McGILL UNIVERSITY

# CYBERNETICS AND INFORMATION THEORY : APPLICATION TO SOCIAL WORK

An Analysis of the Significance of Cybernetics and Information Theory as Methodological Approaches to the Study of Clinical Problems in Social Work

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by

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The purpose of this study is to examine cybernetics and information theory as methodological approaches to the analysis of behavior with specific reference to clinical applications to social work. The applications are in four areas: 1. the development of new approaches to therapy (e.g., functional casework and reality therapy as opposed to dynamic casework); 2. the emphasis on working with groups and families and the promotion of community mental health programs; 3. investigations in linguistic and paralinguistic expression in therapy sessions as illustrated by research in content-analysis; and 4. educational programs to provide accessibility of these approaches to the practicing social worker and integrating these concepts into curriculum training programs. An analysis of the inclusion of cybernetics and information theory in the social work literature, subtitled "systems theory," reveals certain oversimplifications and misconceptions of the two disciplines.

Cybernetics and information theory present means of controlling and regulating entropy and information transmission and transformation. They provide the underlying generative rules for operations within a closed or open system. Man is perceived as an open system, interdependent with his psycho-sociocultural environment. The cybernetic concepts of feedback and network circuits offer a schema for explaining

the transactional system of man and his environment. Information theory provides a means of analysing communication, verbal and non-verbal, and methods for devising efficient transmission. Consideration of the operative mechanisms of man in problem-solving, decision-making, and general cognitive areas reveal similarities to the operative mechanisms in cybernetics and information theory as simulated in computer programming. Contemporary theories in psychology, sociology and communication (syntactic, semantic, and pragmatic) illustrate the integration and influences of cybernetics and information theory in the social sciences.

The social worker is concerned with the breakdown of the system and the disturbed patterns of communication exchanges (cognitive or affective). Understanding man in relation to his self and society and perceiving the problems of regulation, stability and processes of change help the professional worker to improve methods of coping with a system that is unstable. The application of cybernetics and information theory is not a substitute for other approaches in social work, psychiatry and psychology; rather these are significant models that, once incorporated into the existing therapeutic schematas, could benefit the clinician. Examining cybernetics and information theory in their original framework offers a means of appreciating the complexity of the disciplines, a measure for evaluating the validity of the applications to social work, and an opportunity to discover areas for further research.

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# CHAPTER I

## INTRODUCTION

### Statement of the Problem

Consideration of cybernetics and communication can take essentially two forms: one being theoretical and philosophical, the other being theoretical and empirical. The former tries to explain such behavior from a psycho-philosophical standpoint, outlining the epistemological ramifications of the theory in question; however, unless actually applied to behavior as is especially demonstrated in clinical therapeutic transactions, these theories delineate the constructs in abstract form but do not reduce these generalizations to specific situations. One cannot ignore the philosophical perspectives of cybernetics and communication theory in architecture, law, science, fine arts, philosophy and literature as they reflect the tenor of contemporary thought; however, it is the purpose of this study to concentrate on the theoretical and empirical aspects, i.e., clinical applications in social work. The validity and appropriateness of the application of cybernetics, information theory, and computer processing to social work as viable models such that they offer new perspectives, insights, and a system for productive research and predictive inferences for therapeutic techniques are to be investigated.

Cybernetics and Information Theory : Historical and Definitive Considerations

Cybernetics is the study of the transmission and control of information in engineering systems; as such, it is the study of communication. Since approximately 1940, the problem of communication has been fashionably correlated to the theory of cybernetics, "the science of government or control" (from the Greek word meaning steersmanship). This concept of "communication theory" as a function of the study of cybernetics grew out of the separation of power engineering and communications engineering. The former transfers amounts of information and events; the latter transfers the patterned relationship between these events.[1] This process has been integrated into what has become known as the General Systems Theory (GST). Yet, for the purposes of this study, cybernetic theory is considered the major model. It involves the operative mechanisms and explains the functioning and structure of the "General System." A system, according to Rapoport

> . . . is a whole which functions as a whole by virtue of the interdependence of its parts, and the method which aims at discovering how this is brought about in the widest variety of systems has been called general systems theory. General systems theory seeks to classify systems by the way their components are organized (interrelated) and to derive the "laws," or typical patterns of behavior, for the different classes of systems singled out by the taxonomy.[2]

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[1]Deutsch, Karl, Nerves of Government Models of Political Communication and Control (Free Press Paperback, New York: Free Press, 1966), p. 82.

[2]Rapoport, Anatol, "Foreword," in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley (Chicago: Aldine Publishing Co., 1968), p. xvii.

Initially a theory in thermodynamics and engineering and applied to computer systems, the cybernetic model has been manipulated increasingly so as to be relevant to economics, biology, politics, and sociology. Although cybernetics does utilize specific epistemological principles in relation to physics and engineering, it is basically a method of structuring, organizing, and studying knowledge rather than a body of knowledge per se.

In relating the GST to social work, Hearn proposed two questions:

1. Can the clients with whom social workers are concerned in practice be described in terms of GST?

2. When so described, does such translation lead to useful insights for practice?[1]

Approximately fifteen years having elapsed since cybernetics and GST were introduced into the social work schemata, it is important to perceive just what changes have been made and to evaluate if, in fact, the understanding of the individual and treatment has been increased and in what dimensions.

The question as to whether a strict scientific model can be applied to the field of social work may be debated; nevertheless, there is ample evidence to justify this application. For example, Brooks stated: "What is regarded as acceptable for a model of reality, even in physics, is strongly dependent on the scientific environment of

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[1]Hearn, Gordon, Theory Building in Social Work (Toronto: University of Toronto Press, 1958), p. vii.

that time."[1] Two critical aspects of contemporary science are "uncertainty" and "relativity." The "Heisenberg uncertainty principle" indicates that "laws of quantum theory are deterministic or causal in the sense that the state of the universe at any time is determined by its state at some previous time."[2] The principle of relativity implies that there are no fixed points in the universe that have greater claim than any other, there are only relationships.[3] Transformed into sociological terms, these two principles become: behavior of an individual at any time is determined by previous experience and his state at that time as it is a function of the impinging relationships with the environment. The constant flux of the stability of the individual must be accounted for in terms of an interdependent and interactionary process between the organism and the environmental stimuli.

In mathematics, the change in the concept of numbers has significant relevance to the problem of cybernetics and communication theory. Coupled with the introduction of the concept of the variable and the notion of function, was the emphasis on relationships and relativity.

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[1] Brooks, Harvey, "Scientific Concepts and Cultural Change," in Science and Culture : A Study of Cohesive and Distinctive Forces , edited by Gerald Holton (Boston: Houghton Mifflin Co., 1965), p. 74.

[2] Ibid, pp. 78-79.

[3] Ibid.

> Functions are not numbers at all in the plastic sense but signs representing a connection that is destitute of the hallmarks of magnitude, shape, and unique meaning, an infinity of possible positions of like character. . . ."[1]

Thus, it is not specific "bits" of information that are transmitted but the relationships and functions of these "bits," an interaction of sets of possibilities and complex systems.

The concepts of transformational operations, feedback systems, entropy and equilibrium are crucial to the cybernetic model and scientific theories in physics and engineering. How the information is transformed without losing energy, quantity and quality regulates the system so as to maintain the equilibrium of the system. The tendency of an open system to deorganize, through entropy, creates the necessity to have steering regulators. The principle of transformation indicates the method of operation so that the system is dynamic and regulated.

The operation of a closed system is a function of entropy, the second law of thermodynamics. The principle of entropy maintains that a "degree of deorganization in a system (through random activity) tends to increase to a maximum, until eventually the process ends in a state of equilibrium . . . towards homogeneity."[2] An illustration of entropy is the process of dialysis between a saline solution and pure

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[1]Watzlawick, Paul; Janet Beaven; and Don D. Jackson, Pragmatics of Human Communication (New York: W. W. Norton and Co., 1967), p. 24.

[2]Hearn, Gordon, Theory Building in Social Work, p. 41.

water: an exchange continues until both solutions have an equal distribution of water and salt; both systems reach a homogeneous level. The movement in the system is random, decomposing because of the lack of constraining regulators.

In open systems, entropy is also a factor yet one strives for "negentropy," i.e., organization. To compensate for entropy the open system must find means to maintain an ordering process. The homogeneous state of equilibrium in a closed system is stagnant. In open systems equilibrium states are termed "steady-states." The term "steady-state" implies organization and equilibrium without reaching a stagnant homogeneous level.

Bertalanffy has differentiated between the principle of equilibrium in open and closed systems by characterizing the former as "steady-state." The open system is never homeostatic but constantly reaches a new but steady-state after the intrusion of input data.[1] Hearn states that:

> . . . after any disturbance, a system tends to re-establish a steady-state. When any component is added, the organism can react in such a way to re-establish a steady-state similar to the original. If the stimulus is prolonged however, or if external conditions change in any major way, the system can react in such a way as to establish another steady-state.[2]

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[1]Bertalanffy, L. V., "General System Theory -- A Clinical Review," in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley, pp. 11-30.

[2]Hearn, Gordon, Theory Building in Social Work, p. 44.

This hierarchical process is evident in Piaget's system of maturation stages, in Erikson's eight phases of development, and in Maslow's growth theories.

There are two mechanisms that control entropy in open systems. Progressive segregation counteracts entropy by a hierarchical progression of differentiation and order. Subsystems can gain an independence from the main system. Progressive mechanization is a process whereby certain modes of behavior become set as fixed arrangements. The significance of these two phenomena are in their capacity to hold entropy in check and impose restraints as the limits of potential growth. The latter is a deep concern for social workers whose main interest is in the principle of maximizing potential for growth through self-regulation and self-determinism.[1]

Equifinality is related to the principle of steady-states and is defined by Bertalanffy as a process through which "the same final state may be reached from different initial conditions and in different ways." In closed systems the opportunity for alternatives does not exist. "The final state is unequivocally determined by the initial conditions."[2] The concept of equifinality has considerable import for social work as it indicates the possibility that regardless of the origins and experience of different individuals it is possible to strive and maintain a steady-

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[1] Ibid., p. 49.

[2] Bertalanffy, L. V. "General Systems Theory," Main Currents in Modern Thought, II (1955), p. 77, as quoted by Gordon Hearn, Theory Building in Social Work, p. 45.

state and progress upwards; it implies the principle of growth, creativity, and equal possibility. Implicit in the principle of equifinality is the concept of change.

The concept of equifinality has also been applied to psychopathology. In analysing "normal" behavior and deviations one does not merely consider intrapsychic phenomena as a result of the genesis of the product but rather one perceives the behavior as a function of the ongoing system of transactions. The change in perception of the etiology of schizophrenia exemplifies the working principle of equifinality. The system itself becomes the best explanation of the behavior rather than the "initial circumstances." The study of the system, of its organization and activity, is the appropriate methodology.[1]

Jackson applies the concept of equifinality to schizophrenia:

> Historically the place of psychogenic trauma in etiology appears to be shifting from Freud's original ideas of a single traumatic event to the concept of repetitive trauma. The next step would be not who does what to whom, but how who does what. Perhaps the next phase will include a study of schizophrenia (or schizophrenias) as a family-borne disease involving a complicated host-vector-recipient cycle that includes much more than can be connotated by the term "schizophrenegic mother."[2]

The steady-state of an open system is maintained by feedback mechanisms. The importance of functional unity is expressed by

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[1]Watzlawick, Paul, et al., Pragmatics of Human Communication, p. 129.

[2]Jackson, Don D., "A Note on the Importance of Trauma in the Genesis of Schizophrenia," Psychiatry (Vol. 20, 1957, 181-184), as cited by Watzlawick, Paul, et al., in Pragmatics of Human Communication, p. 129.

Radcliffe-Brown:

> . . . a condition in which all the parts of the social system work together with a sufficient degree of harmony or internal consistency, that is, without producing persistent conflicts which can neither be resolved nor regulated.[1]

Feedback mechanisms serve to regulate and adjust the process of the network in order to achieve "functional unity." Wiener states that feedback allows an organism to "adjust future conduct by past performance."[2] The energy and information of a system is derived from the operations of the system and redirected into the system as new information and energy; this process is referred to as the circular network.

Deutsch defined feedback or servo-mechanisms as "a communication network that produces action in response to an input of information and includes the results of its own action in the new information by which it modifies its subsequent behavior."[3] The shift from linear systems (as indicated by the more orthodox stimulus-response theories in psychology) to a feedback loop suggests the importance of the interrelationship between the organism and environment. Systems that are

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[1]Radcliffe-Brown, A.R., "On the Concept of Function in Social Science," American Anthropologist, (New Series, Vol. 37, 1935, 397) as cited by Gordon Hearn in Theory Building in Social Work, p. 46.

[2]Wiener, Norbert, Human Use of Human Beings (Avon Books, New York: The Houghton Mifflin Co., 1970), p. 33.

[3]Deutsch, Karl, Nerves of Government, p. 88.

self-regulating and reach a state of stability are dependent upon the process of feedback mechanisms.

In closed systems, one is dealing with the transformations to be able to control energy; information is considered "negentropy." In open systems one is confronting the problem of transmission and transformation of communication patterns, i.e., information, rather than pure energy. Information theory is critical, therefore, to the open system, being a necessary component to the understanding of the flow and transformation of communication.

Cherry defined communication as "not the response itself but essentially the relationship set up by the transmission of stimuli and the evocation of responses."[1] In understanding human development, communication patterns, and pathology in systems and communication one needs to deal with the relationships. Cybernetics is able to study relationships through mathematical and statistical laws. The sociologist and psychologist can benefit from these laws. The theories of networks, feedback, redundancy, negentropy, and statistical communication have a significant application to studies in social work.

## Cybernetics and Human Behavior : An Analogic System

The analogic components of cybernetics and social systems with reference to social work are apparent on specific levels of comparison;

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[1]Cherry, Colin, On Human Communication (2nd ed., Cambridge, Mass.: The MIT Press, 1966), p. 7.

yet, the term "analogy" implies isomorphism and a superimposable or interchangeable metaphor. The danger in assuming that engineering and mathematical models are comparable to, if not identical to, social systems is evident. In comparing human processes with mechanical processes one must consider the restrictions of the machine-bound theories.[1] The scientific model deals with a closed system in which all the entities are known, i.e., the structuring of the mechanism, the amount and quality of the input and all the possible operations that can be performed on the data. In man, one is dealing with an open system in which neither the mechanisms of the brain nor the phenomenon of the unconscious are completely understood. All entities are not observable and one cannot accurately measure the impact of stimuli. Yet in both systems, objects have existence because they are perceived. The environment is not a structure waiting to be discovered. It is a set of external conditions which interact with the organism's sensory nature. Information is important precisely because it has meaning to the organism; therefore, the information that is integrated and stored is that which is being perceived and assimilated into a specific matrix by the organism. This interactionary system occurs on all levels of "in-put" and "output" processing.

Therefore, rather than suggest that cybernetics is analogic to social patterns of communication in the common understanding of analogy,

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[1]Hovland, Carl I., "Computer Simulation of Thinking," in Readings in the Psychology of Cognition, edited by Richard C. Anderson and David P. Ausubel (New York: Holt, Rinehart and Winston Inc., 1965), pp. 158-172.

the term analogy is used to indicate a more basic conceptual and structural schemata applicable to both cybernetics and social work fields. It is the extractable deep structural phenomena of cybernetics and the operations that have significance to human societies, nerve systems and communication patterns.[1] Cybernetic models and computer models are used, therefore, not as equivalents of human thought and transaction, but as partial simulators for a methodological schemata.

In the field of psychology, Broadbent has attempted to show the advantages of applying the study of cybernetics to man's neurophysiological system.

> The use of cybernetic language has had four main advantages:
> 1. it has allowed us to keep the words stimulus and response for observables,
> 2. S-R terms press us constantly towards open-chain models of the nervous system, towards a peripheralism which is by no means always justified . . . . Some events must take place within the organism,
> 3. a description of the integrative action of the nervous system in terms of information flow will be readily attached to physiological knowledge,
> 4. information theory emphasizes the relationship between the stimulus now present and the others which might have been present but are not.[2]

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[1]The concept of the extractable deep structure of a system which consists of generative rules is clearly exhibited in the work by Chomsky in linguistics. These generative rules provide the methodological principles for organizing knowledge. Refer to Chapter IV, pp. 104-106.

[2]Broadbent, D.B., Perception and Communication (New York: Pergamon Press, 1958), pp. 304-305.

Wiener has not only developed and presented an intensive study of cybernetics as it relates to psychology, but has delineated the specific relevance of cybernetics to neurology, language, law, business, economics and psychopathology.[1]

Cybernetic and Information Theory : Influences in Social Work

Social work as a clinically oriented field must deal with the problems of therapeutic processes in relation to the individual and group. Precisely because its major concerns are the person, the group (l'homme engagé) and the existing communities and society which fosters the individual, the sociological, political, and economic theoretical considerations are fundamentally important to social work. The application of cybernetics in the clinical as well as the theoretical framework is therefore scrutinized in this study.

The way in which one perceives the social and psychological systems directly affects the choice of treatment process. Lewin's "field theory" suggests the interaction of forces and energy in society. Neo-Freudians (e.g., Erikson, Horney, Fromm) and existential psychologists (e.g., May and Laing) include the problem of environmental stress and the interaction between man and society. Piaget's schemata of organization, assimilation and accommodation, emphasizes the interdependent processes and the hierarchical progression of more complex stages.[2]

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[1]Wiener, Norbert, Human Use of Human Beings.

[2]Piaget, Jean, Six Psychological Studies, translated by Anita Tenzer (Vintage Books, New York: Random House, 1967).

These theorists, as do the theorists in cybernetics, ask not "what is the society?" but "what does it do, what functions does it serve, what are all the possible behaviors it can produce?" The important aspect is the "set of possibilities, not the individual elements in the set."[1] An important aspect of the set is the extent to which the social system and the individual is subject to determining or controlling factors. No information or signal or determining factor may pass from part to part without its being recorded as a significant event.

At the present time, there is considerable evidence in the social work profession of the application of cybernetic theories: 1. The development of functional casework, reality therapy and crisis intervention as opposed to dynamic casework; 2. the increasing emphasis on family therapy and group therapy with related research efforts; 3. the recognized importance of community psychiatry and community mental health projects; and 4. the heightened concern with communication patterns, verbal and nonverbal, an interest which has created new areas of research in content-analysis. The investigations in communication as a therapeutic technique, especially witnessed in the work on content-analysis, have, of necessity, branched into studies of linguistics and paralinguistics.

The major portion of this study investigates the clinical applications stated above with specific concentration on cybernetics, systems

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[1]Watzlawick, Paul, et al., Pragmatics of Human Communication, pp. 19-43.

theory, and information theory, as they relate to casework, family therapy and community organization. Some discussion is given to theoretical principles in psychology and sociology as they bear significant relation to the process of treatment and to the pathological causes and patterns in behavior. In conclusion, a review of the basic cybernetic theory as it was originally devised is presented as a means of appreciating its complexity, soundness, and richness so as to be able to evaluate the validity of applications, to perceive oversimplifications or misuses, and to realize further extensions of the model in relation to social work.

The broad scope and implications of cybernetics for social work necessitates the imposition of certain limitations for this paper. The study is not a review and synthesis of all of the major literature and research in the field but rather a concise selection of the pertinent literature as it reflects the more critical aspects of cybernetics theory that will be helpful to the social worker in practice -- to assist the worker in understanding pathological patterns of behavior and in developing therapeutic techniques.

# CHAPTER II

## CYBERNETICS IN RELATION TO THEORIES IN PSYCHOLOGY, SOCIOLOGY AND INFORMATION TRANSMISSION

One might quickly ascertain the danger of applying the orthodox cybernetic model to social work and question the lengths to which one can develop a valid interpretation of the exercise: How can a machine model be relevant? Is it not dehumanizing to the individual and society to compare them to "machines?" Can a mathematical statistical measurement of signals, a measurement void of semantic meaning, be translatable into a system whose exchange of signals is precisely determined by the exact semantic meaning? Is human dialogue and social transaction condensable into a computer system? What contribution can cybernetics make in terms of general psychological and sociological knowledge?

In considering these questions, this chapter discusses the human organism in terms of its operative mechanisms in areas of cognition and emotion, the resemblance of the organisms thought processing to computer programming, the critical psychological theories with relation to relevant sociological trends, and information theory as it relates to the "human system."

Human Operative Mechanisms

The organismic mechanisms of human information processing resemble the computer in many facets. Scheflen presented the necessary operations for the computer and for man.

> The organism will have to have subsystems like the following: recallable cognitive representation of programs, continuous sensory input about any ongoing interaction, continuous monitoring of his metabolic and physiological state, and a mechanism for effecting and regulating behavior.[1]

The ability of the organism to recalibrate its state as it functions in perpetual interaction with the environment also assists the organism in being able to anticipate how another will respond and reciprocate; Scheflen called this capacity the "organismic state indicators."

Broadbent also has explained the nervous system as a human computer mechanism:

1. a nervous system acts to some extent as a single communication channel, so that it is meaningful to regard it as having a limited capacity;

2. a selective operation is performed upon the input to this channel, the operation taking the form of selecting information from all sensory events that have some feature in common . . . (e.g., intensity, pitch, and spatial localization of sounds);

3. the selection is not completely random and the probability of a particular class of events being selected is increased by certain properties of the events and by certain states of the organism.[2]

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[1]Scheflen, Albert, "On the Structuring of Human Communication," American Behavioral Scientist (Vol. 10, April, 1967), p. 9.

[2]Broadbent, D.B., Perception and Communication, p. 297.

The central nervous system acquires control through selectivity which is determined by the "subject's" need to establish meaning and continuity in his experience.[1] The role of memory is particularly important as it too regulates the selection and interpretation of incoming stimuli.

Studies in the problem of concept formation as a problem in cognitive psychology indicate that man does code the input stimuli which is selected through the power of attention, forms an abstract representation of the information as he assimilates it into his own schemata, and organizes the elements into more complex units which in turn are concretized and transmitted as output. Often this selection and conceptualization process occurs below the level of consciousness and eludes examination. Conceptualization requires codification and categorization of the information into a smaller number of units. Load limitation and commodity capacity, critical in concept formation, are also critical in cybernetic processing. The formulation of concepts and the process of heuristic thinking are instrumental for coping with "multiple-inputs" and an "overloaded channel" since the capacity of information with which a person can effectively absorb , assimilate, and retain has limitations. Concept formation, viewed in these terms, is interdependent with cybernetics and problem-solving.

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[1] Parry, John, The Psychology of Human Communication (New York: American Elsevier Publishing Company Inc., 1968), p. 37.

Goal-direction, selectivity, channel capacity and recursive logical processing are therefore critical aspects of concept formation as well as cybernation. Gregg stated that:

> . . . concepts are the names for coherent sequences of information processing acts carried out by an individual in performing a particular task. [1]

Considering the human mind as the operator and given the problem of concept formation, an essential question is: What are the components into which this process can be segmented? There appear to be at least five basic types. The first is the innate structural unit which is comprised of a series of sensory encoders (as in the operators of Uhr and Vossler's analyzers). [2] The second is the innate structural unit of memory, a memory cell. [3] The third type is the innate functional unit. Unlike the first two types which are passive, the third type is an active relating element of cognition, a cognitive mechanism, which is context-free. Included in this type would be all the transformational rules of language and formulas that can be applied to information. Type four includes a functioning principle that permits a multi-dimensional classi-

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[1]Gregg, L.W., "Internal Representation of Sequential Concepts," in Concepts and Structure of Memory, edited by Kleinmuntz, B. (New York: John Wiley and Sons, 1967).

