new equilibrium would be established.

Stable change process of the kind illustrated by the motion of classical mechanics seem to have few, if any, counter-parts in human behavior.[9] Situations analogous to equilibrium maintenance and change processes, however, are relatively numerous. The term equilibrium identifies the process system among variables which remains constant through change in the values of the variables. Equilibrium maintaining processes, then, are those which operate to compensate for any deviations from that system and to return the variables to the original system. For example, the laws of a society order, or systematize, the relations which hold between the variables, in terms of which social actors are described. Slavery, for example, is one relation that is unacceptable. Should it occur, processes would be set in motion to restore the variables to the original order. Again, if consumer wants relative to the supply of goods and services produced by an economic system were completely stable, the production processes internal to the system would continue in a routinized manner. The fact is, however, that wants change continuously, requiring compensatory processes within the system (which do not change the basic structure of the economy) to satisfy the demands of consumers.[10] It should be apparent that the state of an educational system in relation to the consumers of its services might be conceived in parallel terms.

The processes most characteristic of social systems would appear to be various forms of communication. Communication may be viewed as a set of control (feedback) mechanisms, involving several kinds of media, through which the values of process variables are kept within limits compatible with the maintenance of the main structural system. Power, for example, can be conceived as a circulating medium (utilized in the communication of binding decisions) which controls the outputs of other units in the interest of maintaining stability in relation to the environment. Similarly, the expenditure of money can be conceived as a form of communication through which one unit controls the behavior of another.

When circularity of action, e.g., reciprocal communication, exists among the structural units of a system, feedback may be said to be present.[11] "Negative feedback is that which operates in a direction opposite from that of the input."[12] Positive feedback is that which operates in the same direction as an input. "Automatic pilots that counteract deviations from level flight exhibit negative feedback."[13] Negative responses to deviant performances of social actors can be conceived similarly, just as positive responses can be seen as operating in the same direction as, or reinforcing, a given kind of performance.

Associated with the concept of equilibrium processes is that of processes of structural change. Clearly, an alternative to the maintenance of a state of equilibrium is failure to maintain such a state. Failure of compensatory mechanisms to operate successfully leads to structural change, an extreme example of which is dissolution of the system, as in the death of a living organism in which temperature maintaining mechanisms fail. Short of dissolution, there are less drastic structural changes, as for example the differentiation of new structural elements from existing ones. A familiar example from our own field may be seen in the historic process through which administrative roles came to be differentiated from the teaching role. A more recent example is the differentiation of the guidance counselor role from that of the teacher.

Functional System.[14] The system, i.e., the kind of order, referred to most widely in the social sciences is functional. Functional system is that in which changes in the values of given variables have consequences for the other variables involved in functioning of some system. For example, it might be said that the function of a given type of act for an organization is the maintenance of solidarity. Beyond this, functional system implies that the value of variables such as solidarity depends on the performance of certain kinds of activities, and that these activities are characteristic of certain structural units. Thus, for example, roles may be conceived as functionally differentiated units of a social system. To say that the function of such a unit is goal-attainment for example, is to say that it contributes to the maintenance of a system goal-state in relation to an environment.

It is important to recognize that the classification system utilized in the identification of roles does not necessarily coincide with the common-sense designations such as that of principal, teacher, or superintendent. If roles are viewed as functionally differentiated units of social systems, then the labels which are utilized to designate them and distinguish them from one another will reflect the functional frame of reference within which the analysis is made. Put another way, roles identified within a given frame of reference will probably not map precisely on to the common-sense frame of reference. So long as one insists on using both analytical and common-sense concepts there is a problem of moving between them, and one is faced with the task of saying that the common-sense role that we speak of as "principal" corresponds to such and such a role, or roles, in the new language.

The reason for this is clear. Every day language has relatively little "system" built into it. To identify someone as a principal, for example, implies some things about how the person so designated will behave, but far from enough to be scientifically useful. The situation is very similar to that faced by the chemist. To identify a substance as wood implies that the substance will float, burn, return to the earth if thrown into the air, etc. On the other hand, to identify a substance as carbon implies a great many things both about its properties and about how it will behave. Similarly, the identification of an organism as a fish or a mammal enables one, without further investigation, to make certain assertions concerning the organism's circulatory, nervous, excretory, and respiratory systems. The adoption of a classification system is never a matter of deciding what things really are (e.g., is a whale really a mammal) but a matter of maximizing the information provided with the identification of entities. Names, whether of the common-sense or scientific variety, are grounded not in the immutable nature of things, but in the convenience of the users.