[2]Infra, pp. 101-102. Uhr, L., and C. Vossler, "A Pattern-recognition program that generates, evaluates, and adjusts its own operators," in Computers and Thought, edited by E.A. Feigenbaum and J. Feldman (New York: McGraw Hill, 1963).

[3]Miller, G., "The Magical Number Seven, Plus or Minus Two," Psychological Review (Vol. 63, 1956), 81-97.

fication of and interaction between such things as emotions and values and organizes movement into a continuous flow of action. Type five is a regulator and selects the particular content and subdivides the information into metric units; it chooses among a variety of possible scales for the axes. Given these five basic types, all the permutations of their interactions can be defined as the process of cognitive development. In short, a concept is the output of a search procedure through a concept hierarchy, i.e., movement from a simple to complex structure. Explained in the preceding manner, concept formation, linked with problem-solving, mirrors the cybernetic mechanism and computer approaches to simulation of thought processing.

Psychological Theories Relevant to Cybernetics

The development of "cybernetic-thinking" in psychology appears to have been a derivative of the field of cybernetics although in fact much of the theory was developed simultaneously in both disciplines. Certainly theories in Gestalt and behavioral psychology (especially later developments in mediational-response systems) include several major concepts delineated in systems theory and cybernetics. Considerations of prominent attitudes in psychology are important as they affect the manner in which one chooses to appreciate, understand and help the person who is suffering from problems in his relations to others and himself.

In Gestalt psychology, thought is not considered to be a series of isolated units pushed together, a collection of elements; each "unit"

is coterminous and is part of a chain of cause and effect and should be seen in relation to this whole. The whole is not so much "the sum of its parts" as an entirely new product, a fusion which gives rise to a new element. The Gestalt psychologist sees shapes, forms, relations, and qualities rather than specific objects. The problem of whether or not there are simple mental processes and higher mental processes was resolved by the Gestalt school. For them there was no higher mental process which "constricted" the relationships; there was a "self-organizing" process at the sensory level.

> The stimuli reaching sense organs are unorganized and uncombined. But nerve impulses from sense organs on reaching the brain interact and organize patterns.[1]

This separate power for mental activity was seen as part of the psychological organic system. The "organisation" of the brain was compared to a machine by Kohler. "The structure is a system of restraints that will determine what effect the energy shall produce."[2] The energy of the "machine" must be directed, i.e., constrained for specific responses. One does not deal with each item as a separate isolated variable, the items of stimulation (input) "coact;" the "organism responds to a pattern of stimuli," the mapping of which is a function of the tendency of the brain to organize.[3]

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[1]Woodworth, Robert S., and Mary R. Sheehan, eds., Contemporary Schools of Psychology, (New York: The Ronald Press Co., 1964), p. 219.

[2]Ibid., p. 224.

[3]Ibid., p. 226.

The Gestalt "field theory" which describes the organization of patterns and the interaction between the stimuli and organism, was primarily concerned with thought as an operational system which is selective and adaptive. The dynamic system which organized thinking was integrally related to the field. Through the processes of "means-production" and "means-abstraction" one can synthesize and integrate specific information, form relationships and create new responses. Wertheimer presented various principles of organization of experience or "field forces" (e.g., proximity, similarity, continuity, closure tendency, familiarity, and attitude). Behavior and thinking is not composed of separate responses to stimuli but is governed by the total field; one reacts to an integrated response, to the pattern as a whole situation.[1]

Thought as a purposive operation was elaborated upon by Duncker. In a response argument against the associationists, he stated that one could not apply learned associations to deal with new relationships. One has to create a method of solution out of the situation given by developing the problem. The notion held by Duncker, that the answers arise from the problem itself, is extremely important in the field of cybernetics and social work in relation to the helping process. The concept of thought as operation, problem-solving, and a continuous flow of relationships is fundamental to the cybernetic model as well as social work.[2]

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[1] Ibid., p. 222.

[2] Mandler, Jean Matter, and George Mandler, Thinking: From Association to Gestalt (New York: John Wiley and Sons, 1964), pp. 262-298.

The concept of "field theory" as presented by the Gestalt school has been further elaborated upon by Lewin with significant implications in systems analysis. According to Lewin, an individual lives in a "field space," a "life space." This field is a system containing subsystems. If a person is engaged in activity, a related subsystem is in tension. If the person is interrupted in this activity, further tension is increased and the person might redirect the activity as a substitute to "drain off" the tension.. This concept has been expressed and diagrammed in the following manner by Mackay.

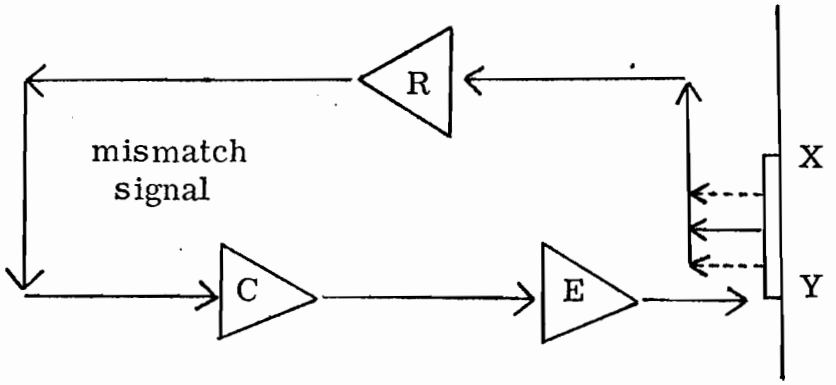


Fig. 1 A Model of Goal-Seeking and Tension-Reducing Behavior

E represents the effector system, C the control system. E is capable of "effecting certain behaviors;" the function of C is to control and select from the range of variables which factors will be emitted to E. X is the desired goal in the field, E, and the interval Y-X is the interval between the first act and the final act of reaching the goal. If for any reason the act is thwarted at any point between X and Y then the organism rechannels the behavior through a receptor system (R) to signal

the mismatch and misdirection to the control system (C).[1] The discrepancy between Y and X and the rechannelling to R is exemplary of the feedback loop mechanism in cybernetic engineering models.

For Lewin the environment has positive and negative valences according to the needs. The attraction to these valences is a vector or force producing the locomotion towards the desired direction. The concept of locomotion indicates a goal-seeking behavior, such that if the problem involves some act that will occur tomorrow, the "field-space" is not only the present but the future, i.e., the anticipated environment. This phenomenon is significant in terms of problem-solving for the client.

The use of the terms valences and vectors demonstrates Lewin's incorporation of several mathematical precepts which have direct correlation to the problems in the cybernetic models in engineering. Lewin's enlistment of mathematics stemmed from the fact that he was discontent with the inexactness of predicting behavior. He wanted a means of "mapping life space" at a specified moment in time, to be able to predict the possible routes for achieving specified goals. He used a method of "topology" for mapping the life space. This aspect of Lewin's theory simulates pattern-recognition processes and indicates a direct association with the cybernetic model:[2]

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[1]MacKay, Donald M., "Towards an Information-Flow Model of Human Behavior," in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley, pp. 360-361.

[2]Infra, pp. 101-104.

> We must define our symbols 1. conceptually by relating one symbol to another, as for example by relating the concepts of need, valence and vector, to each other; and also 2. operationally, by indicating how the facts covered by our concepts are to be observed and measured. [1]

Lewin's formula for behavior is expressed as $B = f(P, E)$. Behavior is a function (f) of the interaction between the Person (P) and the Environment (E). In discussing the environment as part of the "field space" Lewin suggested that behavior has originated from the totality of the coexisting parts – the state of one part is dependent on every other part of the field.

Lewin's theory corresponds to cybernetics not only as a system of individual-field interaction but also in relation to constraint and feedback mechanism. For Lewin, barriers, as constraints, exert no force until some demand is made upon them, and they then offer resistance. How much of a barrier a particular object becomes is directly proportional to the degree to which it can be overcome. One must therefore devise strategies as a means of dealing with the constraints. Constraints, in this sense, bear a negative connotation. In cybernetic theory, constraint is a necessary and positive mechanism when seen as a means of controlling an infinite number of variables and probabilities. In respect to constraint and feedback, Lewin stated that:

> Some of these circular processes correspond to what the physical engineer calls feedback

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[1] Woodworth, Robert S., and Mary R. Sheehan, eds., Contemporary Schools of Psychology, p. 243.

> systems, that is, systems which show some kind of regulation.[1]

Lewin raised the basic question: Is there anything equivalent in life which steers social action. His work in group dynamics and organization revealed the circular process as negative and positive mechanisms. In discussing citizen's groups, army regiments, and businesses, he demonstrated the necessity of applying the regulator-steering processes in cybernetics, e.g., one needs to know exactly what the problem is and to be able to judge how efficiently the problem can be managed.

> An efficient steering of social action presupposes that fact-finding methods have to be developed which permit a sufficiently realistic determination of the nature of the position of the social goal and the direction and amount of locomotion resulting from a given action. To be effective this fact-finding has to be linked with the action organization itself: it has to be a part of a feedback system which links a reconnaissance branch of the organization with the branches that do the action . . . [which leads] to a correction of actions or to a change of planning.[2]

This examination of the importance of man's relation to society has been extensive in other theoretical works in psychology by Adler, Allport, Sears, Fromm, Horney, Erikson, to mention a few. The literature in existential psychology presents the problem of man completely in terms of his engagement in society and poses the dilemma

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[1] Lewin, Kurt, "Feedback Problems of Social Diagnosis and Action," in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley, p. 441.

[2] Ibid., p. 442.

of the maintenance of the "authentic self" since one is perpetually bombarded by the "others."

Gordon Allport, whose theory of "becoming" in itself suggests the cybernetic influence of self-regulation coupled with goal-direction, has delineated specific applications of cybernetics to psychology in a discussion of systems theory and personality. An important aspect of the closed system in cybernetics is the principle of entropy. This law indicates that the closed system has no "restorative properties" as it reacts. The principles of restoration and transaction are necessary for the open system. Allport suggested four criteria for the open system:

1. There is intake and output of both matter and energy;
2. There is the achievement and maintenance of steady-states so intrusion of outer energy will not seriously disrupt internal form and order;
3. There is generally an increase in order over time, owing to an increase in complexity and differentiation of parts;
4. There is more than mere intake and output of matter and energy; there is extensive transaction commerce with the environment.[1]

The necessity to maintain a steady-state as the organism develops and grows is one of the primary principles of Piaget's system of assimilation and accommodation and Erikson's theory of the eight stages of man. Piaget explained that each new stage is steadier than the previous until further demands are imposed and the system must alter its state

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[1]Allport, Gordon, "The Open System in Personality Theory," in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley, p. 345.

and reach a new level of adjustment.[1] This phenomenon can work in reverse, i.e., one may reach a pathological steady-state as a means of adapting to noxious input. The phenomenon of adaptive change is the tendency to increase order, to become something more than what the system is at present.

Adler felt that the individual must be understood as a product of interweaving, dynamic, somatic, psychological and social processes. The unity of the self is only perceived in terms of the dynamic interaction. Horney also emphasized the sociocultural phenomena; the individual interacts in a system which not only includes libido energy but sociocultural pressure. She rejected the Freudian triad, id-ego-superego, and in its place postulated a more holistic dynamic approach. Fromm similarly repudiated Freud's emphasis on the libido and believed that the basis of character is in the person's relatedness to the world and that pathology is a function of society's role as a creative vs. repressive force; anxiety and neurosis were viewed as by-products of the inter-relatedness between man and society.[2]

Robert Sear's theory of personality is based on a "dyadic" or interactional model which focuses on action rather than on internal structures or processes. The interdependency of the milieu and individual determine the psychological reality. The "dyadic sequence"

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[1]Piaget, Jean, Six Psychological Studies.

[2]Munroe, Ruth L., Schools of Psychoanalytic Thought (New York: Holt, Rinehart and Winston, 1955).

illustrates that the acts of one person are conditional upon the acts of another and produce the environment for the other. This conditionality is evident in the existential phenomenonology which is expressed by Laing; the purpose is to "set all particular experiences within the context of one's whole being-in-his-world."[1] In all of these theories, the basic common denominators are the principles that man is embedded in the social matrix, that the alliance between man and society is perpetuated through a feedback loop, that pathologic or normative behavior ought to be considered in these terms and that man's functioning is conditional upon the interrelationship between man and the socio-cultural-schema and the desire and tendency of the organism to reach steady-states through regulation.

Sociological Perspective in Relation to Cybernetics

The shifts in sociological theory appear directly correlated to the increasing emphasis in cybernetics in other fields of study. The mechanistic model in sociology (as presented by sociologists of the seventeenth century) stated that man was similar to a complex machine and could be studied as one would analyze the principles of a machine or the mechanisms of the universe.

> Man, his groups, and their interrelations thus constituted an unbroken continuity with the rest of the mechanistically interpreted universe. All were based on the interplay of natural causes,

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[1]Laing, Robert, The Divided Self (Pelican Books; London: Penguin Books, 1969), p. 17.

> to be studied as systems of relationships that could be measured and expressed in terms of laws of mechanics.[1]

Later in the nineteenth century, the mechanistic model was reintroduced with the concepts of "fields of force," "transformation of energy," and "social entropy." The works by Talcott Parsons, George Homans and Kurt Lewin intimate some correlation with the theories of the nineteenth century group, especially Pareto, a trained engineer, who emphasized the concepts of equilibrium. Still the mechanistic model was inadequate to explain the complexity of the social system.

The process model, started in the early twentieth century, revealed weaknesses in the mechanistic model and organic model (Darwinists) and illustrated the application of cybernetics. Included in this group are G.H. Mean, R.E. Park, E.W. Burgess who had been influenced by G. Simmel and L. von Wiese. The process model viewed society as an inherently "structure-elaborating and changing system . . . . Process then focuses on the actions and interactions of the components of an ongoing system."[2] The Marxist dialectic system can be included in this model. The emphasis was on the fact that systems are not static; growth is not endogenous but a function of the interaction between man and society and the problem-solving ability of the individual and group.

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[1]Buckley, Walter, Sociology and Modern Systems Theory (Englewood Cliffs, N.J., Prentice-Hall, 1967), p. 8.

[2]Ibid., p. 18.

Parsons, along with Merton, has been grouped with the structural-functional analysts. Function in this theory implies the pursuit of a value or goal or understanding of the contribution of a unit to the maintenance of the structural continuity of the system. By stating that structure "x" fulfills the function "y," one can consider several possible patterns to arrive at the solution. Three questions arise:

1. How much does this structure have to contribute to what kind of output in order to perform what kind of function at the minimum level required for the continuation of the organism?

2. How much does it in fact contribute?

3. What happens when the kind of its contribution remains the same but the quantity is varied to just what extent?[1]

Deutsch indicated a major weakness of the theory in the lack of criteria established to search for goals and solutions.

A basic principle for Parsons is order. Order is understood as a function of interdependence of parts, — an interdependence which regulates the parts, randomness, and variability. Order can also refer to illegitimate order, the maintenance of a deviant system; yet, Parsons fails to make this distinction. A main corollary to Parsons' notion of order is self-maintenance — the concept of equilbrium which Parsons states is nonproblematic, but rather the "first law of social process." Deviance is controlled by this principle of equilibrium.

> Mechanisms of socialization and mechanisms of social control thus work hand in hand with mechanisms of defense and adjustment in the personality

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[1]Deutsch, Karl, Nerves of Government, p. 48.

> system to motivate actors to conformity with the given system of expectation, counteract deviance and other strains in the system to bring it back to the given state, and maintain the initial equilibrium.[1]

However, note that in later theories, equilibrium does not mean a return to the initial state but a stabilized new steady-state; equilibrium becomes part of a hierarchical progression. Parsons does feel that one must have a fixed point of reference from which one judges whether or not change has occurred.

Buckley presented several areas where Parsons' theory is either ambiguous or problematic: 1. "The social system of determinate relations comes to include only, or primarily, those determinate relations making up an institutionalized dominate structure of conformity to role expectations."[2] This theory only includes the relations which exist peacefully; 2. The question of deviance is not appropriately integrated and accounted for; 3. The "law of social inertia" does not appear applicable to the dynamic system; 4. The theory of mechanisms of control is not adequate; it is viewed as an "arbitrarily isolated part of a total system that is itself treated as a system in order to judge its relevance for the total system."[3] The mechanisms of control are judged in relation to only the legitimate structures and a fixed point of

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[1]Buckley, Walter, Sociology and Modern Systems Theory, p. 25.

[2]Ibid., p. 29.

[3]Ibid., pp. 29-30.

reference; and 5. In relation to the fact that Parsons' model does not adequately deal with deviance, it can not deal with social change.[1] In cybernetics change is not considered from a fixed point but rather on a sliding continuum.

Homan's model is far more reflective of cybernetic theory. It includes all of the parts of the system, deviant or otherwise, and there is no fixed point in the balanced structure from which one can judge change. The interrelations are now seen as a complete system. Maintenance of a structure is not considered automatic or assumed but perceived as problematic, "even a miracle."

> Not every state of a system is in equilibrium, nor does a system 'seek' equilibrium. Furthermore, a system does not have 'problems', and structures do not arise because they are 'needed' by the system — because they are functional imperatives — but because there are forces producing them, forces manifested in the nature of the elements of the system and their mutual relations . . . . The system is the social control, it does not 'impose' a control.[2]

Homans spoke of an internal and external system correlated through feedback. He reclarified the concept of equilibrium to mean the constant movement towards a steady-state such that a system can never go back to an "original state" as indicated by Parsons. Homans' "practical equilibrium" is quite similar to the concept of equilibrium in open-systems theory which is based on cybernetics. Diagrammed, the

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[1] Ibid.

[2] Ibid., p. 32.

equilibrium models are explained in the following manner:[1]

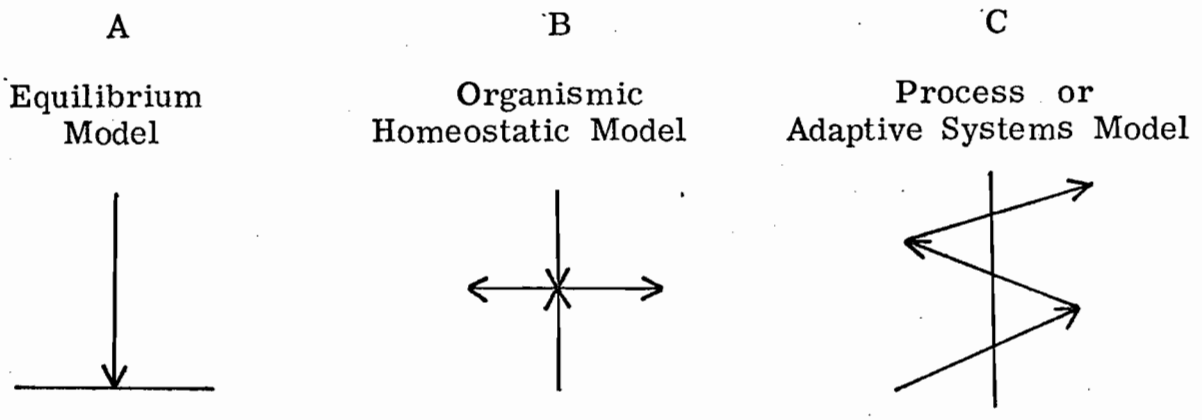


Fig. 2 Equilibrium Models

Model A is a simplified statement of the equilibrium principle in a closed system in which the system, upon moving to an equilibrium point, tends to deorganize through entropy and holds itself at a minimum level given apparently "narrow conditions of disturbances." Model B represents the equilibrium system of a more complex organism which is able to maintain a relatively high level of organization despite impinging forces to disrupt the organization. Model C exemplifies the process of the open-system in the human organism and the hierarchical progression of evolutionary steady-states. This model, as it is termed "adaptive," needs and benefits from environmental variety and disturbance for the purposes of growth unlike the other two models which must maintain themselves in spite of the disturbances.

Homan's theory of "practical equilibrium," indicated the emphasis on constant transactions which lead to new relationships. His explana-

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[1] Ibid., p. 40.

tions of social approval, interpersonal attraction, and social influences indicate that decisions and acts are not monads but part of an interdependent interpersonal matrix of exchanges.

Another important theory in sociology and economics is game theory. Originally a mathematical theory employing cybernetic operations, it has been extensively applied to psycho-sociological phenomena. In devising a program for a computer to play chess, Newell, Shaw and Simon employed a system of generative rules based on heuristic thought processing. Four basic underlying goals were outlined (e.g., is the king in checkmate?) and each goal has a subroutine.

1. A routine that specifies the goal in terms of the given position;

2. A move generator that finds moves positively related to carrying out the goal;

3. A procedure for making a static evaluation of any position with respect to the goal which essentially measures acceptability;

4. An analysis move generator that finds the continuations required to resolve a situation into a dead (final) position.[1]

The game theory is based on certain assumptions: that both players are rational, that they have opposing invested interests, that the game situation is defined by explicit rules, that there is a choice of strategies and that there is a preferential sequence of outcomes on a hierarchical scale.

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[1] Newell, A., J.C. Shaw, and H.A. Simon, "Chess Playing Programs and the Problem of Complexity," in Computers and Thought edited by E.A. Feigenbaum and J. Feldman (New York: McGraw Hill, 1963), p. 57.

Applied to sociology, the strategy conflict and the interdependence of decisions and moves between the players are two critical concepts in any exchange, be it personal, political, social, business, intellectual and the like. The degree of rationality controlled in the computer programs of chess playing is not stabilized in human exchanges on the interpersonal level.[1] Still, the use of game theory has helped to make sociological problems "conceptually quantifiable" and has provided a more sophisticated method of understanding behavior.[2]

An overview of the cybernetic theory as it is applied in current sociological systems theory is helpful as a means of realizing how cybernetics has been integrated. Man is viewed as an open system; he is not considered as a discrete entity, but as an organism whose development is dependent upon the interchange with the external environment.

In considering the sociological unit as an open system which is negentropic (one that does not tend to "run down") the principle of tensions is significant. Man lives in a constant state of crisis. Deutsch integrated the concept of tension with feedback in the sociological schemata. Two critical aspects of feedback systems are "lag" and "gain."

> Lag is the time that elapses between the moment a negative feedback system reaches a certain distance from its goal and the moment it completes corrective action corresponding to that distance. Gain means the extent of the corrective action taken.[3]

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[1]Buckley, Walter, Sociology and Modern Systems Theory, p. 124.

[2]Deutsch, Karl, Nerves of Government, p. 53.

[3]Ibid., p. 90.

Lag is more important since it indicates the degree to which the system is in tension and is not properly regulating the variables.

The concepts of "morphogenesis" and "morphostasis," utilized for sociological descriptions of system functions, indicate the influence of cybernation. Buckley defined morphostasis as:

> . . . those processes in complex system-environment exchanges that tend to preserve or maintain a system given form, organization or state. Morphogenesis will refer to those processes which tend to elaborate or change a system given form, structure, or state.[1]

Coupled with the theory of morphogenesis is the theory of multifinality, that similar conditions can lead to many different states.[2] Thus, in analysing a city's growth processes one would have to consider the transformational processes leading to numerous results rather than to consider the specific facts in relation to the initial states and the outcome. The sociocultural patterns are generated by rules of transactions which are context-free.

Questions of causality have been further clarified by cybernetics. The more traditional framework is the "efficient" cause (a$\longrightarrow$b) or the "final" cause (a$\longleftarrow$b). A later principle, the mutual-interaction cause (a$\longleftrightarrow$b) has been replaced by the feedback-circuit cause (a$\circlearrowright$b) as explained in cybernetics. This feedback-circuit model is goal-directed with internal systems for measuring and controlling the

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[1] Buckley, Walter, Sociology and Modern Systems Theory, p. 58.

[2] Ibid., p. 60.

reintroduced data.[1] The perception of causality as an inherent principle of systems processing serves to clarify the reasons for disturbance and lag and provide a method for rectifying the imbalance. Sociologists have employed these theories of transformation to most institutional structures and social systems.

In planning for urban development, industrial management, mental health advancement programs; coping with the changes in the family units, rural transitions, and a general increase of conflict; and applying political, sociological, and economic progressive ideology to the community and governmental structure, Winthrop has suggested the importance of the role of cybernation. He stated that the "blueprints" for social change must develop an "ecological interdependency."

> The blueprints to which I refer involve many matters. They will call for innovations in institutions of government which are adapted to the mode of production and the relations of production created by cybernation. They will entail the redesigning and replanning of communities, but only after the concept of community itself has been redefined for an age of cyberculture . . . . A cybernated society is likely to encourage community life on a small scale in order to avoid much of the social pathology and alienation . . . . A cybernated society will require blueprints which show how modern science, technology, cybernetics and automation can be adapted to small-scale communal existence without sacrificing the more important social, educational, cultural and scientific advantages which have been the concomitants of the large-scale urban-industrial complex.[2]

Buckley presented the salient features of the application of cybernetics to sociological theory.

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[1] Ibid., p. 70.

[2] Winthrop, H., "Sociological and Ideological Assumptions Underlying Cybernation," American Journal of Economics (Vol. 25, April, 1966), pp. 124-125.

1. A common vocabulary unifying the several "behavioral" disciplines;

2. A technique for treating large, complex organization;

3. A synthetic approach where piecemeal analysis is not possible due to the intricate interrelationships of parts that cannot be treated out of the context of the whole;

4. A viewpoint that gets at the heart of sociology because it sees the sociocultural system in terms of information and communication nets;

5. The study of relations rather than "entities," with an emphasis on process and transition probabilities as the basis of a flexible structure with many degrees of freedom;

6. An operationally definable, objective, non-anthropomorphic study of purposiveness, goal-seeking system behavior, symbolic cognitive processes, consciousness and self-awareness, and sociocultural emergence and dynamics in general.[1]

Information Theory

Another critical principle of cybernetics applied to sociological perspectives is information theory. In the closed system, the relations between components are a function of spatial and temporal factors and the transmission of energy. The open system depends on the transmission of energy in the form of information. The carrier of energy may vary (e.g., different media) but the function of information transmission remains constant. Information must correspond to or match the other components in the system; it must be dynamically related.

> Thus information is not a substitute or concrete entity but rather a relationship between sets or ensembles of structured variety.[2]

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[1]Buckley, Walter, Sociology and Modern Systems Theory, p. 39.

[2]Ibid., p. 47.

This shift from energy flow to information flow is critical in the open-system and needs to be examined further in terms of information theory.

The information theory is concerned with the ideal, most efficient transmission of information; the studies of human communication deal not with what should be ideally, but with the natural occurrences of behavior. Communication in human transactional systems is not a summation of "bits" of information in a single channel; it is highly complex exchange through a multi-channeled series of behaviors for multiple roles and situations.

A major difficulty in any analysis of communication is that one must use communication to discuss communication. In this sense the study becomes self-reflexive. Means by which to evaluate communication, need to be objective and removed from participation. The communication to study communication therefore has been termed metacommunication. The metalanguage for the study of information transmission is threefold: 1. the mathematical or syntactic; 2. the semantic; and 3. the pragmatic.

Cherry presents a good example of the difference between these three approaches in the interpretation of communication:

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Syntactically one observes the signs as separate bits. Semantically one relates these signs to things or events. Yet the "statement" can have a different meaning for each person depending upon his circumstances, state of mind, or whether or not he has placed a bet on the horse.[1]

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[1]Cherry, Colin, On Human Communication, p. 227.

In semantics one is concerned with the factual, truthful, and meaningful; in pragmatics, the usefulness, value, and relevance of the information.

The syntactic approach is closest to the mathematical theory of information. The mathematical theory begins by considering some source which generates signals , reduces the information into quantifyable bits, and organizes the variety of generated signals through a receiver. The theory employs averages of "bits" as information measurements which have been generated by a long chain of sequences, possibly to infinity.

Current studies in mathematical analysis of information have been performed by Shannon and Weaver. Their major concern is in regard to the maximum capacity of an information-carrying channel. To cope with the extensive amounts of possible units of information, Shannon devised a method of processing information in terms of binary digits, and the "shortest channel symbols." At first glance one might feel that Shannon's statistical theory of communication is irrelevant for this study since it deals with signs as "bits" of information and measures the "statistical rarity of signals from an observed source."[1] Shannon's theory may be called syntactic as it refers only to the "signs." Although the syntactic or mathematical approach does not deal with meaning but with quantity, it does provide certain rules which are essential to further studies on the semantic and pragmatic level. For example,

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[1]Ibid., p. 50. Infra, pp. 126-127.

one might apply the principle of probability to account for a recipient's interpretation or reaction through a process of associating them with the set of conditional probabilities.

Information represented as a binary digit, capable of precise statistical and mathematical analysis, is the form of much of the data introduced for computer programming. In digital computer analysis, the metalanguage is the codification system of information. "Words" in digital analysis are explicit and directive based on the convention of the language (be it a conventional or a fictitious code language) and can be analyzed as a "bit," a unit of delimited information. This "bit" or "binary digit," has little ambiguity.[1] Yet, the very failing of digital language is within its quantification mechanism; it cannot explain the dilemmas of relationship but only explains a "bit" in terms of itself.

In human communication, there is also a coding system (e.g., language through linguistic or behavioral gesture). However, human communication studies can never be as precise as computer analysis. The latter employs cybernetic and mathematical principles. In human communication one has both digital and analogic expression. The latter, as defined by Watzlawick, is more "primitive," "archaic;" it is "thing-like" and nonverbal.

> We hold that the term must comprise posture, gesture, facial expression, voice, inflection, the sequence, rhythm, and cadence of the words themselves, and any other nonverbal manifestation of which the organism is capable as well as the communication clues unfailingly present in any context in which an interaction takes place.[2]

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[1]Infra, p. 126.

[2]Watzlawick, Paul, et al., Pragmatics of Human Communication, p. 62.

In analogic analysis there are no equivalents for "if-then," "either-or," or negation sequences as there are in digital analysis; each gesture has an individual ambiguity (e.g., tears can mean sorrow or joy, a smile may mean sarcasm or pleasure). It is extremely difficult to translate analogic information into digital language for precise analysis. Therefore the desired accuracy of evaluations in information exchanges in the human system is difficult to obtain. Watzlawick cogently summarized the two forms of communication, both of which are problematic in computer systems.

> Human beings communicate both digitally and analogically. Digital language has a highly complex and powerful logical syntax but lacks adequate semantics in the field of relationship, while analogic language possesses the semantics but has no adequate syntax for the unambiguous definition of the nature of the relationships.[1]

Digital analysis is exemplary of the study of syntax, the relation between signs. This form of analysis has been extended to meaning and semantics by Carnap and Bar-Hillel. Analogic analysis is part of pragmatic communication which deals with behavioral aspects of interaction.

In studying language in terms of syntax, Zipf proposed the "Principle of Least Effort." Cherry explained this law by stating that since man is a goal seeking organism, all of his strivings and exertion, the path of his actions, are governed by the desire to minimize the effort. "A system will move so as to minimize the total action inte-

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[1] Ibid., pp. 66-67.

grated between any two instants of time."[1] A corollary to the law is the law "Force of Unification and the Force of Diversification" between one speaker and another.[2] Zipf codified all the words of James Joyce's novel Ulysses to give evidence of his law. He coded the meaning-frequency of words. "Such statistical content-analysis might reveal something of the nature of the verbal constraints which canalize our thought and writing . . . the laws may suggest that we are not free to say what we please; that we are bound in some mysterious way to conform to rule."[3] A clarification of Zipf's law in reference to the "forces" acting upon language reveals that the social forces act upon an entire system rather than specific acts of the individual.

Mandelbrot did further studies in the concept of "cost" in syntax. All words and messages "cost" something in effort. The theory first shows how to assign probabilities to words in such a way that their total cost will be minimized on an average keeping a certain property (their information rate) invariant.[4] The theory of "cost" is critical in cybernetics and computer processing.

Bar-Hillel and Carnap have applied the problem of "statistical probability" in syntax to the study of "inductive probability" in semantics

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[1]Cherry, Colin, On Human Communication, p. 103.

[2]Compare the Laws of Force of Unification and the Force of Diversification to segregation and progression mechanisms as means of controlling entropy, supra, p. 7.

[3]Cherry, Colin, On Human Communication, pp. 106-107.

[4]Ibid., p. 109.

and measurement of semantic information content. This application of information theory has relevance to content-analysis for social work treatment purposes. "A statistical probability" applies to classes of things, or to a system; but an "inductive probability" applies to pairs of statements, the 'hypothesis' and the 'evidence'."[1] The latter implies the relationships between the hypothesis and evidence (e.g., one places a bet only after careful scrutinization of the team's performance and the odds). The theory of "inductive probability" of semantics can be easily superimposed upon the cybernetic model and information theory of Wiener and Shannon, as it refers to semantic noise, efficiency rate, transmission of symbols and information rate averages in assessing the meaning of the hypothesis.

Semantics is the study of meaning. Weaver states that the "Semantic problem of communication [is] concerned with the identity, or satisfactorily close approximation, in the interpretation of meaning by the receiver, as compared with the intended meaning of the sender."[2] Charles Pierce delineated the triangular nature of meaning, i.e., the relationship between thought, signs, and designata (i.e., the referent, that which is referred to in the external world). Pierce also suggested that signs "are capable of" evoking other signs, that one sign does not provoke a singular reaction but an endless series of reactions. Ogden and Richards diagrammed this concept of meaning and represented the triad

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[1]Ibid., p. 235.

[2]Ibid., p. 117.

in terms of "a person having a thought, a symbol, and a referent."[1]

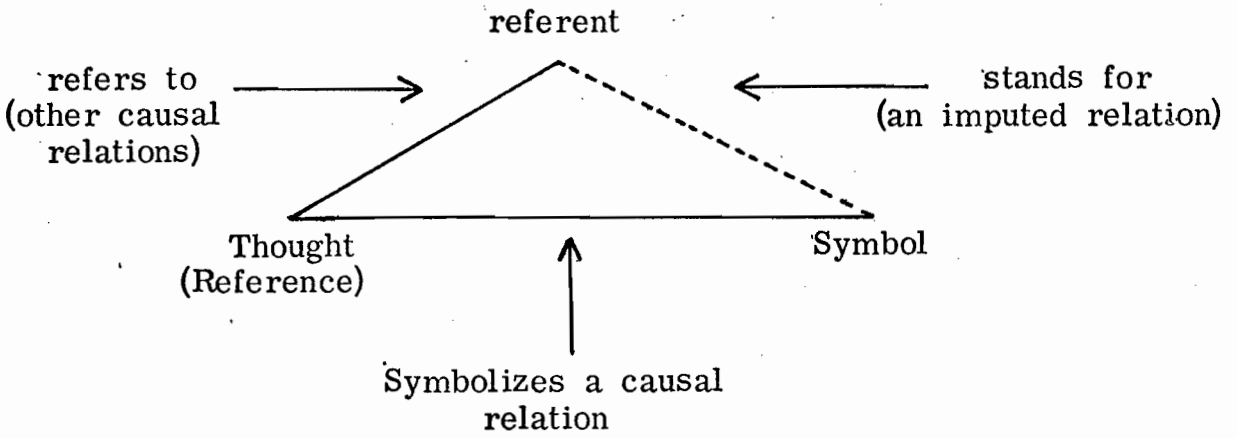


Fig. 3 A Semantic Model : the Relationship Between the Thought, Symbol, and Referent

The diagram illustrates an interdependent system. The concrete, literal and external unit of information is the referent which is introduced into the triad by the organism and is codified or symbolized with specificity to the referent and organism. The "imputed relation" between the referent and symbol can take several forms but it is controlled by the organism. Semantic meaning is considered dependent on this triangular interchange.

Cherry has transfigured the above diagram as a method of discussing meaning in terms of "functional flow"; as such, it is perceived as an open system.[2] This is evident in Figure 4.

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[1] Ibid., p. 113.

[2] Ibid.

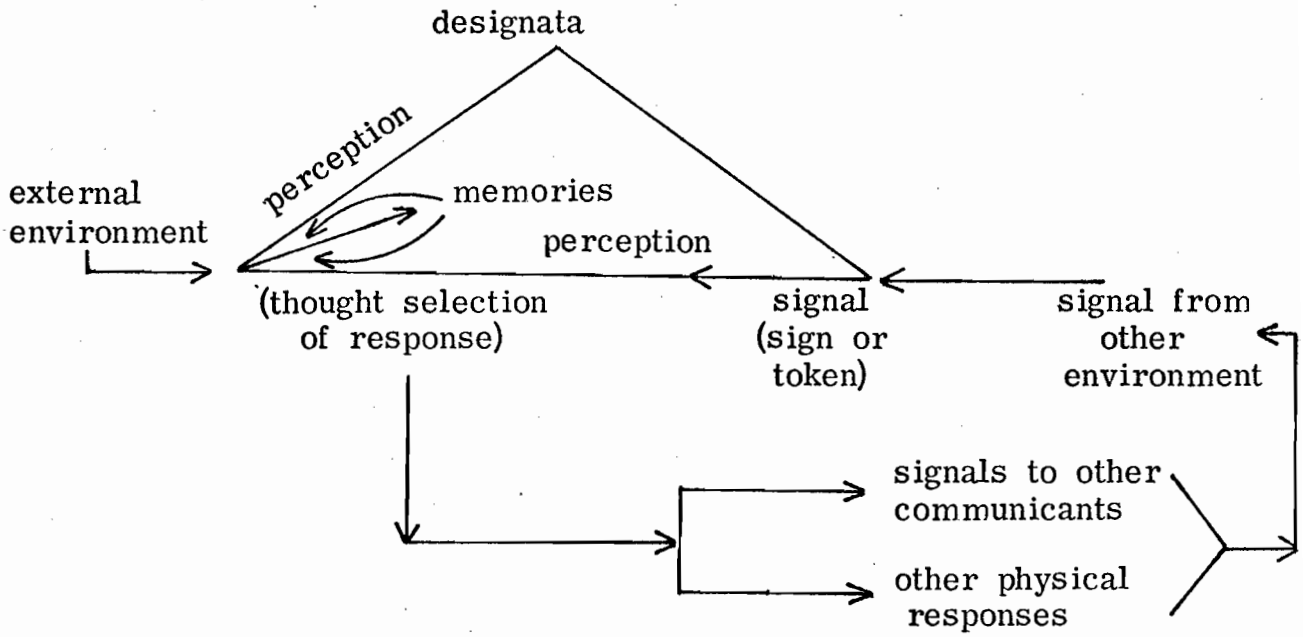


Fig. 4 A Semantic Model : the Influence of the Feedback Loop in the Semantic Triad of Thought-Signal-Designata

The diagram capitalizes on the role of the organism as the regulator. Not only are the perceptions of the designata (referent) a function of the organism's capacity in "thought selection," but also they are a function of memory which can either limit or extend the interchange between the organism and designata. The signal (symbol) is a second force introduced to the system and as an abstracted symbol is dependent on the relation between the other two factors. The feedback loop mechanisms operating within the system mirror the feedback mechanisms in the cybernetic model. Cherry has adapted what was intended to be a model for semantics to a more pragmatic system that operates within the scope of cybernetic principles.

However, the more orthodox studies of semantics are concerned with the problem of meaning and the transmission of meaning, and do not account for the interaction of behavior. Pragmatics is primarily involved with the relationships and the subjective probabilities. As in information, cybernetic and semantic theories, the study of pragmatics is directly engaged with the phenomenon of selection "power." What is valued in the source of communication is the predictive and exclusive elements, i.e., the value of the information to help the individual select further action and the selectivity to the exclusion of apparent "useless" information. The individual brings to the information an entirely subjective schemata based on his self-past experience, anticipations, and expectancies.

Newcomb's A-B-X Model defines this interaction in social systems through communication patterns. Persons A and B transmit information about object X. The theory states that two or more individuals communicating about object X must have similar orientation toward one another and toward the object such that the transmission of information is maintained.

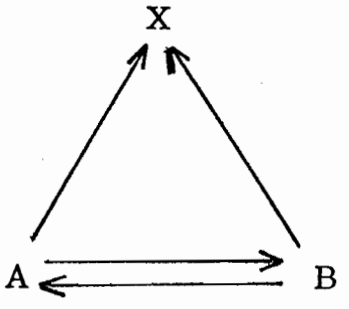


Fig. 5 Newcomb's A - B - X Model

The response of A is contingent on B's response and orientation to A and object X. This model of interaction of Newcomb, employing a symbolic apparatus, "permits us to get at finer and subtler details of social behavior and social organization than does any scheme utilizing only sequences, rewards, and conditioning,"[1] as are suggested in behavioral psychology approaches.

The structuring of pragmatic communication is seen as an "organized complexity" which is constantly exchanging information.

> Interactions among components mediated by the selective 'triggering' of information flows are possible, only because the system components are themselves organized and relatively unstable, or 'sensitive', or in 'tension' such that they react easily to a small influence of the correct type (or code) and can release much larger amounts of bound energy than that embodied in the triggering signal.[2]

In understanding the flow of information and the meaning on the semantic and pragmatic level one needs to define the selective capacity in perception and definition of the individual, i.e., its "organizing function," in relation to the variety of information flow. In a highly complex socio-cultural system the linkages of communication are through an intricate conventionalized process of role-playing, decision-making, emotional responses, values and the like. The problem of pragmatics is ultimately the most significant in terms of various theories in communication on the interpersonal level and is therefore highly significant for the social worker.

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[1]Buckley, Walter, Sociology and Modern Systems Theory, p. 115.

[2]Ibid., p. 48.

Summary

The discussion on cybernetics in relation to theories in psychology, sociology and information transmission does not pretend to give an elaborative analysis of the theories presented, but rather its intention is to monitor the major issues which bear critical relevance to the social worker. One can appreciate the problematic areas in psycho-sociological investigations which focus upon the cybernetic and systems analyses. Not only are the operative mechanisms of human thought-processing complex as indicated in its similarities to computer-simulation, but the processes, when viewed on a macrocosmic scale in terms of a highly industrialized and urbanized society, become even more comprehensive and intricate. Perceiving society as an open system which is governed by the controls of the cybernetic system permits one to grasp the phenomenology of society's structures and function. Thus, man's relationship to his self, family and his community environment is more aptly expressed as a relationship based on "pragmatic communication." The social worker cannot provide appropriate treatment programs unless the individual-in-treatment is understood in terms of his membership in the psycho-sociocultural system and the behavioral communication patterning programs. Rather than consider the individual in a linear context as was described by earlier theorists, one now perceives the matrix of man's life and its parameters as a circular network, continuously interacting, "ecologically interdependent."

# CHAPTER III

## SOCIAL WORK PERSPECTIVES IN RELATION TO CYBERNETICS AND INFORMATION THEORY

In appraising the social work applications of cybernetic theory and the possible extensions of these considerations, a selective review of the literature indicates an employment in social work of a concentration of specific cybernetic concepts: systems (open vs. closed), entropy, feedback mechanisms, redundancy, transactional patterning, transformations, equilibriated "steady-states," constraint, and metric analysis of information. These cybernetic principles have been absorbed in the various conceptual frameworks of social work in reference to the following: 1. the client-environmental psycho-sociological system and, 2. the therapeutic intervention process between client and worker. The underlying common denominator in the two dimensions of cybernetic theory integration in social work is the phenomenon of the relationship and variability of possible interactions. The knowledge of cybernetics can be used to understand and organize the total field-environment in which social work functions, a knowledge that can help one to improve the processes employed for treatment purposes and the role of social work as a profession. The general theories of cybernetics (in which systems theory and information theory are but subdivisions) appear on the surface to be quite amenable to social work theory. In depth analysis indicates that there are further enriching applications which have not, as of the

present time, been incorporated into the existing schema.

Definition Discrepancies

In social work literature one finds the various concepts of cybernetic theory embedded in and referred to as "systems theory" without sufficient correlation to the theory of cybernetics. It is important to clarify the terms as they are exercised throughout this study and to recognize how these terms are already instituted in social work literature. The use of the term "systems theory" in the literature is somewhat misleading and limits the scope of the study of cybernation. Systems theory is a corollary to a more inclusive and technical study of cybernation. Bertalanffy has provided definitions of the various concepts which reveal the distinct differences.

1. Cybernetics, based on the principle of feedback or circular causal trains providing mechanisms for goal-seeking and self-controlling behavior.

2. Information Theory, introducing the concept of information as quantity measurable by an expression isomorphic to negative entropy in physics, and developing the principles of its transmission.

3. General System Theory in the narrower sense (GST), trying to derive from a general definition of "system" as complex of interacting components, concepts characteristic of organized wholes such as interaction, sum mechanization, centralization, competition, finality, etc., and to apply them to concrete phenomena.[1]

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[1]Bertalanffy, L. V., "General Systems Theory — A Critical Review" in Modern Systems Research for the Behavioral Scientist, edited by Walter Buckley, p. 13.

Boulding distills the usages of the terms of cybernetics and GST by stating that GST "lies somewhere between the highly generalized construction of pure mathematics and cybernetics and the specific theories of the specialized disciplines."[1]

One could question whether or not the emphasis of term definition is significant since each basically purports and employs certain similar characteristics (e.g., regulation-controls, entropy, feedback) and each theory interlocks with the others. These distinctions in terminology are important inasmuch as without specific articulation one runs the risk of over-simplification, misuse of concepts, imprecision of application, and an omission of the richness of the schemas. The differences appear, at first glance, as perhaps inconsequential subtleties.

Models

Models can be extremely useful in explaining and clarifying complex systems. The choice of a model can serve either as a creative catalyst as it verifies and extends existing knowledge, or as a binding construct which restricts knowledge of the complex ramifications of a problem. Two major subdivisions of models are: 1. the content model or organization schema which delineates the epistemological framework of the perception of the universe and, 2. the technique model which explicates the processes employed to create and apply the former. In relation to the first model, one can approach the problem in two different

[1]Boulding, Kenneth E., "General Systems Theory — The Skeleton of Science," ibid., p. 3.

ways. Boulding suggested that:

> . . . a first approach is to look over the empirical universe and to pick out general phenomena which are found in many different disciplines and to seek to build up general theoretical models relevant to these phenomena. The second approach is to arrange the empirical fields in a hierarchy of complexity of organization of their basic individual or unit of behavior and to try to develop a level of abstraction appropriate to each.[1]

Two forms of approaches to the content model as suggested in the social work literature are the analogistic and the generic; systems theory has been discussed in terms of each model. In the analogistic form, the system begins at a specified point. One observes the model, reflects the similarities and differences of the model with others, and applies the model to various hypotheses. The generic form attempts to create a master model which includes all of the levels within a system. Cybernetic theory is primarily generic.[2]

Lathorpe suggested four technique models: expository, research, prescriptive, and practitioner (professional). The expository model is an efficient means of condensing, codifying and transmitting information. The research model is a means of problem-solving through heuristic thought. The prescriptive model is "normative" and explicitly outlines what to do, often by algorithmic means; it is a concrete approach as

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[1]Ibid., p. 5.