It is also important to recognize that it is conceivable, indeed likely, in any analytically advanced formulation, that the contributions of any common-sense role-unit, e.g., principal, will prove to be divisible into two or more roles at the analytical level. This should come as a surprise to no one, since the human scientist, like the chemist who long ago moved beyond common-sense classifications such as wood, water, air, metal, etc., must supplement ordinary language with more useful categories of his own. Reclassification of subject matter in the light of new categories is a characteristic of science.

CONCLUSIONS AND IMPLICATIONS

The most general conclusion to be drawn from all this would seem to be that research is the search for system, or order, in experience. Thus, some acquaintance with the concept of system is valuable if only because it helps to know what one is searching for. One immediate implication of the concept has to do with the matter of "problem finding" in any field. The fruitful search for order seems typically to begin with the observation of order which requires an explanation. Thus, the observation that projectiles fired from cannons continue to move long after the force of the explosion has ceased is said to have led Galileo to initiate his inquiry into the motion of terrestrial bodies. Lightning precedes thunder; why? The vast majority of elementary school teachers are females; why? All certificated administrators in public schools are required to have been teachers; why? Administrative posts in public schools are sought after, while similar posts in universities are not; why? Goods and services produced by business firms are made available to consumers on a full-payment of cost basis, while those produced by hospitals are made available on terms which vary according to the consumer's ability to pay; why?

The point of providing an explanation for observed order is, of course, not for the ensuing feeling of understanding which often follows, but the capacity of an explanation to suggest extensions of the original order. For example, if one observes that the decisions of administrative heads of schools of education are less frequently challenged by faculty members than are the decisions of heads of academic departments, and if one explains this by suggesting that since professors of education seldom publish or otherwise develop an independent claim to prominence, the advancement of their careers depends heavily on securing good recommendations from administrative personnel and they are therefore reluctant to "kill the goose that lays the golden eggs," then a number of testable implications follow immediately. One implication is that the addition to the staff of persons who have established reputations through publication, etc. will be followed by an increase of faculty criticism of administrative decisions. Another is that a greater proportion of the credentials of personnel in schools of education will contain recommendations from superiors than will those of, say, sociologists.

Positive results in the testing of such an explanation, (or hypothesis) by tracing out and testing its implications has two important consequences. First it extends the system, or order, from which one started. Second, it lends tentative support to the explanation and encourages one to use it as a guide for further attempts to extend the order.

The implications of the preceding remarks for a fledgling research field like educational administration seem fairly clear. Although the search for order in a given field is often facilitated by drawing upon the orders identified, and the explanations advanced, in other fields, there is no substitute for data from the field in which one wishes to identify order. I think one can assert justifiably that we have yet to identify explicitly, much less explain, the common-sense orders that characterize our field. Until we have done so it makes little sense to insist that all research be carried on at theoretical levels. The first task of theory is to explain common-sense order, order such as "personnel in educational organizations are granted tenure, while those in business firms are not;" "the recipients of the services of commercial firms are free to accept or reject that service while those of certain educational organizations are not;" "military organizations secure some of the human resources required for their operation through compulsory contract, while other organizations must rely on voluntary contract." The lack of theory in educational administration is often cited as a serious weakness. While there is, no doubt, a considerable amount of truth in this, an equally serious weakness is the lack of much observational data about which to theorize. Olds has observed that:

> Available theory in psychology cannot even predict [explain] the things that a Fuller Brush man knows about psychology of his customers; what extreme temerity we have then to presume that we will predict psychological subtleties that the Fuller Brush man does not know.[15]

One could easily substitute administration for psychology and administrator for Fuller Brush man in the above statement with little loss of accuracy. The implication that I draw from all this is that the expansion of knowledge about educational organization and administration will probably be served at least as well by cataloging systematically the existing (and often implicit) fund of common-sense knowledge, as by attempting to produce new knowledge on the basis of theories which cannot explain what we do know.

To speak of cataloging systematically available knowledge, however, implies that there is available a widely accepted categorical system in terms of which such an ordering may be accomplished. Categorical systems are necessary prerequisites to theory, and of course, theories are sources of sets of categories which may be used both to order existing, and produce new, knowledge. One of the primary tasks of students of organization is the development of a maximally informative set of categories in terms of which organizations, and elements within organizations, can be classified. What is required is a category system with the same properties which characterize those of physical and biological sciences. That is, the classification of an organization, or a structural entity within an organization, as such and such, should convey the maximum amount of information about the object. One would wish to be able to say, even as the biologist who knows that a mammal has certain respiratory, digestive, circulatory, and other characteristics, that organizations of such a type have characteristics A, B, C----.