[2]Hearn, Gordon, ed., The General Systems Approach : Contributions Toward an Holistic Conception of Social Work (New York: Council on Social Work Education, 1969), p. 2.

it maps the procedure. The practitioner model is a synthesis of the three former models and is subdivided into a "master model for practice" and a "working model for concrete cases."[1] The technique models are all utilized in computer operations. The effectiveness of a working model can be evaluated in the following manner, a method similar to cybernetic approaches:

1. conceptualizing and understanding the problems with which social workers customarily deal;
2. partializing or partitioning these problems along lines conducive to their solution;
3. conceptualizing the relevant corresponding professional tasks and the problems lying therein;
4. suggesting lines of attack.[2]

Acceptance of the difficulties in translating a model from one discipline to another, maintenance of the integrity of the original "content" model, and provision of visible and appreciable applications of the content model are the three stipulations which need to be considered as one inspects the various principles of cybernetics as they have been integrated in the social work literature to the present time.

Systems Theory

Matter, living or non-living, is a network of systems in constant interaction with the environment; as such, the system is "open." The

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[1]Lathorpe, Donald E., "The General Systems Approach in Social Work Practice," ibid., p. 46ff.

[2]Ibid, p. 50.

individual, marital couple, family, group, organization, and community all have certain self-defining and self-delimiting characteristics which separate it as a system from the environment at-large; yet it exists precisely because it reacts with the environment. No living system can exist as an isolated entity. In contrast, the "closed" system in engineering can exist as a finite and isolated unit. The orthodox usage of the term "closed system" in cybernetics refers to an operative network that does not exchange matter or energy with the environment (e.g., a chemical experiment in which the reaction, once started, does not interchange with the external environment).

The term "system" has appeared in almost every area of science. It is concerned with organization, cohesiveness, and activity. Hall and Fagen defined a system as "a set of objects with relationships between the objects and between their attributes."[1] The definition expresses the importance of the concept of relationships and the interchange between the object and environment. The objects, defined by their attributes, are not individual entities but are identifiable by their interactive, communicative behavior (as opposed to intrapsychic attributes which are bound, by definition, to the conscious-unconscious system within the individual).

The boundary of a system as defined by Miller is the region which requires a greater amount of transmission of energy to reach

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[1]Hearn, Gordon, Theory Building in Social Work, p. 39.

it than areas immediately surrounding it or inside of it.[1] Sociologists (especially in reference to conflict groups) describe the boundary as a function of the intensity of the interaction between the members of the group.[2]

The environment of a system has been divided into the proximal and distal.[3] The former is the part of the environment of which the system is aware; the latter, is the environment which affects the system but the stimuli of which the system is unaware. Each system varies in terms of its activity, intensity, reaction with the environment and capability of sustaining itself "in life-producing, life-sustaining, life-fulfilling, and life-threatening qualities."[4] In social work, as one deals with a variety of systems, one must recognize the needs, desires, goals, pressures, conflicts, communication patterns, values and cultures of each system.

The shift from attempting to individualize the person-situation complex to perceiving the individual as a transactional system has been influential in the fundamental changes in social work perspectives. This shift is also evident in psychological theories as witnessed by the trans-

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[1]Miller, J.G., "Toward a General Theory for the Behavioral Sciences" in American Psychologist (Vol. 10, 1955), pp. 516-517.

[2]Coser, L., The Functions of Social Conflict (Free Press Paperback, New York: Free Press, 1966).

[3]Hearn, Gordon, Theory Building in Social Work, p. 42.

[4]Lathorpe, Donald E., "The General Systems Approach in Social Work Practice," p. 53.

ition from orthodox Freudian intrapsychic emphasis to ego-psychology in which the effects of society and the pressures of the environment are viewed as prominently important.

Freudian theory was based on goal-seeking behavior on conscious and unconscious levels. Conflict was defined as the result of not achieving innergoals because of external forces. The energy force was considered internal, restricted to the individual. The Freudian theory did not fully explain pathology in terms of the "person-in-environment." His concern with the intrapsychic forces led to a polarization of the two worlds, i.e., individual-oriented vs. environmental-oriented schools of thought.

There have been attempts made to integrate the psychological and sociological, the person and environment, in casework. A recognition of the problem is evident in works by Mary Richmond, Florence Hollis, Gordon Hamilton and Eleanor Cockerill. The employment of psychoanalytic techniques or systems theory approaches affects what is considered health, insight and improvement. Vinacke suggested that insight and improvement should be based on the principles of problem-solving. Unlike other branches of social work (e.g., community organization, social action, problem making) which are intricately part of the sociocultural field, casework is more restricted to the individual. In working with the individual, however, one cannot ignore the forces of social structure, roles, status, class, organization of family and influence

of reference groups.[1]

W. Gordon explained this shift in relation to the social workers role as a helper. In view of the individual-environment and the transactional relation, Gordon labeled the therapeutic responsibility as one of "matching," "intervening by whatever methods and means necessary to help people be in situations where their capabilities are sufficiently matched with the demands of the situation, 'to make a go of it'."[2]

The phenomenon of the open system as an exchange process has been explained by the principle of transaction. Weiss made a good distinction between interaction and transaction. Interaction, commonly used, suggests one person's response to another. Transaction is defined as a continuing exchange of communication between individuals in a given field. The transactional exchange of energy and matter is self-evident in the cybernetic system.[3]

The underlying principle of the transactional system is the transmission of energy. One must understand the energy in the system before evaluating how an individual sustains himself when confronted with internal and external conflicts. Sources of energy have been viewed on the psychic

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[1]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," Social Casework (Vol. 50, No. 2, February, 1969), pp. 74-82.

[2]Gordon, W., "Basic Concepts For an Integrative and Generative Conception of Social Work," in General Systems Approach, edited by Gordon Hearn, p. 6.

[3]Weiss, V., "Multiple Client Interviewing : An Aid in Diagnosis," Social Casework (Vol. 43, No. 3, March, 1962), pp. 111-114.

level as instinctual, emotive, and cognitive or on the sociological spectrum as role expectation, reference group pressure and the like. "Importation of energy suggests an analytic reference for the ways in which the environment serves the individual and is used by him."[1]

Gordon in his discussion of transaction suggested that there are "inputs" which enter the system and originate from both the organism and environment and "throughputs" which pass from the organism to environment. "Throughputs" are the transformations of energy. He indicated that there are no "outputs." The energy from the action of "inputs" is presumably utilized in accomplishing the transfer or "throughputs."[2] "Throughputs" involve the mediational steps between the stimuli and response, it involves defense mechanism and the hyphenated interactions between all the significant persons, e.g., mother-child-father-grandparents-friends.

The discrediting of "outputs" by Gordon appears to be a slight distortion of the intended significance of the transactional system as a process of growth and expression of the transformation principle in cybernetics. Although the information and energy that enters the system is selected, organized and "pushed through" as "throughputs" and re-enters the system (feedback loop) as information energy, new elements have been formed. The complexity of these newly created "units" of

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[1]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," p. 79.

[2]Gordon, W., "Basic Concepts For an Integrative and Generative Conception of Social Work," p. 7.

information is suggested by the hierarchical progression in the "steady-state" principle. It is by virtue of the creation of new elements, through transformations, that the system can be involved in a growth process. Janchill supported the importance of outputs as inherent features in the behavior system.

> Depression, for example may be interpreted in psychoanalytic terms: object loss, the incorporation of the object so that there is no longer any difference between the self and the object, and punishment of the incorporated object what was originally the subject of ambivalent feelings. Another way of interpreting depression is by means of its latent functional consequences: the control it gives the patient in environmental systems, such as the family and employment. Systems analysis, then, may be a reference for a larger view of symptomatology. The notion of an output that activates another input also enriches understanding of role complementarity and role induction.[1]

The capacity to integrate the stimuli from the environment, react to it, and regulate the system in relation to it is referred to in the social work literature as the "coping mechanism." The concept coping is similar in function to the regulator in cybernetics:

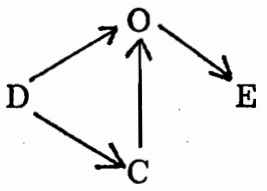


Fig. 6 A Model of Disturbance Control

The diagram (later discussed in relation to cybernetics) delineates the role of the coping mechanism.[2] D is the disturbing stimuli of the input;

[1]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," p. 80.

[2]Infra, p. 111.

O, the organism; C, the control mechanism or coping mechanism; and E, the effect of the transformation and resulting output. In terms of intervention by the social worker in a therapeutic relationship, Gordon stated that the concern of the social worker is in "matching of people's coping patterns with the qualities of impinging environment for the purpose of producing growth — inducing an environmental ameliorating transaction."[1] To achieve a steady-state the open system must possess a capacity to regulate the interchange between input and output. Each selection by the regulator in turn narrows the possible number of variables available for further action.

Lathorpe, in his description of the mechanisms of the open-system in terms of the individual, prescribed a process quite similar to the "Black Box" phenomenon of Ashby.

1. Input: the nature of input, that is, what is available in the way of resources and selectivity utilized by the primary system as input;

2. Processing: what the system does with the input, that is, the conversion or processing of it; and

3. Output: what the output or outcome of the processing is like; the system acts back on its relevant environment.[2]

A fourth element in the system is feedback in which the output is reintroduced to the system. This process is diagrammed in Fig. 7.

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[1]Gordon, W., "Basic Concepts For An Integrative and Generative Conception of Social Work," p. 10.

[2]Lathorpe, P.E., "General Systems Approach in Social Work Practice," p. 51.

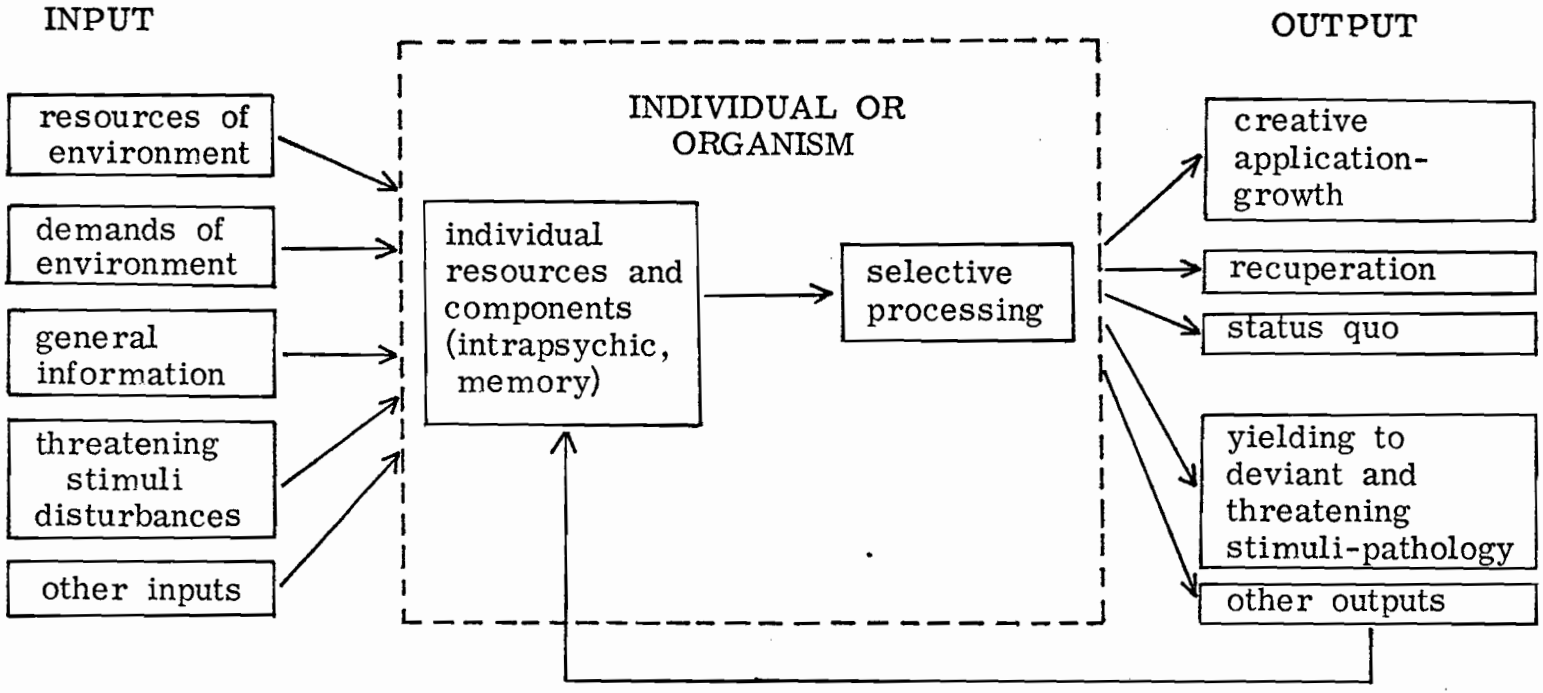


Fig. 7 The Computer-Like Processing of Data by the Individual Demonstrating the Relationship of the Individual and the Environment and the Function of the Feedback Mechanism.

The process is evident in the transactional relationships in the family. The family is more than the sum of its parts. It is composed of the individual, the relationships in subgroups, the reciprocal influences, and the rules of communication. The family can be viewed as a closed and open system. It is a closed system in the sense that there is an established patterning of behavior that is circulated via the feedback mechanisms such that the pattern can be self-maintaining. This self-sustaining feedback mechanism has been termed negative feedback.[1] The family can reach a state of entropy if it continues as a closed system, i.e., becomes increasingly deorganized till it reaches a state of pathological equilibrium (as defined by the second law of thermodynamics).

This state has been described in terms of the "schizophrenic family." The degree of openness or "closedness" of the family is indicative of the degree of pathology and breakdown of the family system. Yet in considering the term closed in relation to the family, one should recognize that it does not indicate the extreme discreteness of the closed system in thermodynamics. Watzlawick discussed the system of regulating rules within the family system that can perpetuate the characterizing behavior.[2]

Systems theory has been helpful in altering the perception of mental illness from an isolated phenomenon of the individual (physio-

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[1] Infra, p. 107.

[2] Watzlawick, Paul, et al., Pragmatics of Human Communication.

logical or psychological) to an aggregate of concepts of behavior which is a function of the individual and the environment. The cause of deviance is viewed as dependent on interacting feedback circuits. Typically, schizophrenia, at one time considered an illness specific to the individual, is now perceived in a framework which includes family and socio-cultural phenomena as well. Work with families in which one or more members are schizophrenic supports the hypothesis that schizophrenia is a condition whereby the patient alters his internalized representation of reality in order to escape from insoluble conflicts or to maintain the system of rules in a schizophrenic family through a "pseudo-mutual" manner of behaving. The family is a good indicator of the varying interpersonal transactions in a microcosm. Many of the pressures, conflicts, and rules witnessed in family transactional behavior can be observed on a macrocosmic level, in society-at-large.

There are several areas that are of specific concern to the breakdown of the family. Intrapersonal parental inadequacies involve the particular neurosis or psychosis prevalent in one or two members of parents and these systems are likely to be recreated in the child. The schismatic and skewed families (often seen in schizophrenic families) cause considerable fragmentation. In the schism family, members take sides, form allies, and the sides are continuously pitted against each other. In the skewed family there is a dyad other than the parental one which dominates and controls, e.g., one parent wants the spouse to treat him/her as a child. These dyads violate the generation bound-

aries which define roles and confuse the role-identification of the child. Faulty communication distorts the perception of reality for both parent and child and hinders cognitive development. Aberrations of behavior can be learned in the family to maintain the status quo. Other areas which demonstrate pathology are in scapegoating, inadequate gender-models which usually affect the same-sex child more, general role divisions, and inadequate crisis-coping mechanisms. The proper channels for emotive expression become thwarted and appropriate behavior is warped. What appears to happen is that the family settles into a life-style and behavior pattern that can best accommodate these pathologies and discrepancies.

It is when the achieved system no longer works and a conflict arises that the family comes for help. Areas for conflict can be in cultural and social discrepancies, interaction discrepancies and individual discrepancies. If one superimposes the cybernetic model onto the behavior pattern of "schizophrenic familes" (families in which one or more members are schizophrenic) and considers the negative feedback circuits, the input and output processing, and evaluates the capacity to make decisions and problem-solve, i.e., apply the "generative rules of transformation and transmission of stimuli, much of what might appear to be incomprehensible or chaotic behavior can be understood within a very structured and regulated system. The operative mechanisms of this open system are basically decision-making and problem-solving processes. The individual is confronted with "input," he must select

and perform transformations and resolve the discrepancies between input and his present state. Stanoulov presented a diagram of decision-making processes of the individual tracing the movement from 1 to 5.[1]

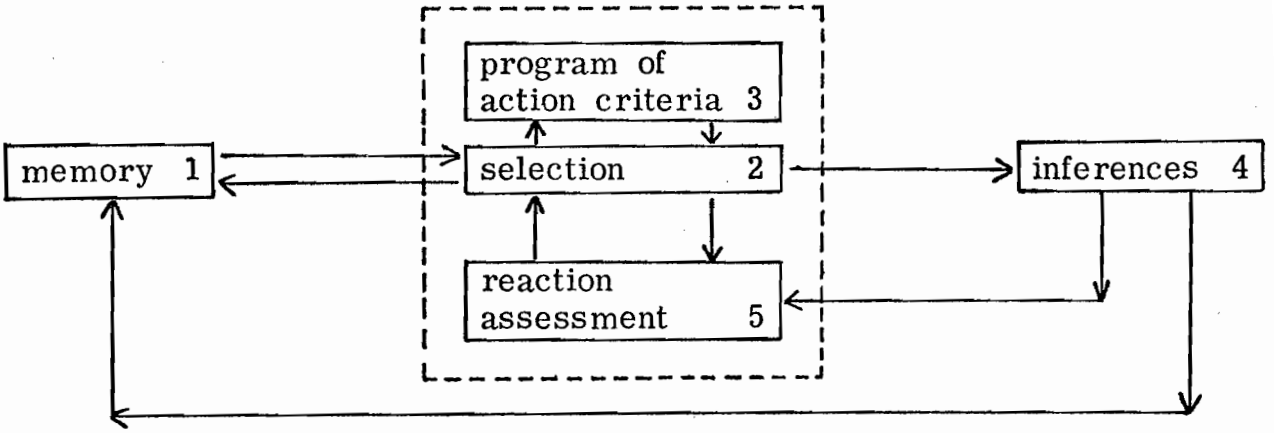


Fig. 8 Stanoulov's Model of the Decision-Making Process

A breakdown of the system is exhibited if there is negative feedback sustaining a pathologic behavior pattern, if the pattern arrangement is too set or too numerous, if the transaction between the object and environment is unbalanced and energy and matter can neither pass to nor without the organism, and if entropy overpowers organization and growth. The individual who appeals to the social worker for help is in a state of unbalance along a wide spectrum of possibilities, i.e., he is in a state of crisis. Negative entropy is also essential to an open system; it serves to halt disintegration. An open system achieves negative entropy by "importing more energy from its environment than it spends."[2]

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[1]Stanoulov, N., "Some Remarks on the Capacity for Selection in a Proposed Functional Scheme of Human Thought," in Cybernetic Basis of Modern Medicine (3rd International Congress of Cybernetic Medicine, 1964), p. 479.

[2]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," p. 80.

Health is then a function of the degree to which the person can be open to incoming stimuli. These environmental inputs can be system-supporting. Janchill suggested the importance of negative entropy in therapy by emphasizing the support-inducing interrelatedness.

In summary, the operative mechanisms in cybernetics are important as they explicate the various processes of the system and relate the function to the structure of the schema. Social work has applied these mechanisms to the open system, an application that has deepened the understanding of man in relation to his environment. Knowledge of these operations are not only helpful in working with families but also with groups. A corollary to the operation schema is the theory which explains "what happens to what has been operated upon." Information theory has extended cybernetic principles to explain the process of information transmission, i.e., the problem of communication.

Communication Theory : Transmission of Information

It is impossible not to communicate; there is no such thing as non-behavior."[1] Behavior is hierarchical in that it originates as small units, integrates with large units, and develops a progression of aggregate units. One can say that within the culture-bound aggregate of behavioral units there are programs. The basic rules for communication programs are established by the culture and these are interdependent. The individual and subgroups within the culture form networks which

[1]Watzlawick, Paul, et al., Pragmatics of Human Communication, p. 49.

have rules unique to the characteristics of the group. Each person has many repertoires of coded behaviors, coded as they apply to kinship relations, territorial hierarchies, dominance patterns and other systems. In reference to communication behavior in terms of the culture-bound language code, Cherry stated:

> The language of a people largely constrains their thoughts. Its words, concepts, and syntax, out of all the signs people use, are the most important determinants of what they are free and able to think about. It makes their particular epistemology, their special view of the world, what they notice or do not notice.[1]

Although this statement is controversial, as it can be argued in terms of to what degree does language actually formulate our perception of the world, nonetheless, it suggests the importance of studying language as a means of comprehending the individual's whole system and orientation.[2]

The effect of the word depends upon the culture and the context in which it is used. Words have meaning because of convention. The direct word message, referent and word, is termed the denotative expression; a denotative statement leaves little ambiguity as to its meaning. Connotative language is often more abstract and more elusive as it is one step removed from direct representation.[3] Since most com-

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[1]Cherry, Colin, On Human Communication, p. 73.

[2]Piaget questions the construction of reality in the prelinguistic and postlinguistic stages of development of the child in his book The Construction of Reality in the Child, translated by Margaret Cook, (Vintage Books, New York: Random House, Inc., 1967).

[3]Cherry, Colin, On Human Communication, pp. 70-74.

munication is representative, i.e., connotative, the importance of correspondence or, matching between one's thought, what one actually states, how it is received, and the degree to which the entire communcation can be ambiguous must be kept in mind. Another distinction of word usage is presented by Ogden and Richards, the symbolic and emotive word. The former represents things, categorizes, classifies; the latter is not "accurate" but represents the aesthetic expression in terms of feeling.[1] The emotive word, similar to the analogic expression, can create ambiguity and uncertainty.

In human discourse, verbal exchanges to communicate information must reduce the uncertainty and ambiguity. This is not only a function of the word used but also of the intention of the user and the degree of preparedness for reception of the other party involved. Conversation can be direct or ambiguous; the meaning distorted, or clarified, and punctuated to suit the speaker.[2]

Conversation is also goal-seeking. Assume you are conversing and you hear a stream of sounds. Before this reception you are in a state of mind which includes beliefs, emotions, factual knowledge, etc. When the person speaks to you, the sounds he makes constitute evidence to you concerning an intended message. "To these intended messages from the other speaker, because messages are in his mind, you have

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[1]Ibid., p. 75.

[2]Watzlawick, Paul, et al., Pragmatics of Human Communication, pp. 54-59.

no direct access, no true knowledge. This evidence then converts this prior state of belief to what we may call your posterior belief or preparation for another response."[1] The conversation can either be direct or distorted via the double-bind theory.

> A conversation, regarded as a closed-cycle, goal-seeking activity proceeding by a continual modification of the two communicants . . . is of extraordinary complexity. The course of such goal-seeking activity depends upon beliefs about past, present, and future events. In overt terms, behavioral responses are definite actions, definite selections from a range of alternatives. A response sign, an utterance or gesture, may be delayed until more evidence is gathered from the partner's speech or action but it must be made at some time.[2]

Conversation is like a "game" with definite sets of rules, signs and goals. Newell, Simon and Shaw have computed the game of chess; perhaps it is not too removed from computerizing a conversation for the purposes of understanding the process of selection, effect and probability. It is this power of selectivity which is related to the human "commodity capacity." In referring to a painter's style, one could explain it in terms of what he has left out, what he does not include versus what he selected to include.[3]

One can also observe a conversation and evaluate meaning as the outside observer. Two meanings must be evaluated, that of the 1st and 2nd person, but one cannot dismiss the variable of the observer-3rd person.[4]

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[1]Cherry, Colin, On Human Communication, p. 250.

[2]Ibid., p. 251.

[3]Parry, John, The Psychology of Human Communication, p. 53.

[4]Cherry, Colin, On Human Communication, p. 92.

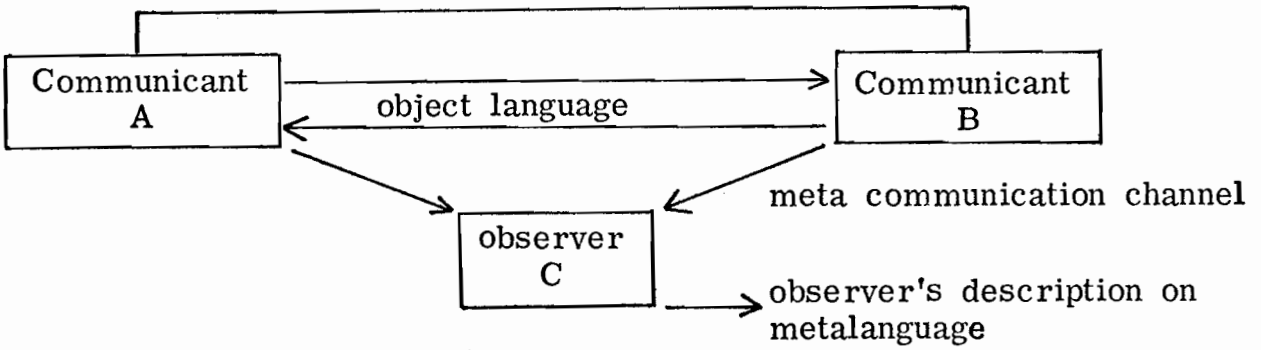


Fig. 9 The Role of the Observer in the Semantic Analysis of Communication Exchange

The metalanguage (that language used to describe the conversation) can be the observer's description in terms of the rules of the statistical measurements, content analysis, linguistic hierarchies (phonemes, morphemes, etc.). Yet the significance of this model is also because of the feedback and interdependency of the triangular relationship. What B states is dependent on A plus the entire environment and experience that B brings to the situation. B also selects that to which he responds.

The transactional aspects of communication can be explained in terms of a circular feedback mechanism in which a series of overlapping stimulus response triads are formed: $A \longrightarrow B \longrightarrow A_1 \longrightarrow B_1 \longrightarrow A_2 \longrightarrow B_2$. $A_1$ is the combination of A plus the integration of B's response which was a product of A. In this series each reaction is a function of the other's preceding behavior.[1]

What becomes important to each respective relationship is the

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[1]Watzlawick, Paul, and Janet Beavin, "Some Formal Aspects of Communication," American Behavioral Scientist (Vol. 10, April, 1967), pp. 6-7.

phenomenon of punctuation in the communication series. Punctuation involves selectivity from a set of variables (e.g., country H arms because country P is arming and vice versa; a depressed person withdraws, a withdrawal causes others to worry, which in turn makes the depressed man feel guilty for causing the worry and the depression increases). The parallel to this is viewed in the negative feedback system which supports the punctuated sequence and the hierarchical escalation of the structure of organization.

The "double-bind theory" in communication, viewed in terms of punctuation is quite relevant in appreciating pathologic communication in terms of information theory and systems theory.[1] The double-bind is also supported through negative feedback. The hypothesis suggests that meaningful figures in an individual's (e.g., schizophenic's) early life frequently communicate puzzling, conflicting messages to the patient-to-be. These messages are impossible to interpret as transmitted, require clarification or revision before the communication is meaningful. The classic double-bind dilemma is a "damned if you do, damned if you don't" situation. Double binds are usually mutual. Thus, there is not a binder and a bound, but rather, two or more victims tragically enmeshed in a reciprocal victimizing and rescuing process. Almost any part of a double bind sequence in behavior or conversation may then be sufficient to precipitate panic or rage.

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[1]Watzlawick, Paul, et al., Pragmatics of Human Communication, pp. 211-219.

All communication, verbal or non-verbal, is significant; therefore, the concept of "noise" as unwanted insignificant interference (as explained in cybernetic and mathematical theories) is not applicable; "noise" as a distractor is as equally important and influential in human communication behavior as "information." In the study of human communication, the concept of entropy needs to be reinterpreted; what is lost is equally as important as what is gained, reasons for loss of information (e.g., sender is unable to express himself such that the receiver understands) are extremely important in faulty communication that leads to pathologic patte rns. Noise is basically unwanted sound, interference, and is extremely critical as a deterrent in a closed system. Redundancy in open and closed systems is one means of overcoming noise. The probability of understanding the succeeding sign is directly proportional to the knowledge of the antecedent idea. Redundancy is critical in complex messages yet an overuse of redundancy can eliminate efficiency. The opposite of redundancy is condensation, or cue-suppression. If condensation is too great, there can be an increase of tension in the system, confusion, and misunderstanding.[1]

These considerations in communication exchange patternings, be they verbal or non-verbal, suggest the frequent duplicity and often tenuousness of a meaningful discourse. What might be comprehensible to the speaker is unintelligible to the recipient. The recognition of the problems

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[1] Birdwistell, Ray L., "An Approach to Communication," Family Process (Vol. 1, No. 2, September, 1962), pp. 194-201.

of "uncertainty reduction" in "pragmatic" transactions as indicated in the commentaries on digital and analogic analysis of communication, the symbolic and emotive words, the punctuation sequences, the double-bind theory and information transmission which is dependent upon the degree of noise, the decrease of entropy, and insurance through redundancy has immediate significance for the social work profession. The studies on content-analysis are indicative of the sensitivity of therapists to the problem of communication, be it affective or cognitive.

There are two applications of communication theory in social work: the description of the communication process at large within the psycho-sociological environment of the individual and the employment of the communication theory for helping purposes. The emphasis on content-analysis in the last decade suggests the climate of the research efforts in relation to information theory and the therapeutic processes. It is not within the scope of this paper to present in depth, the studies in content-analysis as reported in the literature. However, in terms of the relevance of this approach to cybernetics an appreciation of the different content-analysis models are important.

Content-analysis has been utilized in evaluating psychoanalytic psychotherapy, and counselling sessions. Marsden defined content-analysis as:

> . . . a research technique for the systematic ordering of the content of communication processes . Typically it involves procedures for division of content into units, for assignment of each unit to a category or to a position on a metric, and for summarizing

> coded units and arriving at inferences concerning the significance of the summations.[1]

Fundamental to the justification of content-analysis is the concept that information can be reduced to quantification levels sufficiently finite to be workable as data as in computer analysis. The controversy between content and quantification, meaning vs. measurability, is quite evident yet the import of the quantification approaches need not be disqualified by the controversial counter opinions. Each method has its value and limitations.

There are three models of content-analysis described by Marsden: the classical, pragmatic, and nonquantitative. The classical model has been described by Berelson as the "objective, systematic, and quantitative description of the manifest content of communication."[2] For Berelson the frequency of content was highly significant. He wished to restrict the study to the syntactic and semantic aspects to avoid the problem of ambiguity one encounters in the pragmatic study of communication. One should not, however, infer that this exclusion in the study suggests a lack of appreciation for the significance of the relationships between the communicants.

The pragmatic model questions the exclusion of the relationship from the classical model. "In the pragmatic model units are coded to categories descriptive of some condition of the communicator or of the

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[1]Marsden, G., "Content-Analysis Studies of Therapeutic Interviews : 1954-1964," Psychological Bulletin, (Vol. 53, No. 5, 1965), p. 298.

[2]Ibid.

relationship between him and his communication."[1] It is not the verbal content of the interview that is significant but the complexity of the clinical construct which involves the helper and person or persons being helped. In both the pragmatic and classical models, the frequency of occurring events is what is being measured; frequency is directly correlated with intensity. The pragmatic model has been used for analysis of conjoint family therapy, group therapy, and individual therapy.

The studies in nonquantitative analysis have been performed in an attempt to develop alternative measures other than frequency and intensity. The preferred method of study is the linguistic approach. In comparing content-analysis to linguistics, the distinction has been made that "content-analysis is primarily concerned with meanings, while linguistic analysis is concerned with the properties of language as a code for the transmission of communication."[2] The problem of transmission is later discussed in reference to cybernetics.

Marsden has indicated specific flaws in the approach to information and communication analysis: the basis of selection of unit and category seems to have been made on the premise that they are separate and unrelated phenomena; and the delineation of units often appears as a function of easily segmental divisions rather than based on structural and functional differences and their logical relation to the psychological-

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[1] Ibid., p. 299.

[2] Ibid., p. 300.

sociological category schema.

Although there are many flaws in the system as it has been developed thus far, the value of the approach is in the attempt to understand the process of communication in terms of methods intended to eliminate the intuitive aspects of treatment processes and to develop criteria based on scientific knowledge. Cybernetics introduces principles which help to bring scientific precision to the study of communication (e.g., methods such as uncertainty reduction, transmission, feedback, redundancy, control for loss and gain). Adaptation of these models of information exchange have already been applied to the study and treatment of schizophrenia and other psychopathological systems.

The new approaches to communication and content-analysis are exemplified in the "Black Box" concept. One cannot see the contents of the "Black Box." Certainly Freudian analysis is an attempt to discover the contents of the "box," to know <u>why</u> it responds and works the way it does. The concentration , of late, has shifted to the observation of the input-output relations specific to the "Black Box;" "what" goes on intrapsychically is considered not to be essential in understanding the person in relation to the greater system in which it is involved. Rather than to continue "groping" for "pure" understanding of the intrapsychic mechanism, "one can limit oneself to observable input-output relations, that is, communication. Such an approach is believed to characterize an important recent trend in psychiatry toward viewing symptoms as one kind of input in to the family system rather than as an expression

of intrapsychic conflict."[1]

In summary, the problem of information transmission is critical to social work especially, because the basic tool for the clinician is language (verbal and non-verbal). Without adequate means of understanding the processes, one cannot develop relevant and adequate techniques for diagnosis and treatment.

Social Work Intervention Theories

In working with the client, there are four conceivable areas into which the problem can fall: input, processing, output, and feedback. The worker is presented with the output, i.e., the behavior of the individual, family, or group. In attempting to understand, the worker can ask questions or be alerted to statements concerning the general system of which the individual is but a part. The goal of the worker is to help the client towards understanding, decision-making and self-determination. Lathorpe relates this process to the principle of equifinality, that there is a "wide range and variety of possible combinations of habits of mind and feeling and of lines of behavior which can be put together to achieve desired output and to constitute a person's, group's, or organization's life-style.[2]

Observation as to how the individual processes and selects information has been considerably facilitated by information theory.

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[1]Watzlawick, Paul, et al., Pragmatics of Human Communication, p. 44.

[2]Lathorpe, Donald E., "The General Systems Approach in Social Work Practice," p. 59.

Understanding feedback mechanisms in the system also helps the worker to steer the individual to be able to control his own direction.

> Improving the feedback processes of a client system will allow for self-steering or corrective action to be taken by him or it . . . . In diagnosing a client system, the practitioner asks: What are its feedback procedures? How adequate are they? What blocks their effective use? Is it a lack of skill in gathering data, or in coding and utilizing the information?[1]

In applying knowledge of feedback mechanism to therapy intervention Phillips and Wiener have presented a set of rules:

1. A feedback system, or loop, is composed of elements which do not have, and do not need to have, any a priori or hierarchical or causal order. The feedback loop is entered wherever possible;

2. Within a feedback circuit, it is often advantageous, for the sake of control, to enter the loop as close as possible to the point of desired change;

3. Within a loop, one selects the unit or factor most loosely related theoretically to the output one wishes to alter.[2]

Recognizing general criteria of feedback mechanisms in the system provides the worker with guidelines for proceeding in treatment. Since living systems respond to increasing stress whether through a lag in response, compensation, or overcompensation, with an eventual destruction of the system, an ability to judge the breaking point could mean that the worker would be able to intervene prior to the breaking point and provide treatment. In trying to cope with the stress, individ-

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[1]Chin, R. "The Utility of Systems Models and Developmental Models for Practitioners," p. 206.

[2]Phillips, E. Lakin, and Daniel N. Wiener, Short-term Psychotherapy and Structural Behavior Changes (New York: McGraw-Hill Book Co., 1966), p. 96.

uals tend first to employ the less costly defenses. This is helpful for the worker in order to know how to pace the plans for helping the client use his own personal resources. If reduction of the stress is not easily possible, one also has to be able to "partialize" the problem into smaller units.[1]

The changes in treatment intervention, from dynamic to functional casework, are relevant to the study of cybernetic influences. The latter methodology is premised on the perception of the individual as a system which must regulate and control the forces impinging from the external world as well as accommodating to them. . Crisis intervention reflects specific cybernetic principles in that the "system" in crisis has lost control and cannot cope with the numerous variables.[2] Although there have been many studies on various forms of therapy based on the systems approach, an examination of functional casework and crisis intervention reveals the prominent tenets of the approach.[3]

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[1]Miller, James G., "Towards a General Theory for the Behavioral Sciences," American Psychologist, Vol. 10, 1955, pp. 513-531.

[2]Family Service Association of America, Diagnostic and Functional Casework Concepts (New York: F.S.A.A., 1950).

[3]Some of the literature in applying cybernetics and systems theory approaches appear in the works by the following authors: Shulman, Lawrence, "Social Systems Theory in Field Instruction : A Case Example," in The General Systems Approach : Contributions Towards an Holistic Conception of Social Work, edited by Gordon Hearn; Stein, Irma, "The Application of Systems Theory to Social Work Practice and Education," paper presented at the annual program meeting of the Council of Social Work Education, New York: January 25-27, 1966; Katz, Daniel, and Robert Kahn, The Social Psychology of Organizations, New York: John Wiley and Sons, 1966; Vinacke, W. Edgar, The Psychology of Thinking, New York: McGraw-Hill, 1952.

In appreciating the significance of these theories in relation to cybernetics one needs to perceive the correlation of the theories to the originating principles. Crisis theory, although it is similar to functional casework in certain respects, is a derivative of the Freudian diagnostic conceptual framework. Functional casework is based on the philosophy-psychology of Otto Rank and will therapy. Both crisis theory and functional casework have certain basic principles related to ego-psychology.

The organization of the personality in Freudian terms, is a combination of various interacting forces. These forces are not only intrapsychic but also environmental. However, the maintenance of balance of these forces can only be achieved through experiencing one's relationship to oneself and the others. The ego, for Freud, is the balancing mechanisms which attempts to reconcile intrapsychic needs and impulses with demands of reality. The locus of emphasis is therefore the psychic energy. "The strength of the ego is a variable factor determined largely by the favourable and unfavourable course of the person's psychosocial development. The ego's strength also contracts or expands at points of greater or lesser inner and outer pressure."[1]

Freud's concept of a struggle between two polarized forces reflects the ancient Chinese philosophy of the Yin and the Yang. Life and the maintenance of life was seen as strife between two opposing forces. Strife became the implicit life-energy force; destruction, the imbalance of the strife. Homeostasis, as we know it, only became a familiar

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[1]Family Service Association of America, Diagnostic and Functional Casework Concepts, p. 8.

phenomenon with Aristotle, i.e., his theory of moderation, balance at the mean. The life fear and death fear (fear of independence, of giving up safety, of loss of life) is a constant driving force. In this sense, man is continually in a state of crisis. Freud perceived this struggle as a detriment, an exhausting battle between desire and inhibiting forces. Yet crisis has been perceived in crisis theory and functional casework as a growth-implementing source, compelling a constructive potential to impel change.[1] The principle of strife, translated into the cybernetic framework, presents the problem of regulation, steering the organism towards a state of stability. The principle of homeostasis has been altered and now is discussed as dynamic steady-states.

The concept of the will and the power of willing is the basic principle upon which the schism between Freud and Rank pivots. Freud did not perceive the ego as an autonomous phenomenon, capable of action, of "willing;" there is no equivalent to the "will" in his psychology. The individual cannot be, therefore, a "fashioner of his fate;" he is rather a product of his fate and, as such, has to be dealt with in treatment differently. Help is conceived of as "goal-directed" treatment (Freudian) rather than "experience in form" (functional). In the former, help is towards resolving inner conflicts. In the latter, help is mobilizing ego strengths and social planning to reduce the weight of reality

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[1] Rapoport, L., "The State of Crisis : Some Theoretical Considerations," in Crisis Intervention, edited by H. Parad (New York: Family Service Association of America, 1965), pp. 22-31.

pressures."[1] The latter integrates the transactional process between the individual and society. In functional casework it is the client who determines and gives form to the treatment relationship because implicit in the theory is the individual's power of the will.

Rank's will theory postulates that the organizing force in the relationship is the will; the individual is not only "acted upon" but "acts upon." Ego becomes a result of "the creative use of inner and outer experience by means of the will."[2] The birth of the self occurs because of a process of individuation: "the power or strength to individuate this primal or cosmic psychical energy into a formed personality, a psychic ego."[3] The emphasis on the problem of separation is integrally related: to become one's self, one must wrench oneself from the other rather than attempting to strive for a completion of the self through the other. The ultimate goal, therefore, is to release one's power to act, to be, and to organize and control one's own experience. Since the inherent problem is seen in terms of the relationship with the other, and control, the relationship process itself is the focus in treatment. The client must take responsibility to determine his own action, to assert his will. There is not the Freudian emphasis on norms of unpathologic behavior but rather an emphasis on the uniqueness of the individual's creative potential to assert his self.

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[1]Family Service Association of America, Diagnostic and Functional Casework Concepts, p. 8.

[2]Ibid., p. 9.

[3]Ibid., p. 22.

Rank's theory has many correlations to existential psychology and ego psychology. The prominently used phrase "identity crisis" perhaps best expresses the link between crisis theory and Rankian psychology. Events, feelings — all of life — is threatening when there is no sense of self to counteract the impinging threats or hazardous forces of life.

Laing spoke of "ontological security", the security in being one's self. If one has a strong sense of his self he also has a belief in the permanency of things and the substantiality of the others. He then can enter into a reciprocal recognition of the other's identity. Laing stated that in this reciprocal relationship there are two elements:

a) I recognize the other to be the person he takes himself to be.

b) He recognizes me to be the person I take myself to be.[1]

It is through man's relationship to the other that defines his own ontological independence. It is this relationship process and the attempt to identify the self in existential terms such that the self is the center of strength and being that crisis and functional theorists have adopted for their conceptual framework.

Crisis has been defined as "an upset in a steady-state."[2] The aspect of maintenance of homeostasis is evident when crisis is defined as a disequilibrium. Crisis has also been described as "a stage in any

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[1]Laing, R., The Divided Self (London: Penguin Books, 1968), p. 35.

[2]Rapoport, L., "The State of Crisis : Some Theoretical Considerations," p. 24.

given interactional process where a person or group is involved in a problem that has proved insoluble by whatever customs, habits or routines have been depended upon . . . ."[1] This statement indicates the multifaceted influences on the precipitation of a crisis. The crisis is not only a result of hazardous events, but of intrapsychic and socio-cultural prepatterned methods of perceiving and coping. The crisis theory does not exclude the intrapsychic phenomena; it is relevant to the individual's manner of behaving under stress.

Parad and Caplan suggested five aspects of a crisis: 1. the stressful event creates a problem that appears insoluble, 2. the problem overtaxes the psychological resources and disrupts the individual's capacity to function and solve the problem, 3. the situation is seen as a threat to life goals, 4. the crisis period is marked by a crisis of stages of disorganization, movement towards recovery and reorganization, 5. the crisis period awakens unresolved problems of the past.[2] Crisis is usually acute rather than chronic. There are generally observable changes in the behavior, feelings of anxiety, helplessness, and fear of danger. The crisis, a sudden alteration in the field of social and psychic forces within which the individual exists, can be created in several significant areas: a threatened loss or actual loss of a significant person or thing, an introduction of new member(s) into one's social

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[1]Miller, K., "The Concept of Crisis, Current Status v. Mental Health Programming," Human Organization (22, 3, Fall, 1963), p. 195ff.

[2]Parad, H. and G. Caplan, "A Framework for Studying Families in Crisis," in Crisis Intervention, edited by H. Parad, p. 66.

orbit, changes in social status, and maturational processes.

Erikson discussed the developmental changes as creating "crises of maturation:" the eight stages of development: oral sensory, muscular-anal, locomotor-genital, latency, puberty and adolescence, young adulthood, adulthood, and maturity.[1] The adaptive mechanisms at each level must be mastered and added to the repertoire of functional coping mechanisms. Often breakdowns in crisis reflect unmastered levels of development which thwarted the strength of the ego-adaptation mechanisms and sense of self identity.

The recognition that a crisis is a function of the intrapsychic and environmental affects the use of diagnosis and casework as defined in the traditional Freudian sense. Kaplan suggested that diagnosis is a tool, not a process.[2] The diagnosis should take into account the ego-adaptive responses of the individual and etiology of behavior only to the extent that it is helpful for the treatment. This is different from the diagnostic school which uses the diagnosis as part of the treatment goal.

Albee stated that psychotherapy (in the Freudian sense) is not indicated in crisis intervention; rather short term intensive supportive treatment emphasizes the responsibility and potential of the individual to bring together his own resources to meet the problem.[3] The impor-

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[1]Erikson, Erik, Childhood and Society (New York: W.W. Norton and Co., 1963), p. 273.

[2]Kaplan, G., "Concept of Acute Situational Disorders," Social Work (N.A.S.W., Vol. 7, No. 2, April, 1962).

[3]Albee, G., "Models, Myths, and Manpower," Mental Hygiene (Vol. 52, No. 2, April, 1968), pp. 168-180.

tant teaching process of the treatment is to help educate the person to know his resources and to feel confident that he has ego-adaptive mechanisms on which he can rely so that if another crisis should arise he could be more dependent upon himself.

This problem of rejecting the disease model as an impediment for treatment, for the patient to be perceived as having strengths, self-respect and potential, is critical.[1] The shift from Freudian psychology to ego-psychology, suggests an emphasis on health, on the strength of the individual himself. The flexibility of the individual, his ability to utilize his potential and reactions, healthy and pathologic, and the necessity for the individual to concentrate on resolving his emotional crisis suggests the useful assets of the individual as "the self" tries to resolve the painful crisis.

The proponents of crisis theory see the client "en situation." This "Satrean" philosophy places the dynamics within man's relationship to the others. As such, the process of interaction becomes extremely important: how does the client relate to the worker? what does he expect? demand? why has he come at this time?

Methods of communication become important. The person is involved on the intrapersonal level, but also on the interpersonal and suprapersonal (transactional) level.[2]

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[1]Parad, H., and G. Caplan, "A Framework for Studying Families in Crisis," Crisis Intervention, edited by H. Parad, p. 56.

[2]Ibid., p. 53.

The emphasis in crisis intervention becomes the client's ability to problem-solve; an understanding on the cognitive level and the ability to restructure facilitates movement towards equilibrium and ego-stability. The role of the worker is, therefore, to identify and clarify the stressful event and precipitating factors. Isolation of the problem helps to bring all available resources to it. The worker should understand and recognize the manoeuvres used by the client: irrational attitudes, negative and inappropriate responses, defense mechanisms and resistances. One should be acquainted with the responses he is warding off and the historical patterns of coping.

Crisis theory integrates many new concepts and perspectives to make crisis intervention a viable process.