The search for structural order in human behavior is analogous to the search for structural order in the physical world in which seventeenth century chemists were engaged. Their questions were, "What are the material constituents of things?" and "How are they combined to make a thing what it is rather than something else?" They assumed that the number of constituent elements was limited and that each of the wide variety of types of things was a particular arrangement of some of these elements. Over the centuries physical scientists have identified some 100-odd elements. Having succeeded in the analyses of the material world, i.e., having identified the basic constituent elements which in their various arrangements make up natural things, they found it possible to engage in synthesis, i.e., to create from these elements structural orders not found in nature.

There are a number of parallels in the human sciences. Psychologists ask "What are the constituent elements of the human personality, (or perhaps human behavior)?" and "What makes a particular type of personality (or behaving organism) what it is rather than something else?" Similarly, students of organizations ask, "What are the constituent elements of organizations?" and "How are they combined to make organizations what they are?" Like the chemist, the student of organization must assume that there is a limited number of constituent elements out of which the many types of organizations are constructed. If there were as many kinds of elements as there are organizations, then we might as well make an exhaustive catalog of organizations and be done with it. The advantage of taking the analytical point of view, of course, is that given a knowledge of the elements and their actual and potential combinations one can say, like the chemist who says that salt is sodium chloride, that this type of organization is such and such. Moreover, this approach leads ultimately, as it does when the chemist says, "We can combine these elements in a new way to form nylon," to the capacity to synthesize combinations not found in nature.

The identification of structural order at a given level leads to further questions. The identification of material elements in chemistry and their arrangement in the periodic table (which illuminated both the periodicity of the chemical and physical properties of the individual elements, and the ways in which the elements combined to form compounds) gave rise to much speculation about the structure of the elements themselves, i.e., the structure of the atom. In the same way, the identification of the constituent elements of organization, combined with information about how they enter into combinations leads to questions as to why they enter into these combinations and not others. Why, for example, do organizations with certain kinds of objectives characteristically grant tenure to operative personnel while organizations with other types of objectives do not? And why do we seldom find the combination of highly expert operative personnel and highly centralized decision-making?

The two great difficulties encountered in the study of organization structure have been (1) the lack of any widely accepted system for the classification of the unit and relational aspects of structure (it is as though each and every chemist had his own set of categories for classifying elements and their relations); and (2) the fact that more frequently than not, a particular common-sense structural unit, e.g., the role of principal, is studied in isolation (it is as though the chemist selected a single element of a compound for examination and never got around to investigating how that element related to other elements of the compound).

We have had innumerable studies of expectations for the roles of principals, superintendents, teachers, guidance counselors, board members, etc., but we know very little about <u>organization</u>. Most of the research done thus far has been based on nothing more systematic than every-day language categories. Such an approach provides little basis for specifying the central elements which distinguish a given structural unit from others. Until structural units and relations are examined within some coherent frame of reference so that they can be related to one another our knowledge of organization structure will remain relatively insignificant.

There are at least two ways in which this might be accomplished. Given the framework, investigators might, in a single investigation, examine the full range of units and relations in given organizations. Somewhat similar, but less dependable, results might be obtained by the use of a common frame of reference in smaller scale studies across organizations.

Knowledge of structural system is important in its own right. But since structure is the framework which channels interaction, it is important as a base for studies of process. If we know little about structure, then we know even less about how those structures are maintained and changed. Although my acquaintance with the full range of research on educational organization is far from complete, it would seem that studies of process are relatively rare. The bulk of process research seems to concern interaction between teacher and student. The problems here are much the same as those encountered in the investigation of structure. The basic requirement is a system of categories in terms of which communication exchanges can be described.

As a concluding note it may be worthwhile to mention what appears to be a rather important reorienting implication of the concept of process system. There seems to be a marked tendency in the field of education to view persons, in so far as control of their behavior is concerned, as discrete, autonomous individuals. There is, for example, little awareness of the subtle kinds of system--that obtain between behaviors of individuals. It is rather commonly assumed by both university and public school teachers that if a student performs in a given way, say poorly, then it is the student alone who is responsible. Grades therefore reflect student performance. These kinds of assumptions can be defended only on the basis of some further assumptions about the nature of the teacher-student interaction. If grades reflect student performance alone, then there can be no system between teacher behavior and student behavior. But if the student does well we want to attribute it to our efforts, so there must be a system such that the student can turn it on or off at will.

Here as well as elsewhere, the concept of system can alert one to the possibility of subtle kinds of order among events which, in the common-sense view, are wholly matters of "free will" on the part of the individual.