> It makes use of ego-psychology as well as newer social science concepts . . . such as role-transition states and social network . . . . The theoretical formulations give greater precision and clarity to the nature of the operative conditions, processes, and hence possible techniques which might be developed for intervention.[1]

It is the inclusion of ego-psychology , the emphasis on the operational process through relationships, and the use of time that align crisis theory with functional casework.

The functional casework theory, embedded in Rankian psychology, emphasizes the relationship between the worker and the client, the helping-process. The strength of the will is developed as it opposes the will of the other, reaches a state of autonomy; yet this can be

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[1]Lovis, Paul, "Crisis Intervention," Mental Hygiene (Vol. 50, No. 2, January, 1966), p. 31.

achieved only through the process of relationship and "transactional" confrontation. Elements of separation-union dichotomy as witnessed between the infant-mother now become translated to mean the client-worker. The primary aim of the functional school is growth in the individual to act on his decisions and choose for himself. "Functional" in this sense means the capacity of the "will" to function to full potential, as one differentiates oneself from the other and forms his own identity and creative action. Through the process of the relationship one discovers what he wants to do. The client gives direction to this process with the worker taking responsibility in helping the client to release this process.

In functional casework, the program is not client-centered but agency-centered: the agency's policy, form, and structure. The agency remains in control of the situation in providing a service but the action is ultimately up to the individual client, reorganization of his life is a function of the relationship with the worker in which he is given the opportunity to work through the will-conflict. The structure of the agency's function gives form to the relationship, it describes what are the factors that are being brought together. The strength of the structure seems necessary, to the functionalists, to provide the strong counter-will and control from which the individual must battle against, i.e., to be controlled to control.

Smalley states:

> All social work process, to be effective in social work requires the use of relationship to engage the other in making and acting on choices.[1]

The emphasis on process and relationships, the transaction between man and the "field of social forces" is related to the emphasis now on communication analysis and cybernetics. In social work, the development of group work and community organization relies on the "process" of interaction at the operational level. One treats not "things" but ways of behaving; one asks not "what is this thing" but "what does it do" and "what are all the possible behaviors it can produce."[2] These questions exemplify the cybernetic approach.

Cybernetics and information theory are relevant to functional casework and crisis theory because of the behavioral sets of possibilities. The important aspect is the set of possibilities, not an individual element in the set. The important aspect of the set is the extent to which "the system is subject to determining or controlling factors. So no information or signal or determining factor may pass from part to part without its being recorded as a significant event. Cybernetics might, in fact, be defined as the study of systems that are open to energy but closed to information and control — systems that are information-tight" (that which is contained in the "black box").[3]

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[1]Smalley, R., Theory For Social Work Practice (New York: Columbia University Press, N.Y., 1967), p. 167.

[2]Ashby, W. Ross, Introduction to Cybernetics, p. 1.

[3]Ibid., pp. 3-4.

It is this interaction that becomes relevant to functional casework and crisis theory as it relates to ego-psychology. Man, constantly affected by experience — society, the other, the agency , must process the data but this can be done only by interacting within the process itself. From the sets of possibilities, one extracts a position for himself that reorganizes and brings him to a position "to be" and "to act." Smalley defined the desired resulting phase:

> . . . a mutual and mutually shared discovery of various contributory factors, in order that the client may be more fully in control of a continuing life process, further developed and affirmed as his own.[1]

The important principles which are prevalent in crisis intervention and functional casework are suggestive of the concerns of the social worker who recognizes the "lag" in social work epistemology and practice, especially in psychoanalytic-oriented casework, with respect to current advances made available through other disciplines. Certain difficulties which remain are: 1. The lack of integration of social science disciplines in current theory and practice. Simply adding systems theory to psychoanalytic perspectives is not sufficient; it must be integrated; 2. The problems of environmental manipulation and value considerations are not as yet manageable, free from a more static framework; and 3. The lack of a cohesive body of knowledge and methodology to be used for teaching purposes restricts the rapidity with which social work as a profession

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[1]Smalley, R., Theory of Social Work Practice, p. 128.

can capitalize on new and creative channels of development in order to be able to meet the challenges of an otherwise accelerating system.[1]

The rationale for the incorporation of cybernetics into the training curriculum for social workers is in the emphasis on systems. The worker can only appreciate the significance of the interdependency of living systems and life cycles through a study which integrates perspectives and methodology into a systems framework. Segmentation of theories can impair the ability of the worker to relate the varying elements.

> The central construct in such a theory might have the qualities of a system of interacting entities described by general systems theory. It would provide us with a compelling rationale to redraft the traditional model for teaching social work methods into a unified course dealing with all modalities of social work practice.[2]

Summary

Cybernetic theory, general systems theory, and information theory can offer the social work profession a framework which opens many areas of advancement. The disease-model which appraises the individual's and society's behavior in terms of normative value-laden rules can be changed to a health-model in terms of systems theory to permit a "value-free exploration of the relational determinants of

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[1]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," p. 77.

[2]Shafer, Carl M., "Teaching Social Work Practice in an Integrated Course : A General Systems Approach," in The General Systems Approach:, edited by Gordon Hearn, p. 27.

behavior through its focus on a synchronic analysis of interacting systems."[1] The circuit network rather than the linear approach alters the perception of causality from a one-to-one relationship to a system of functional consequences which organizes the multi-variables through transformation processes, and maintains the transactional system through a feedback loop. It also suggests that one can look to other systems for causes rather than limiting the diagnosis to a one-dimensional unit. This method of relating causes and processes to outcomes is helpful for research for predictive measures which would lead to earlier and more effective intervention. Although the cybernetic approach does signify more appropriate points of intervention, it leaves open the question of strategy and suggests that there are many techniques and strategies that can be employed.[2] The study of information transmission and transformation of energy offers open-ended exploration into the mechanisms of the transactional system of man's relationship to man and society.

To appreciate all the ramifications of the cybernetic model and the information theory model, the social worker needs to return to the very basics of the disciplines themselves, to grasp the "metalanguage" of the generative systems. The purpose of the following chapter is precisely that, an identification of the salient elements of cybernetic theory and information theory viewed in terms of itself.

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[1]Janchill, Sister Mary Paul, "Systems Concepts in Casework Theory and Practice," p. 81.

[2]Ibid.

# CHAPTER IV

## CYBERNETIC SYSTEMS AND INFORMATION THEORY

An engineer is presented with a "Black Box" that has terminals for input and terminals for output. He may introduce through the input terminals any number of shocks or other disturbances and observe the output. He does not know the mechanism inside the box but through observing the output, with the knowledge of the introduced variables, he can learn to know the contents of the "Black Box." A child is given a "Black Box," a music box. He must manipulate the handle (input) to wind the mechanism such that he can produce the desired effect, the music (output). However, he does this without ever knowing the internal mechanism of the "Black Box." In everyday life each of us is confronted with systems whose internal mechanisms are unknown to us. For the cybernetician, the problem of the "Black Box" presents several problems:

1. How should an experimenter proceed when faced with a Black Box?
2. What properties of the Box's contents are discoverable and what are fundamentally not discoverable?
3. What methods should be used if the Box is to be investigated efficiently?[1]

From the onset of the experiment, the Box and the Observer form a relationship. The process of investigation in order to understand the

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[1]Ashby, W. Ross, Introduction to Cybernetics, p. 87.

system when focusing on the specific question or problem, the related object, and the observer is basically the study of the relationships between the experimenter and his environment with specific attention given to the transformation of information.

The solution to the "Black Box" problem needs to be considered from two perspectives: 1. the operation mechanisms which provide coordination, regulation, and control and 2. the information itself which is being acted upon; the latter is to be discussed in terms of information theory. The former, as it deals with operation mechanisms, is explained within the cybernetic framework as well as further explicated in computer programming methods.

The Mechanisms of Operation

The concept of change is fundamental to cybernetics. The problem of differences between two states occurs either because two objects are different from the onset or because of an alteration in time. It is to be assumed that these changes occur in finite discrete steps; although, due to the infinitesimally small size of each step, the change often appears as continuous.

There are two theories to explain change. The cause-effect chain states that B responds in a certain way as a direct reaction of A's behavior — this is considered a positive explanation (e.g., the tennis ball moves because the racket struck the ball).[1] The cybernetic

[1]Bateson, Gregory, "Cybernetic Explanation," in American Behavioral Scientist, (Vol. 10, April, 1967), pp. 29-32.

model states that change is not "positive" but "negative;" one considers all the possibilities that could occur and then asks why each possibility was not followed. The events that do occur are the only possible remainders. The reaction from A to B, therefore, is dependent upon the system of constraints which helps one to arrive at the lowest denominators, "those factors that determine inequality of probability."[1] An example of negative explanation to change is expressed in the following illustration:

If one finds a baboon striking the keys of a piano and the music one hears is a Bach Fugue in C minor, one should look for restraints either in the baboon (perhaps the baboon could not strike any other keys) or in the piano (perhaps the piano could not play any other piece regardless of the keys being struck).[2]

The question of variables can be considered from two perspectives. The input into the system can be one variable or "n" variables. The number of input variables directly correlates to the number of possibilities of reaction as well as controlling, to a certain degree, the number of possibilities to be considered. The system is a function of these variables. Ashby defined system as "not a thing but a list of variables. This list can be varied and the experimentors commonest task is that of varying the list until he finds a set of variables that gives the required singleness."[3] In large systems, the cybernetician is dealing

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[1]Ashby, W. Ross, Introduction to Cybernetics.

[2]Bateson, Gregory, "Cybernetic Explanation," pp. 29-32.

[3]Ashby, W. Ross, Introduction to Cybernetics, p. 40.

with an infinite number of variables and therefore is forced to employ statistical averaging and heuristic processing to deal with the number of variables.

The machine itself is a "determinate, single-valued closed system." It is defined as "that which behaves in a machine-like way, namely, that its internal state and the state of its surroundings defines the next state it will go to."[1] The closed system is regular and follows a reproducible course. A system starts at a given state and will pass through a succession of states, as it is a function of the energy operators and the transformational elements. In defining a system, the importance of the "single-value" is evident. To relinquish the single-value element would mean an uncontrollable situation, i.e., the introduction of multi-variables. Since every object has a multitude of variables it also has a multitude of possible systems and changes. The facts concerning the object which are important therefore are only those which bear specific relevance to the problem. In this sense, they are information-giving. Two aspects of change in a machine model and closed system of the cybernetic model are the effects of tension and energy and the process of transformations.

In the closed and machine-model systems all energy quantities (E) are considered to be a function (f) and by-product of two entities, a capacity factor (C) which comprises the information content and an

[1]Ashby, W. Ross, "Principles of the Self Organizing System," in Modern Systems Research for the Behavioral Scientist, edited by W. Buckley, p. 111.

intensity factor which provides a force (F); therefore $E = f(C \cdot F)$. The intensity factor (F) pushes the quantity of information (C) through the transmission channel. In living systems the intensity factor can be related to drive, motivation, adaptation. The degree of tension inherent in the drive is directly proportional to the force of the drive until a state of equilibrium is achieved and the tension is reduced. The amount of tension indicates the degree to which a system is not in a steady-state. Quantification of the tension and energy source is critical in evaluating the impact of the impelled change in the system.

Changes of energy in a system are related to two factors: C and F. Since F serves as a pusher, directing and utilizing the information, it increases the value of the content of the information. The value of information is related to the extent to which it is usable and significant to the system in working through a particular problem; all unrelated material is valueless. The "pusher" must therefore be equipped with a mechanism for selecting the relevant information. The change of energy in the system is then a function of the sum of the value change between the content input and content output.[1]

Illustration: In a closed system, a computer is programmed to solve geometry theorems. The quantity of information input can contain numerous variables. The goal, the solution of the problem, and the value of each variable (the degree to which the variable is necessary

[1]Korein, J., "Towards a General Theory of Living Systems," in Cybernetic Bases of Modern Medicine, Third International Congress of Cybernetic Medicine, 1964, pp. 233-248.

for the solution) both formulate the strategy which pushes the information through the channel to arrive at a theorem.

In a living system, a blind, thirsty girl is told that if she moves eight feet to the right she will come to a table upon which there is a glass of water. The value of this information is only appreciated if in fact after following the instructions she finds the glass of water. The intensity factor is the thirst.

> Thus as energy is utilized, by the living system and changes ($\triangle$E, meaning change of energy), this change is associated with changes in the value system ($\triangle$V), which indicates the direction in which the system will tend in terms of its 'fits' with the environment, and changes in the information content or the amount of organization of the system ($\triangle$C).[1]

This value quotient of changes in energy within the system is essential to the open system. The social scientist can employ this formula in assessing the changes and potential directions a person, culture, or civilization can take.

Transformation is the operation from one state to another; it is concerned with what happens, not with why it happens; as such it is context-free.[2] The transformation can create two states: closed or open. In the former, the new state, after the transformations (T) are applied to the operands (the given state), may not have been altered

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[1]Ibid., p. 246.

[2]Ashby, W. Ross, Introduction to Cybernetics. The context-free process of transformation is also evident in Chomsky's work in generative grammar, Language and Mind (New York: Harcourt, Brace and World Inc., 1968).

from the original, may not provide any new information, or it can show a single-value change or multi-varied change. However, the critical value of the principle of transformation and change is not the multiplicity of changes possible, but the principle of the transformer as operator. A simple example of a transformation is diagrammed in the following manner: if the operator is the square of the given numbers, then the transformation of 1, 2, 3, 4, would be:

$$T_1 \left| \begin{array}{l} 1\ 2\ 3\ 4 \\ \downarrow \\ 1\ 4\ 9\ 16 \end{array} \right.$$

The transformation carries the transfer of patterns from one state to another.[1]

The codification of language in a telegram or the morse code could not exist if it were not for the transformation of information from one media to another; again, the transformation is context-free but acts as the operator. This process of transformation involves mapping; patterns are transferred into a code before information can be stored and used.

A computer program has been developed by Uhr and Vossler that can select units, quite arbitrarily at first, and use them to recognize the patterns.[2] (E.g., problem: computer must be programmed to recognize all K letters which are fed into the computer. These can be typed

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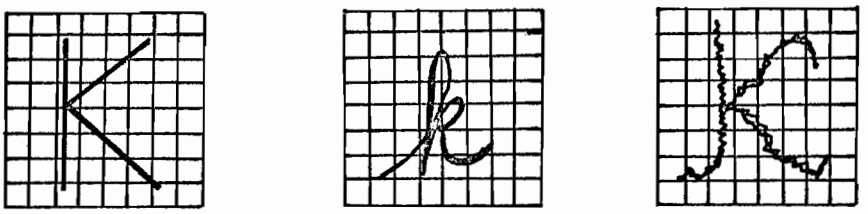
[1]Ashby, W. Ross, Introduction to Cybernetics, pp. 9-23.

[2]Uhr, L., and C. Vossler, "A Pattern-recognition Program That Generates, Evaluates, and Adjusts Its Own Operators," in Computers and Thought, edited by E.A. Feigenbaum and J. Feldman, pp. 251-268.

or handwritten; therefore the degree of variability of each representation must be considered).



grid A grid B grid C

Fig. 10 Variation Grids in Pattern-Recognition Problems of the Letter "K"

The operators which transform the input into "usable" data are, in this case, sample characteristics of the specified letter-patterns. "The program makes use of feedback as to the success of these new operators in mapping unknown inputs in order to increase their effectiveness . . . . The continual replacement of poor operators by new ones then tends to produce an optimum set of operators for processing the given array of inputs."[1] They (Uhr and Vossler) have described a program that generates and composes characterizing functions, or operators, and uses this set of operators to transform an input matrix into a list of characteristics.

Experiments on pattern-recognition suggest that the complexity of numerous independent units can be reduced by the organization and coordination of pattern formations, i.e., abstract con-

[1] Ibid., pp. 267, 253.

ceptions of the units involved. Selfridge and Neisser related an experiment with the Morse Automatic Decode, in which the specific units are transliterated to form meaningful messages. The lengths of spaces and marks are not always similar due to variation in the human operator; a dot in one part of the message can be a dash in another. The information perceived is a function of these variations. "The success of the program depends on the rules by which the continuous message is divided into appropriate segments. Segmentation seems likely to be a primary problem in all mechanical pattern recognition . . . ."[1] The units, in this case, are embedded deeply in the context since they vary in size throughout the entire message. The meaning of a piece of data can vary from context to context, as it is perceived from different points of view. A statement of fact or an action is meaningful only when it is taken in some context. One must remember that it is the process which is context-free.

Three issues are indicated in these considerations of transformation and pattern-recognition: 1. the process of making what would not have been intelligible, comprehensible through transliteration; 2. the segmentation of the information into bits and units to facilitate the process; and 3. the extraction of sets of rules which acknowledge the specificity of meaning as it varies from person to person. There are the operators and the operands in cybernetic models. Man is both the

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[1]Selfridge, O.G., and U. Neisser, "Pattern-recognition by Machine," in Computers and Thought, pp. 237-250.

operator and operand, decoding problems be they in diagnosis of disease, economic geography, or communication between nations or individuals. Once the contextual disparities of the problems are removed, the focalization is on the kernel operations of transformation and base rules of mapping, pattern-recognition, and concept formation. However, one cannot neglect the frame of reference of each participating individual, a factor that is determined in the work by Selfridge and Neisser.

The principle of transformation has been applied to other disciplines and it is important to understand the process as a common denominator. In linguistics, Chomsky has postulated how the principle of transformation operates independently from the content. Chomsky's theory has two salient features: 1. the theory of generative grammar which specified the form of the grammar and structural and operational schema, and 2. the strategy for selectivity such that an appropriate language will be chosen which is compatible to the primary linguistic theory, i.e., explanatory adequacy. The concept of explanatory adequacy serves as an evaluator and regulator.[1] Diagrammatically, Chomsky's theory can be represented (in a simplified version) as in Figure 11.

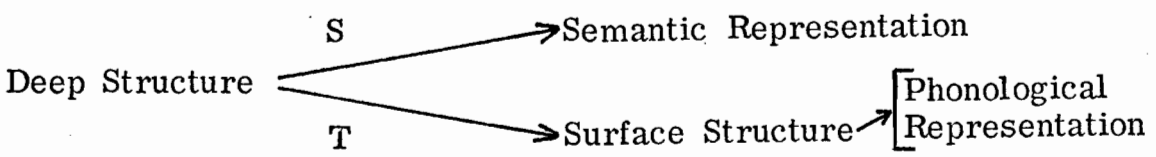


Fig. 11 A Model of Chomsky's Theory of Linguistics

[1]Chomsky, Noam, Language and Mind, (New York: Harcourt, Brace and World Inc., 1968).

The deep structure is composed of the syntactic component which is formed by base rules. T is the transformational component. The surface structure consists of the phonological interpretation. S is the semantic component which is transformational in function and determines the semantic interpretation.

The deep and surface structure of a sentence is represented in Figure 12.[1]

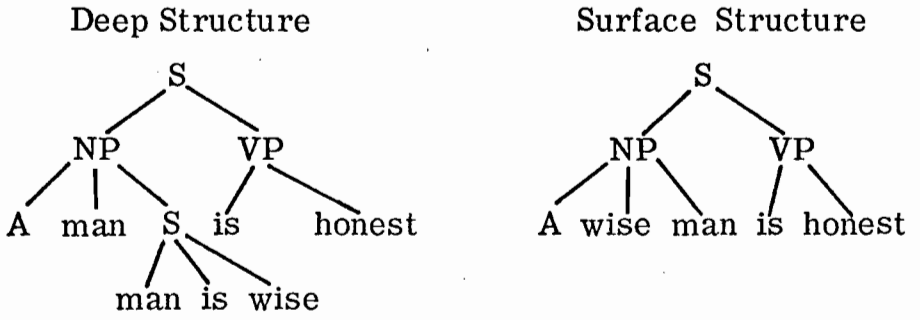


Fig. 12 Models of Deep and Surface Structure in Chomsky's Theory of Linguistics

As in pattern recognition experiments, the transformational rules provide an operational system for mapping the deep structures onto the associated surface structures.

Chomsky's language acquisition model is fundamentally analogous to the models in computer programming and the mechanisms operative in cybernetics:

1. a technique for representing input signals;
2. a way of representing structural information about these signals;
3. some initial delimitation of a class of possible hypothesis about language structure;

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[1] Ibid., pp. 25-26.

4. a method for determining what each hypothesis implies with respect to each sentence;
5. a method for selecting one of the (presumably infinitely) many hypotheses that are allowed by (2) and are compatible with the given primary linguistic data.[1]

Chomsky's language acquisition model synthesizes the major principles of the cybernetic transformation processing and is instrumental for coping with problems in psycho-sociological parameters. Selectivity of variables, restraint factors, codification, and evaluating techniques are critical not only for understanding the viability of the final solution(s) but also for assessing the intrasystem information in terms of meaning and cost: how does each bit fit with each other bit? are the relationships meaningful? what information is discardable in a preferential hierarchy? These operative mechanisms are necessary in large systems when one is only presented with the "surface structure" and one needs to extrapolate the "deep structures."

Another major operative mechanism of cybernetics which has distinguished it from other mechanistic theories is the principle of feedback. With the introduction of many variables into a system, the feedback mechanism serves to integrate and account for the affective change in the system; the system described is a circuitous relationship between the organism and the environment supplying the input. When the universe is linked together by a cause-effect and energy transfer, the result is a completely branching and interconnecting series of

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[1]Chomsky, Noam, Aspects of the Theory of Syntax, (Cambridge, Massachusetts: The MIT Press, 1965), p. 30.

chains of causation which form circuits. The circuits are closed in the sense that they can be traced back to the causal point within the system. Any point along the circuit is expected to effect all positions, be they the original states or states at a later time. However, the circuit is not free from external influence and the circuit, in turn, can effect this external system. If a variable is subject to a random change, the effect on the circuit is not random, it is dependent on the following sequences of the circuit as it returns to the original point. A model of a feedback mechanism is illustrated in Figure 13.[1]

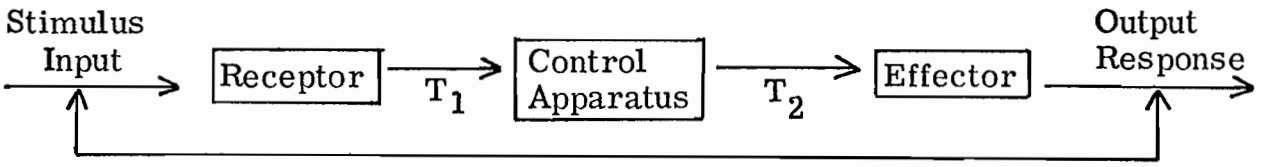


Fig. 13 A Model of the Feedback Mechanism

In cybernetics, the principles of positive and negative feedback are different than in behavioral psychology. In the latter positive feedback refers to reward and a continuation of the rewarded behavior; negative feedback is associated with punishment and the extinguishing of behavior such that a new means of behavior has to be found. In cybernetics these concepts have a different meaning. If a thermostat (a governor) of a steam engine has a stabilizing influence on some quality in the system (e.g., heat, speed), this feedback control is defined as negative. Regardless of whether or not the thermostat must

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[1]Bertalanffy, L. V., "General Systems Theory, A Critical Review," p. 16.

correct for an up or down movement in the engine, it is the error factor which is being controlled.

Unlike the principle of negative feedback which is stabilization, the positive feedback principle in cybernetics has a catalytic effect to speed up a process, either up or down. In a chemical reaction, the chain reaction gains momentum and can end in an explosion as in the atom bomb, or in reverse, if a business is not prospering, the inability to pay off creditors, meet wages, or procure funds for merchandising accelerates the failure of the business.[1] Negative feedback is important as a means of maintaining the stability of the relationships. Positive feedback leads to change — the loss of stability or equilibrium. In both instances, the system's output is reintroduced into the system as information.

Although change, transformation and feedback comprise the skeletal operational components of the cybernetic system, the principles of stability, equilibrium, and constraint are complementary components. Stability is desirable and the degree of stability suggests the flexibility of the system when presented with new input.

> Given such a state or set of states and some particular disturbance we can ask whether, after a disturbance, the system will return to its initial region. And if the system is continuous, we can ask whether it is stable against all disturbances within a certain range of values.[2]

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[1]Ashby, W. Ross, Introduction to Cybernetics, pp. 80-81.

[2]Ibid., p. 85.

The principle of stability and equilibrium is different for closed and open systems. Stability is the ultimate goal for a cybernetic system; for a living system, stability can mean death.[1] In lieu of this difference, the concept of equilibrium and stability is discussed as an operational processor and one must keep in mind the definitional discrepancies between the two systems. The important phenomenon, intrinsic to the principle of stability, is the concept of control and regulation.

Piaget's definition and application of the principle of equilibrium is helpful in understanding the cybernetic reference in a living system. "Equilibrium is an overriding principle of mental development in the sense that all mental growth progresses towards ever more complex and stable levels of organization."[2] Genesis, for Piaget is integrally related to equilibrium; it is "a relatively determined system of transformations comprising a history and leading in a continuous manner from state A to state B, state B being more stable than the initial state and constituting an extension of it."[3]

Illustration: A child is given two glass containers; one container is tall and thin, the other short and wide. The short container is filled with water, a little more than half. The adult pours the water from the short container into

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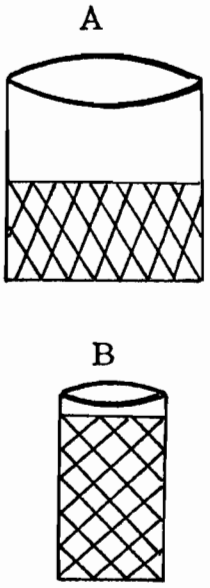
[1]Wiener, N., Cybernetics : Or Control and Communication in the Animal and the Machine, 2nd ed., (Cambridge, Massachusetts : MIT Press, 1961).

[2]Piaget, Jean, Six Psychological Studies, p. xxii.

[3]Ibid., p. 144.




the tall glass and asks the child if the amount of water has changed. At age 3-4, the child states that the amount of water has changed, he sees the change as a perceptual phenomenon, conditional upon an egocentric perspective. At age 9+ the child can reason that the volume of water has not changed, the change in water level is due to the different shape of the second glass. The second stage illustrates that the child is able to objectively evaluate reality and not perceive objects as a function of subjective intuition. At this stage the child has reached a new level of equilibrium, state B, which is steadier than state A. At a later point state B can evolve into state C.

The stability in a living organism is referred to as its equilibrium potential. The stabilizing process is comprised of an ensemblage of operations of organic regulators that maintain the steady-state. If the organism is goal-seeking, a state of stability might not be the original state but a higher level in which the problem is satisfied. The introduced stimuli is responded to in such a way that the organism reaches a new level of equilibrium. "Every very complex organization must have more or less effective self-righting adjustments in order to prevent a check on its functions or a rapid disintegration of its parts when it is subjected to stress.[1]

The degree to which the organism's equilibrium is maintained is called the organism's "survival capacity."

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[1]Cannon, Walter B., "Self-Regulation of the Body," in Modern Systems Research for the Behavioral Scientist, edited by W. Buckley, p. 258.

Illustration:

A can exist in various subsets: $A_1$, $A_2$, $A_3$ ..... $A_n$. Introducing a disturbance (D) if D interacts with A (D⟶A) and the outcome is A or a subset of A, then A has survived. If A always survives the operation D ($A_n$), the A system is not disturbed in its stability state by the intrusion of D.

The degree to which A could be blocked by D is critical to the functioning and regulation of set A. (This example does not exclude the fact that D can be incorporated into the system, provides new information and is reintroduced into the original set in a feedback mechanism.)[1]

The following diagram illustrated the regulatory mechanisms in the problem of variety and disturbance.

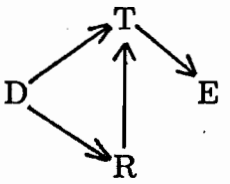


Fig. 14 Ashby's Model of Variety and Disturbance

A table T is given. There are sets of disturbances (D) that act upon T. If the regulator (R) does nothing to compensate or account for D, the essential variables (E) are driven outside of the proper range of values. The value E corresponds to the outcomes of the previous sections. Of all the E values, only a few are acceptable (n) to the system. The R must integrate the E with D so as to maintain a system

[1]Ashby, W. Ross, Introduction to Cybernetics, p. 197.

within acceptable limits. The problem of control is therefore stringently related to the regulator.[1]

The total organization of the system is based on the principle of conditionality, the outcome C is totally dependent on the interaction and regulation of A and B. As a self-organizing system, it changes from a state in which the parts are separate to a state in which the parts are coupled and interrelated. The possibility product for the system and comprehension of the "Black Box" by the observer is conditional upon the real world of what actually is, the constrained subsets, and the observer's subjective perspective of the problem.

The stability and equilibrium are directly correlated to the system's ability to regulate variables. In relation to the control of variables is the principle of constraint, "a relation between two sets, and it occurs when the variety that exists under one condition is less than the variety that exists under another."[2] Thus the constraint reduces the number of possibilities in a set. Given a jigsaw puzzle piece, the positioning of the specific piece is directly correlated to the shape and size (the number of variables) of the other pieces. In considering a problem, cyberneticians consider all the possibilities and then ask why the actualities should be restricted. If in fact the machine protocol showed no constraint, it

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[1] Ibid., p. 210.

[2] Ibid., pp. 206-218.

would function like a roulette wheel. Through constraint principles, the observer can re-code a program consisting of two major principles: a statement of actual input and a statement of the transformations. Rather than having a lengthy program, one can constrain it through heuristic processes and succinct transformations in finite steps.[1]

A critical feature of a good regulator is that it "blocks the flow of variety from disturbances to essential variables."[2] The disturbance, unless it bears information is considered noise and increases entropy. These two concepts are discussed in the section on information theory. The principle of entropy is directly responsible for the lengthy discourse and experimentation the cybernetician has developed in theories of constraint, conditionality and regulation.

In summary, one cannot overemphasize the significance of the cybernetic system as a methodological model for structuring the epistemological phenomena of our world. The operational mechanisms provide continuously dynamic quantifications and qualifications of an enigmatic universe, at best hopefully explainable, and at least allowably confrontable.

Operative Mechanisms as Applied to Computer Models

The computer, as an organism, has two invariants: structural and operational. These two invariants are referred to as the heredity

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[1] Ibid.

[2] Ibid.

factors. Capacities to operate are defined by the limitations of the computer's structural heredity (e.g., amount of information, storage, memory bank, pre-programmed state). The functional heredity factor imposes specific and necessary, and irreducible conditions and relations which direct and assist in structuring and restructuring data as it is programmed by means of these generative rules. The two main features of this system which are interdependent are organization and adaptation. Both are involved in the formation and processing of internal structures of behavior and the interaction between the organism and the environment. Environment for a given system is "the set of all objects a change in whose attributes affect the system and also those objects whose attributes are changed by the behavior of the system."[1]

The computer processing system has a schema which incorporates both structure and operation. As in cybernetic models, it is a goal-directed system (the goal could be merely to stabilize itself) which needs to make decisions and regulate the data through processing. The schema consists of the input data, the goal, the strategy in terms of plans to attain the goal and the actual transformational operations which are a function of the strategy. There is a cyclic regulating system in which the operational schema arranges the elements into categorizations and these structured relations become, in turn, the new allocating schema.

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[1]Hall, A.P., and R.E. Fagen, "Definition of Systems," in Modern Systems Research for the Behavioral Scientist, edited by W. Buckley, p. 83.

Within the schema are two main features: the first is conservation (assimilation), a process of subordination of the environment to the organism, and the second is progression (accommodation), a changing process which bends the organism to the constraints of environment.

Piaget defined the process of organization and adaptation as a function of assimilation and accommodation. Organization involves the formation and processing of internal structures of behavior and adaptation is concerned with the interaction between the organism and the environment resulting in changes which equilibriate the organism and the environment. Piaget attributes the operational system to the function of adaptation, a perceptual process of assimilation and accommodation. Assimilation is the process that incorporates the information with the existing schemas. Operationally, this is comparable to the process of classification, ordering, and linking with previously stored data after the input of new information in the computer. Accommodation is the procedure which expedites a change in the behavior because of the "pressure" of the external stimuli. It is almost impossible to distinguish the point at which one operation stops and the other commences in the computer; they appear to enmesh at specific points of each stage. Accommodation is defined, in terms of the computer, as those processes which transform the incorporated and assimilated data, evaluate the new information and extend the modifications to meet the demands of the desired goal,

i.e., the requirements of the external world.

These two concepts (assimilation and accommodation) have been discussed in relation to social work as means by which the person can adapt and change to problematic issues. The former is exhibited in the manner in which data is codified into units of information. With the infinite variety of variables, methods of establishing a language vehicle are essential.

Reitman with his information processing language (IPL-V), has developed an efficient method of keeping relationships between objects and variables in memory without any wastage of space.[1] This means that new information can be added to related information in a memory store without having had to leave space for it. Yntema and Mueser discussed grouping as a facilitator in remembering several variable states.[2] In the mechanical reader a method is devised to assimilate the specific units through a matching process related to a series of ideal-templates. Another process, the sequential processing system in which the features are inspected in a predetermined order — the outcome of each step predetermining the next procedure, indicates how relations between units can be acquired in pattern-recognition.

There do exist fundamental units in human behavior and in computer organization. The binary unit is the basic element in the computer

[1]Reitman, W.R., Cognition and Thought, (New York: John Wiley and Sons, 1965).

[2]Yntema, B., and G. Mueser, "Keeping Track of Variables That Have Few or Many States," J. of Experimental Psychology, (Vol. 63, 1962), pp. 391-395.

model; but machines that require all programming to be done by binary code are inefficient from the point of view of the programmer. For this reason new and easier programming languages are being developed, allowing the programmer to refer to a whole subroutine of instructions with one line. Yet while the programmer takes full advantage of this system the actual machines in general do not; for while they do store instructions in capsuled form, they are generally stored in binary code since 1) all instruction data must be reduced to that anyway, 2) to store data in decimal or even hexadecimal code is more bother than it is worth, 3) the storage space is theoretically infinite. The important matter, however, is not whether many instructions can be substituted by one statement, but the operative mechanisms which deal with the instructions.

Thus, one is defining units in a purely empirical manner, with reference to their respective efficiency. It should be remembered that just as more basic units must often be grouped to enable facility in using them, large units sometimes are too bulky and must be broken down . This point is very important for an organism cannot internalize information unless it can code its useful units. The more appropriate the coding, the better and faster techniques, allow the organism to deal with more information.

The "set" is an important corollary to the "language system." It is defined by Newell, Simon and Shaw in describing the Logic

Theorist (LT).[1] The set is"a readiness to make a specified response to a specified stimulus"[2]as it is related to already formulated programs and governs the sequence of operations in which data and patterns are examined and tested. The "set" integrates the program with the transformation processes and provides the basis for the accommodating processes to create new information.

For clarification of cybernetic theory as it relates to computers, suppose we have a robot which is presented with a problem: the mapping and understanding of interactions in a group (be it a business, therapy, social or mob-gathering group) as it relates to violence and aggression. The robot must recognize that it has a problem and be "motivated" to adopt some goals in connection with solving the problem. Factors that block the achievement of the goal must be identified and ways of removing these blocks be devised. The robot must move from a recognition of the problem to a description of the situation that would solve it. This process involves stating the solution abstractly, evaluating the different variables, factoring the variables into subsets to simplify the problem and establishing a strategy for solution.

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[1]The Logic Theorist (LT) is a model which is capable of transforming units of information to discover proofs for theorems in symbolic logic. The LT acquires a program which involves a sufficient set of elementary processes arranged in an effective strategy to be able to efficiently produce the result. Success to a large extent depends on the order of the tasks presented such that a hierarchical system from subgoals to goals is created. The set serves to govern the sequence of the steps in which the data and patterns are examined. Newell, A.; H.A. Simon; and J.C. Shaw, "Elements of a Theory of Human Problem Solving," in Readings in the Psychology of Cognition, edited by R.C. Anderson and D.P. Ausubel (New York: Holt, Rinehart, and Winston, 1966).

[2]Newell, A.; H.A. Simon; and J.C. Shaw, "Elements of a Theory of Human Problem Solving," p. 145.

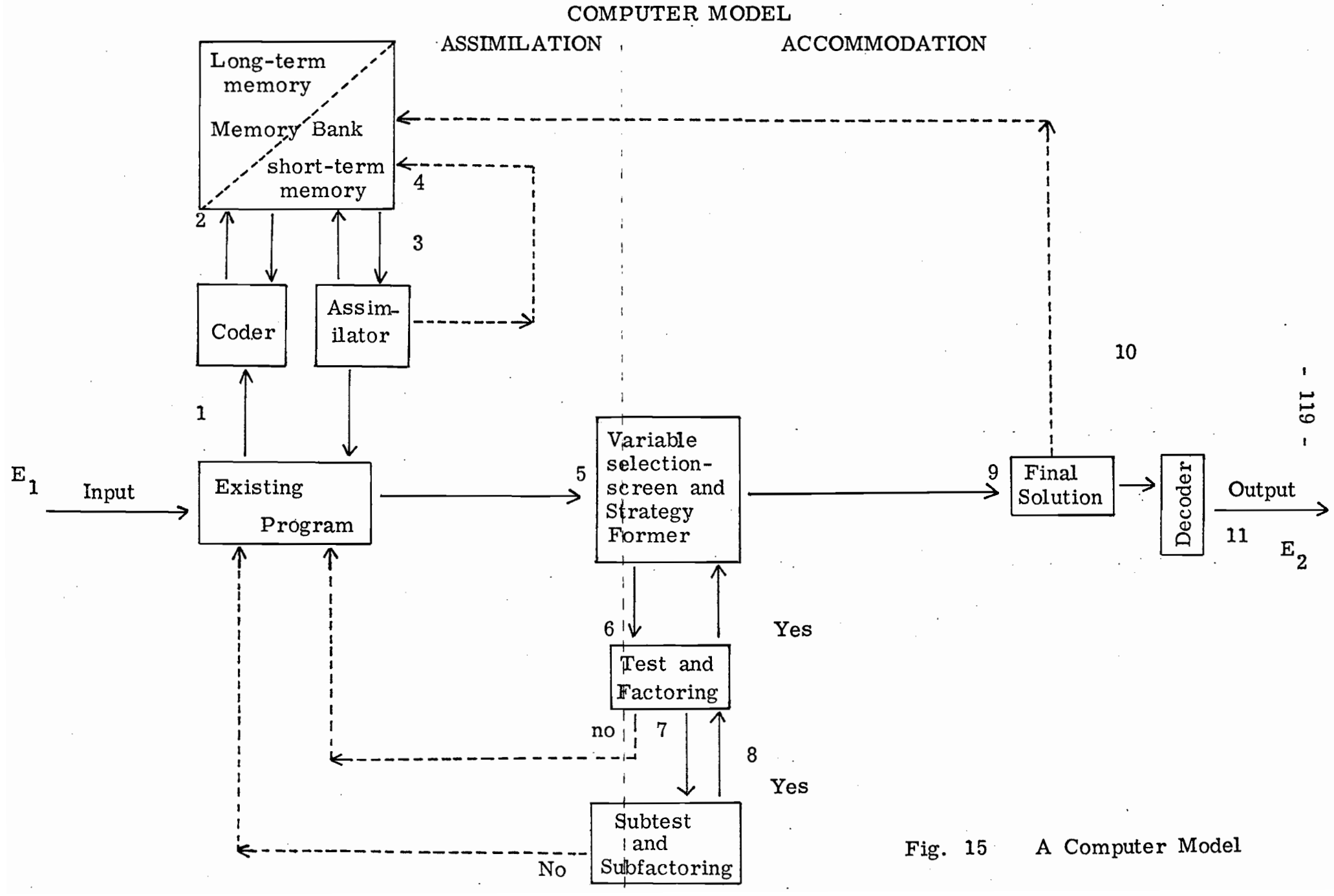


Fig. 15 A Computer Model

Explanation for the diagram of the computer model:

1. The new information stimuli enters the computer (input) and is coded into a system of symbols or "shorthand," "bits" of information.

2. The memory bank is searched for all pertinent information which the computer has previously programmed.

3. The information from the memory bank is assimilated with the new information and the existing "state" of the computer.

4. As the process of information assimilation (directed upon the input coded data, retrieved information, and existing program) creates new combinations, this information is then stored in the memory bank for use at another time.

5. The information is then screened through a selector, evaluating the variables and forming a strategy.

6. Tests and subtests are performed upon the information and the problem is factored into smaller problems; the solutions of the smaller problems are then reapplied to the main strategy (the feedback mechanism).

7. If the subtest proves to be a failure, the computer is directed to return to the starting point and begins the process again.

8. If the subtests are successful, further tests can be made; with similar reactions to a yes/no answer.

9. A final solution is made.

10. This final solution is channelled to return to the memory bank as new data (this return to the memory bank is referred to as the "feedback loop").

11. The final solution is decoded and emitted from the computer as output data.

To the left of the red line, the computer operates on the principle of assimilation in that all the information is synthesized into the "organism." This process has also been called conservation.

To the right of the red line, the computer accommodates the information to the demands of the external environment, i.e., the problem, thus creating a change in the process as it reaches a solution and therefore a new state of equilibrium.

The entire process is controlled by the principle of equilibration. Mechanisms of calibration judge whether or not an act satisfies a problem in order to eliminate unnecessary searching, to be able to put an end-stop to action such that one will not continue to look in blind directions.

In computer approaches the emphasis is on control, how to regulate the system, and operations to reach the goal, an equilibrium plateau, or a state of "negentropy." The actual problem controls the plan by specifying what variables are or are not relevant to the solution.

One computer approach executes its plans through sets of possibilities in a test-operation-test-exit (TOTE) sequence as delineated by the TOTE unit of Miller, Galanter and Pribram.[1] The system, which is basically a trial and error process is dependent upon the feedback loop. This feedback loop process serves as a negative or positive reinforcer as it either maintains or expands the relationships of the new states with the initial states. In the TOTE unit a plan controls the sequence of operations. Miller, Galanter, and Pribram defined plan as any hierarchical process in the organism that can control the order in which a sequence of operations is to be performed. The plan is not separate from the image; the latter is all the accumulated knowledge that an organism has about itself and the world which it brings to the plan. Changes in either plan or image can be effected only by changes

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[1]Miller, G.A.: E. Galanter; and K.H. Pribram, Plans and the Structure of Behavior (New York: Henry Holt and Co., 1960), pp. 30-38.

in the other. These changes are performed by transformations. As the test is carried out, each operation needs to be evaluated as to whether or not it is good. This evaluation mechanism helps to push plans along "grooves" towards the solution.

In Figure 16 one can follow the TOTE system for hammering a nail.[1]

In summary, by tracing the processes of the computer, the highly constraining techniques and implementation of cybernetic principles are evident. One seeks information, negentropy, and can only achieve this goal through steering a system in order to maintain organization. The steering mechanisms provide the skeletal structures which generate change through growth in the system. Although the individual cannot be as "programmed" as the computer, he can institute these methodological approaches in his own problem-solving; the goal, therefore, is to seek information.

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[1] Ibid., pp. 34-36.

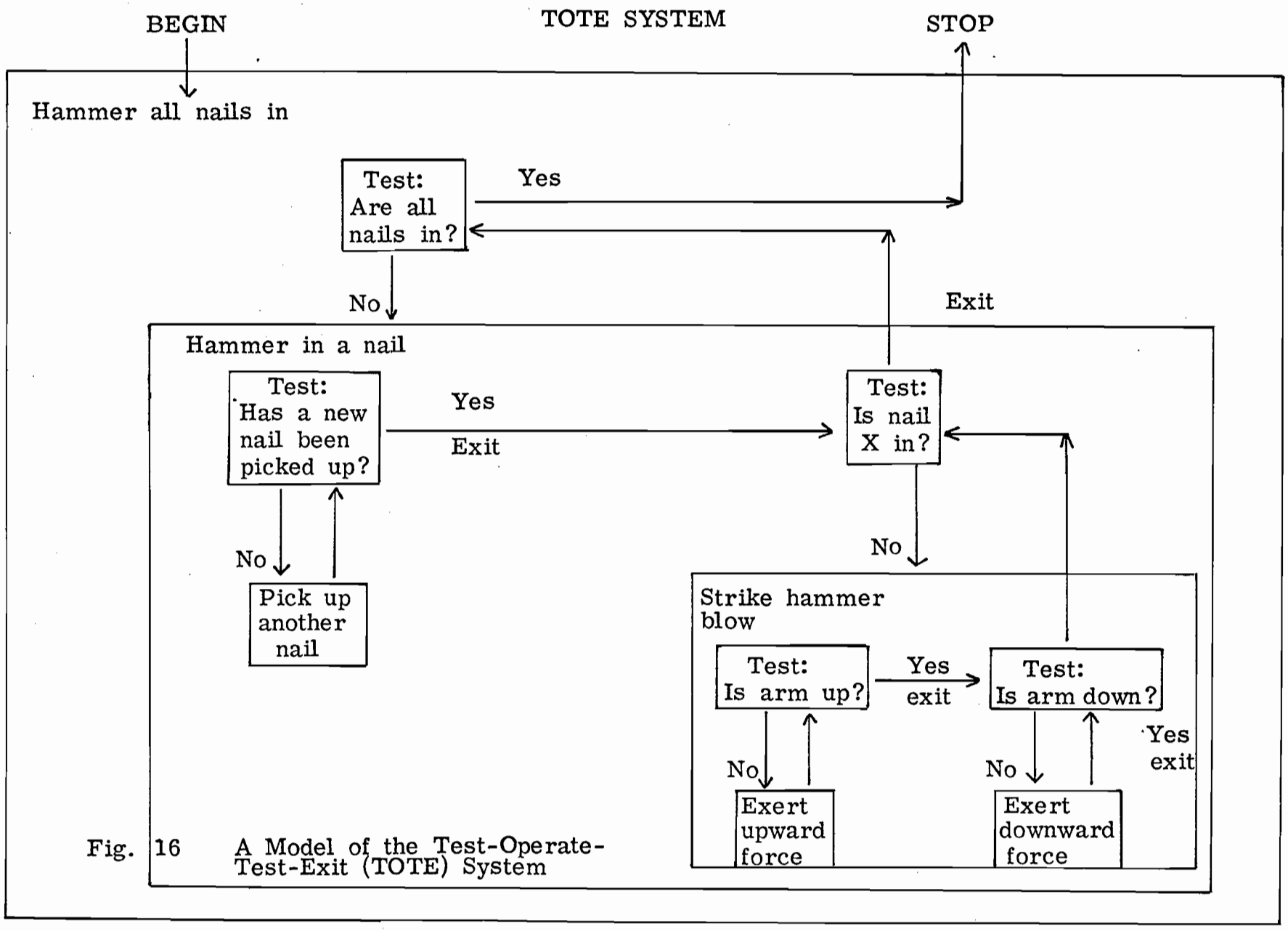


Fig. 16 A Model of the Test-Operate-Test-Exit (TOTE) System

Information Theory : The Mathematical Theory of Communication

Information Theory introduces the concept of information as a quantifiable and measurable entity and the principles involving the transmission of this information. It is fundamentally concerned with "what" is transmitted, using the cybernetic model of operations to explain "how." Information theory, coupled with the cybernetic model, has extensive application to communication systems beyond the engineering disciplines.