References

1. Richard S. Rudner, Philosophy of Social Science, (Englewood Cliffs, New Jersey: Prentice-Hall, 1966) p. 89.

2. System may also be a property of sets of symbols which have no empirical referents. For example, "pure" mathematics is characterized by a high degree of system.

3. W. Ross Ashby, Design for a Brain, (New York: John Wiley & Sons, 1960) Chapter II.

4. See Ernest Nagel, The Structure of Science, (New York: Harcourt, Brace, and World, 1961) p. 290. Also Henry Margenau, The Nature of Physical Reality, (New York: McGraw-Hill, 1950) p. 190.

5. Alfred Kuhn, The Study of Society: A Unified Approach, (Homewood, Ill., The Dorsey Press, Inc., 1963) p. 50.

6. The example is due to Susanne K. Langer, An Introduction to Symbolic Logic, (New York: Dover Publications, Inc., 1953) Chapter II.

7. This discussion of system structure, and the following discussion of system process, draws heavily on Talcott Parsons, "Some Considerations on the Theory of Social Change," Rural Sociology, 26:3, (Sept, 1961). Parsons distinguishes between change and equilibrium processes, but does not consider stable processes identified in item 1.

8. This is to say that from one point of view, the structure of social systems is, in large part, normative. Relations among social roles with given character properties are structured by normative standards, violations of which are punished. Thus, the relations between two roles having the character properties of economic orientation and production goals are structured by the institutions (partly formalized in the legal code) of contract, property, and occupation.

9. Margenau and Smith draw an analogy between some of the problems of the behavioral sciences and those of atomic physics. The major difficulty that arises in connection

with attempts to apply classical mechanics to atomic particles is that such particles do not exhibit continuity of motion. In classical mechanics it proved justifiable to hold that the motion of a body from one location to another could be conceived as a continuous curve on which the location of the body could be specified for any given instant. One implication of this is that it is meaningful to attribute position to the body as a continuously observable property. Atomic physics, however, has found it both practically impossible and logically inconsistent to try to conceive of the motion of electrons as continuous, and hence, as possessing continuously the property of position. In addition, mass, the stable individual property of classical particles, is not stable in atomic particles. It increases as velocity increases.

The analogous situation that Margenau and Smith see in the human sciences is best conveyed in their own words:

> "In the human sciences there occurs a class of observables that, although useful, do not exhibit the unvarying attachment to systems that characterizes the possessed observables of classical physics. Anger, happiness, composure are psychological qualities of man, often used in the same way for the purpose of describing his mental state as the physicist uses position, velocity, and mass of an electron, for example. But there is this important difference: anger, happiness, and composure may be present or not; man is <u>sometimes</u> angry, happy, or composed, but there are states in which the attribution of these qualities is meaningless. Anger, happiness, composure are sometimes present and sometimes not. They might be called "latent" observables, which come into being and then disappear, and no one would be disposed to claim continuity of anger, happiness, and so forth. Henry Margenau and J. E. Smith, "Philosophy of Physical Science," in Guy S. Me'traux and Francois Crouzet, eds., <u>The Evolution of Science</u>, (New York: Mentor, 1963) pp. 389-390.

The conclusion toward which such an interpretation leads is not that human behavior is not lawful, but rather such laws will take the form of probability statements. Thus, a recognition of the discontinuity of the states

of behavioral systems does not entail a renunciation of behavioral science. It means only that we shall not talk about individual behavioral events, or perhaps acts, but about the average properties of a multitude of acts. Even though single, unique behavioral states may not be predictable, the probability of a given state occuring in a given system may be.

10. An internal-external distinction is implied here. Important as it seems to be, it is too complex to treat in depth in this paper. It seems clear however, that one can conceive of system within system, or order within order. For example, one might speak of social order with respect to a society and also speak of economic, political and other kinds of order within the more general order. It is also possible to conceive of the several orders as a cybernetic hierarchy.

11. W. Ross Ashby, An Introduction to Cybernetics, (New York: John Wiley & Sons, Inc., 1963) p. 53.

12. Morton A. Kaplan, System and Process in International Politics, (New York: John Wiley & Sons, Inc., 1964) p. 6.

13. Ibid.

14. There is some question concerning the appropriateness of the terminology used here. One of my colleagues has suggested that it is misleading, and that it would be appropriate to speak of the "functional approach to systems." The pros and cons of the issue are too complex to take up here but the interested reader is referred to the works of Rudner and Nagel cited in footnotes 1 and 4.

15. James Olds, The Growth & Structure of Motives, (New York: The Free Press of Glencoe, 1956) p. 140.