G. A. Miller explained the importance of studying information theory and its application in psychology by stating:

> Information Theory provides a yardstick for measuring organization . . . . A well organized system is predictable — you know what is going to exist before it happens. When a well-organized system does something, you learn little that you didn't already know — you acquire little information . . . . The more disorganized and unpredictable a system is, the less information you can get by watching it. Information, organization, and predictability room together in this theoretical house. The key that unlocks the door to predictability is the theory of probability, but once this door is open we have access to information and organization as well. [1]

The formalized theory of information principally originated from the work of Shannon and Weaver in 1948 and 1949. However, there had been considerable work in this field previous to Shannon's more formalized presentation. For example, the concept of telegraphy introduced the idea of the speed of transmission of information and the problems of

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[1]Miller, G. A., Mathematics and Psychology (New York: John Wiley and Sons Inc., 1964), p. 171.

empressing signals and quantifying information. As early as 1267 Roger Bacon theorized that a "certain sympathetic needle," i.e., a lodestone could be used for distant communication.[1] In 1746 Watson, in England, transmitted electric signals over wire. With the development of the telephone and television, techniques to handle instantaneous sound and picture transmission had to be perfected. The problem of "channel capacity," how much information could the channel transmit before it was "jammed" or before it was supersaturated and efficiency decreased, became a critical issue for the theorists. This disturbance of information transmission is generally referred to as noise. Noise becomes the ultimate limiter of communication.[2] There are therefore two important aspects of information theory that were developed prior to Shannon: the concept of speed transmission and the problem of information capacity and noise within a system. The interrelationships between the sender, the transmission channel and the receiver became the primary factors in the analysis of information processing, the quantification of the speed of transmission, and the control of noise.

Gabor's work in "scientific information" has significance in what is known in social work as content-analysis, especially illustrated in the work by Berelson in "classical content-analysis."[3] On a purely scientific level, Gabor demonstrated that the physical perception of

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[1]Cherry, Colin, On Human Communication, p. 42.

[2]Ibid., pp. 176, 198.

[3]Supra, p. 76.

sound is simultaneously one of time (duration) and frequency (pitch). Therefore, the basic elements of signals such as speech must be analysed as finite in reference to time and frequency. This finite base is considered to be the smallest unit of structural information, and, according to Gabor and other information theorists, is the proper base for studying information.[1]

The smallest unit of information is the "bit" (BInary digiT). In quantifying information, especially in complex systems when the variables are extremely large, the information is measured in terms of bits and averages. For an example, any message transmitted from one person to another could be translated into a binary code, a yes/no series. Each word could be identified by a 1 (yes) or 0 (no) symbol. The words would be represented as 10111010001010. One could ask yes/no questions; "is it in the first half of the dictionary?" Given the answer yes, one could then ask is it in the first half of the first section?

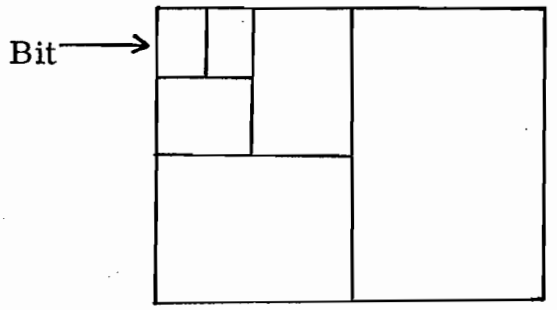


Fig. 17 Successive Partitioning of Probability Space : the Binary Digit

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[1]Cherry, Colin, On Human Communication, pp. 44-46.

Each time the number of alternatives is reduced to half, a unit of information is gained. This unit is the "bit" of information. If a child is told that one of 20 containers is filled with beads, the opening of each box has 20 possibilities; but if he is told that the beads are not in any of the red containers (assuming there are several colors) the child has more information and the probability of success is higher.

Shannon's work in information measurement has crystallized many previous theories and problems in communication theory. His major contribution has been his work in relation to the maximum capacity of a communication channel in the transmission of information. The mathematical formula for measuring capacity is the "greatest rate in binary digits (bits: yes/no decisions) at which the channel can transmit per second but not exceed as the coding is improved." There is a distinct limit that a system cannot exceed. Efficiency and accuracy of transmission is a function of the 'limiter'."[1]

> In telegraphy for example, the messages to be transmitted consist of sequences of letters. These sequences, however, are not completely random. The letter E occurs more frequently than XP, etc. The existence of this structure allows one to make a saving in time (or channel capacity) by properly encoding the message sequences into signal sequences using the shortest channel symbol, a dot, for the most common English letter, E . . . .[2]

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[1] Ibid., p. 52.

[2] Shannon, C.E., "A Mathematical Theory of Communication," in Language, edited by R.C. Oldfield and J.C. Marshall, (Middlesex, England: Penguin Books, 1968), pp. 257-262.

In general, communication processes are concerned with an information carrying commodity in some form of network. In mathematical systems, the commodity can take any form: an electrical impulse, a code, language, or numbers. In human communication systems the commodity can be represented through several media, e.g., language, gesture, art, music, or dance. Regardless of the different forms of commodities, there are some components basic to all communication systems: the transmitter or source, the channel or transmission network, and the receiver. The restriction in commodity capacity is extremely relevant when one views communication exchange in terms of the human being as transmitter and receiver. This model is diagrammed in Figure 18.

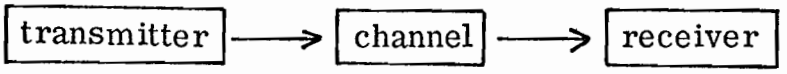


Fig. 18 A Simplified Model of Information Transmission

There can be more than one transmitter in a system and the critical aspect of the system is how the channel is able to organize efficiently, code, and decode to formulate a high-information-giving network. To evaluate the information network, one needs to deal with the source rather than with specific messages to know how much information the source can generate. The measurement is extremely difficult and can be done mathematically in electrical or engineering

closed systems; however, the principles are transferable to other systems.

In the communication model, the source is the sender; it selects and transmits signals or symbols. The selection can be at random or based on some statistical rule as in an engineering systems. It has been suggested that information is derived from a sequence of selected symbols. If each word or symbol is equiprobable and one had to be selected at random, the quantity of information would be part of each selection. For example, the selector could choose any letter from the alphabet which is then picked up and transmitted to the receiver. The actual performance of the intermediary channel could also be based on laws of change.

> If the source transmits a symbol say A with a probability of P(A) and the channel lets through letter A with a probability denoted by P(A/A), then the probability of transmitting A and receiving A is:
>
> $$P(A) \cdot P(A/A)$$ [1]

The channel can be "lossy, a part of the transmitted commodity does not reach its destination or it reaches the destination in a distorted form.[2] There can be interference in the channel, i.e., noise, which is distracting. An important aspect of communication is reducing this distortion and loss of information. This loss of information is

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[1] Reza, Fazlollah M., An Introduction to Information Theory (New York: McGraw Hill Book Co., 1961), p. 3.

[2] Ibid.

called entropy and must be accounted for, understood, and compensated for, if possible.

An encoder transformer is often employed as a means of reducing noise and loss. A message, once encoded, is less susceptible to interference because of the concentration and focalization. If a message has been encoded, it must be decoded into an intelligible form before reaching the receiver. This encoding is similar to the process of mapping, previously discussed.

Diagrammatically, the information transmission process is expressed in the following manner:[1]

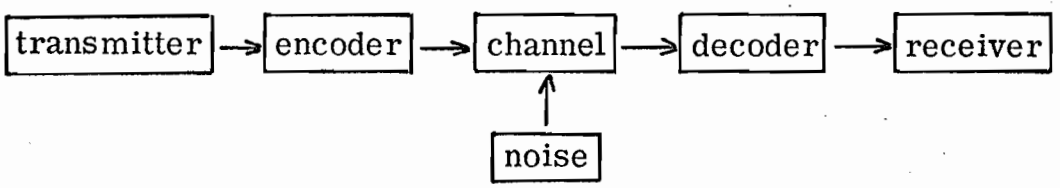


Fig. 19 A Model of Information Transmission Considering the Noise Factor

In working with statistical models (and human communication systems) one main feature is the unpredictability — one has no knowledge of which messages are going to be sent or in which order from a prespecified network of messages. One can know, statistically at any rate, the probability of the transmission of each message. In searching for a measurement, therefore, one searches for a probability scheme which gives averages. In measuring information probability

[1]Parry, John, The Psychology of Human Communication, p. 28.

one must find the most suitable unit with which to measure.

This problem can be illustrated in the problem of ordering an article from a catalogue. One wants to order a television (x). There are $x_n$ possible number of televisions and the one specified is $x_3$ ($x_1$, $x_2$, $x_3$, . . . . . $x_n$). To order television $x_3$, the necessary information to be transmitted is $I(x_3)$. The probability (P) of choosing $x_3$ is a function of (f) $Ix_3$ and $x_3$ . . . . $I(x_3) = f(P\ [x_3]\ )$.

The probability associated with the selection of a message is P(x). The phenomenon of probability in the communication of variables is extremely important in predicting the information commodity transmitted to the receiver. If a source transmits messages $x_1$ and $x_2$ the respective probabilities are $\lambda$ and $1-\lambda$. If x is transmitted the probability of a proper reception is a or 1-a.

> In short, with each probability scheme we associate an entropy which represents, in a way the average amount of information for the outcomes of the scheme. When a source and a receiver are connected via a channel, several probability schemes such as conditional joint probabilities have special significance. An important task is to investigate the physical significance and the interrelationships between different entropies in a communication system.[1]

The measure of information is therefore related to the numbers of equiprobable states of a system before and after the information is received. The purpose of information theory is, therefore, to decrease uncertainty and entropy.

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[1]Reza, Fazlollah M., An Introduction to Information Theory, p. 10.

In terms of probability and relationships in communication theory, the interdependence of these phenomena can be appreciated in the following example. Three men, X, Y, Z, have to choose between two objects, a and b. There are 8 possibilities: aaa, aab, abb, bbb, bba, baa, aba, bab. The object is to predict which choice will be made by the three men. If we know that X's and Y's choice is highly correlated, we have more information as to the outcome and we can predict fairly accurately what Y will do after X.

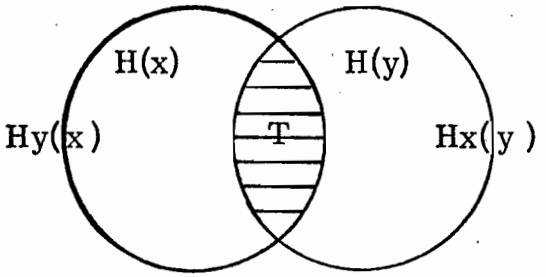


Fig. 20 Miller's Model of Overlapping Sets

The left circle is the information one receives from x (individual, group or society) and similarly the right circle is the amount of information one receives from y (individual, group or society). H(x) and H(y) represent the organization of the interaction of the groups x and y respectively. The overlap T is the information common to x and y and the average amount of information in bits. T represents the measure of correlation, the contingency and dependency between x and y. Hx(y) and Hy(x) are the mutually incompatible or irrelevant interactions (norms or values) for each relative to the other. If x is the source of input information and y the source of the output of information, precisely because x and y are correlated the information that becomes transmitted is the overlap-information common to both. One would

therefore have to compute T to know the quantity of information transmitted. In a stimulus-response model, x is the input stimulus and y is the response output, and T is the measure of the degree of dependence and interaction between x and y.[1]

In the preceding figure, T is also the measure of redundancy. The concept of redundancy is integrally related to the principle of probability. If a person makes a statement that is quite common: "It is spring, the snow has . . . . . ." one might complete the sentence by the word "gone," "melted," "disappeared;" but one would not choose a word such as "green," "tulip," "come," "increased." The number of possible choices is reduced when the completing word bears some information identical to the preceding information and when the antecedent's construction is patterned to allow successful "guessing." The repetition of information is called redundancy; however, the more redundancy necessary in a system, the less efficient it is because very little new information is imparted.

The concept of redundancy is derived by considering the maximum information that can be given in a system and then being able to reduce the total information quantity through the knowledge of information of the surrounding patterns. For instance, if one sees the top of a large building, one can guess that there is a foundation under ground; the former gives information of the latter, i.e., is redundant. Redundancy is also a way of demonstrating the relationship between the message and the

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[1]Miller, G.A., Mathematics and Psychology, p. 180.

referrent.[1] The omission of information forces one to guess but with assured predictability. If omission is too great however, the result is information-suppression and ambiguity.

Information theory, in an abridged account, presents four major axioms:

1. Information [is] a measurable physical quantity which is related to and transmitted by patterns of energy and matter;

2. Information is related to thermodynamic entropy . . . and is identical to negentropy;

3. The quantity of negentropy or information is a measure of the organization of a system, i.e., the number of equiprobable states of the system. This measure of organization of a system [is] the information content of the system;

4. All living systems have a variety of mechanisms which obtain, process, store, and utilize information from their environment and from their internal state . . . .[2]

This discussion has presented some of the fundamental principles of information theory in a closed system; the human being is a living, open system. Since the human system is open, the content of information varies. The energy and/or matter which enters the system is the input. The brain becomes the channel which structures, stores, processes, organizes, transforms the data into information, and transmits this information to the receiver; it is the control system. Korein has diagrammed the open system of the human organism in terms of information theory as the organism reacts interdependently with the external environment and operates to control entropy.

[1]Bateson, Gregory, "Cybernetic Explanation," in American Behavioral Scientist, p. 31.

[2]Korein, J., "Towards a General Theory of Living Systems," p. 237.

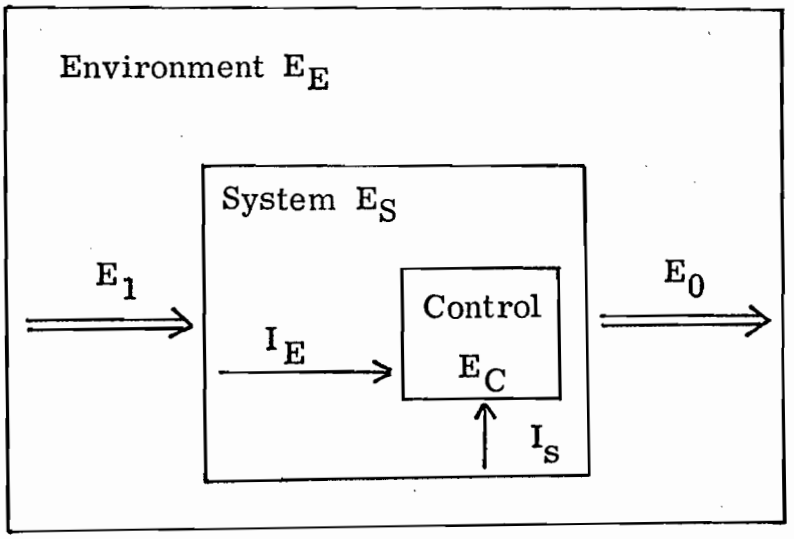


Fig. 21 Korein's Model of a Living System : The Relationship Between the Control of Entropy and Information

Key

$E_E$ = entropy of environment

$E_S$ = entropy of system = information content of system

$E_C$ = entropy of control subsystem = information content of control system

$E_1$ = entropy of energy and matter entering system

$E_0$ = entropy of energy and matter leaving system

$I_E$ = specific information about environment to control system

$I_s$ = specific information about system itself to control system

$I_E + I_S$ = information input to control system

If $E_0 > E_1$, then $E_S$ may decrease while $E_E$ increases.

The diagram indicates the negative correlation between entropy and information, i.e., the greater the degree of entropy the smaller amount of information. The "Information input to control system" $\lceil I_E + I_S \rceil$ is essential to restrict the entropy of the system. It is

desirable to maintain "negentropy" in the organism even if this means an increase of entropy in the environment. However, due to the feedback loop, the increase in the output of entropy is reintroduced into the system, and is decreased through the control regulators. Yet what is discarded as $E_0$ is the valueless or superfluous data, or that which does not emit information. The conversion of information theory as a technical method in analysing the transmission of information in closed systems to an instrumental formula for analysing human communication systems in which meaning and semantic theory is extremely important is critical and problematic.[1] The quantity and statistical measurement of bits of information have seemingly little significance when one wants to comprehend the semantic value of an interchange. The bit, as such, does not have "meaning;" human interchange is a function of meaning. Information theory viewed as uncertainty reduction in statistical analysis versus meaning-impartation in human systems suggests a broad gap between a mathematical and human approach to communication.

Yet the major concern in semantic discourse is the degree of ambiguity; communication in human exchanges depends on the elimination of ambiguity, uncertainty, and paradoxical exchanges which create confusion and misrepresentation. . To avoid ambiguity and uncertainty in mathematical and human approaches two primary criteria are the principles of redundancy and selectivity. To examine the selection, one must also examine the entire set which includes understanding all

[1]Ibid., p. 239.

the relationships and patterns; it is the process of making uncertain information certain. Although one cannot measure accurately the conveyed information in conversation, seminars, rallies, news media, one cannot deny the significance of noise, redundancy, probability and variability. Therefore in comparing the closed system with the open systems one needs to consider the processes involved and the underlying structural principles.

In comparing the two uses of information theory, it is also necessary to consider what occurs as a result of the failure of information due to interference, poor transmission and differences in the sender and receiver networks. Questions that arise are: What makes communication possible? What can destroy communication? What occurs once communication is thwarted?

Shannon and Weaver, in considering the various implications for studying information communication, suggested the following areas for investigation.

1. Technical. How accurately can symbols be transmitted?
2. Semantic. How accurately do transmitted symbols convey the intended meaning?
3. Effectiveness. How effectively does the received meaning influence conduct in the way desired?[1]

These three subdivisions of communication studies have been compartmentalized into the syntactic (relations between signs), semantic (relations between content-qualities, i.e., meaning), pragmatic (relation between

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[1]Parry, John, The Psychology of Human Communication, p. 28.

signs and users' behavior) studies of communication. It is the latter two to which social work addresses itself as it applies the basic principles of the first phenomenon.

Summary

Wiener, in defining the intention of the study of cybernetics, alluded to the methodological basis of the discipline, that cybernetics is a technique for organizing and understanding knowledge, for studying the "Black Box."

> It is the purpose of cybernetics to develop a language and technique that will enable us indeed to attack the problem of control and communication in general, but also to find the proper repertory of ideas and techniques to classify their particular manifestations under certain concepts.[1]

The language for cybernetics is the metalanguage of mathematics and engineering. The rules, generative in nature, and which stimulate the transformation and transmission of data and the regulatory mechanisms which counteract randomness and entropy are predicated on dynamic, basic operative processes, content-free, which serve as executors for the system. Perceiving change and entropy as the disturbers of the maintenance of the stability of the system, necessitates the development of methods for evaluating input stimuli, formulating strategies for the transformation and transmission of data, reevaluating the product (output) of the changes, and the reintroducing of the new data into the system

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[1]Wiener, Norbert, "Cybernetics and Society," in The Human Dialogue : Perspectives on Communication, edited by F.W. Matson and A. Montagu (New York: The Free Press, 1967), p. 16.

(feedback).

Basically, the cybernetic theory is goal-seeking, problem-solving, and decision-making to maintain negentropy. The development methods such as matching, and pattern-recognition, and the establishment of principles of feedback (negative and positive) and equilibrium, demonstrate the concern with constraint and stability in the open and closed system. The demonstrability of the cybernetic theory as an essential methodological approach is witnessed in computer programming analysis in which the generative rules of cybernetics have been actively utilized. Two key features of computer processing, conservation and progression, incorporate the conceptualized necessity for assimilating data through codification and categorization to reduce variables and match information and for accommodating the information to the problem-at-hand, to create new solutions and higher levels of organization.

Information theory, principally a mathematical postulation, is as equally important as cybernetics and needs to be investigated as an interdependent corollary. To be able to measure information allows one to understand the system , to sustain its organization and to make predictions. One wants to discover the most efficient method of transmitting the greatest amount of information without losing the kernel message before interference and noise, i.e., entropy, overpower the order and coherence of the information. Appreciating the potential complications of information transmission assists the professional worker in dealing with disturbed communication and disorganized systems.

The social scientist, and psychologist, can be aided in the development of a valid discipline for investigating human behavior and communication, through becoming sensitive to the exacting demands of statistical and mathematical approaches to the problems of probability, transformation, and stabilization as defined by cybernetic and information theory.

# CHAPTER V

## A CRITICAL COMMENTARY ON THE SOCIAL WORK APPLICATIONS OF CYBERNETICS AND INFORMATION THEORY

The major questions postulated by the cybernetician in exercising his theory in investigations of psycho-sociological problems are: Can experience be communicated? Can intrapsychic phenomenon be expressed as intelligible information to others? Through what methods can human transactions be studied, understood and qualified? Is human behavior quantifiable through a statistical mathematical analysis? In evaluating the applications of cybernetics to social work, an employment of one science to study another, and illustrating possible areas that can be further developed, the differences in the two disciplines need to be kept in mind.

1. Each discipline develops its own vocabulary and there is no reason why the meaning of the more specific terms used by a physicist should be self evident to a (social scientist) . . . The most serious barrier is not the unfamiliar word (which merely delays understanding) but the common term where variations in connotation can escape detection;

2. The subject matter of each discipline poses special problems of evaluation . . .;

3. The nature of the subject matter also influences the nature of the experimental work . . .;

4. An added complication in psychology is the existence of the sub-science of individual differences, which stems from the

> scientists' special relationship with his subject matter (regard for the individual human being as person) and also from the high degree of plasticity in human behavior.[1]

A Résumé of the Climate of Thought in Social Science and the Arts as Related to Cybernetics and Information Theory

Man's perception of the universe in which he lives does affect the way in which he thinks and expresses himself. A brief review of the temperament of the twentieth century in relation to the scientist's conception of reality reveals the salient features of the rationale for the cybernetic approach to the study of systems behavior and information transmission. Cybernetics is symptomatic of the perception of the universe in the twentieth century. By the turn of the century, chance was considered not a secondary or exceptional phenomenon but intrinsic to nature. Chance, in fact, could be more operative in nature than cause-effect which specifies how things actually do behave. The notion of chance and randomness of particular units is observable when an infinite number of particles or molecules are statistically measured. In studying change, the working concept of statistical probability or possibility is more appropriate than the consideration of cause and effect. Randomness and uncertainty are the actualities; "the notion of the inevitable has been replaced by degrees of prediction."[2] Coupled with the shift from the cause-effect explanation to the emphasis on chance and randomness, was the change in the perception of "force." At one time

[1]Parry, John, The Psychology of Human Communication, p. 160.

[2]Sypher, Wylie, Loss of the Self In Modern Literature and Art (Vintage Books, New York: Random House, 1962), p. 81.

in physics force was thought to exert a pressure on objects as cause and motion was the effect. Force is now considered a descriptive term explaining the relationships between objects; the concept of force has been replaced by the notion of feedback circuits.

> Forces are not in nature but rather are our way of describing what goes on in nature . . . . The laws of force . . . are a formula for denoting the ways in which things are interdependent as they exist together in areas of space-time that they create about themselves.[1]

The twin to chance is entropy. "The tendency of an ordered universe to go over into a state of disorder;" behavior tends to become increasingly random. From Aristotle to Einstein the universe was considered to be controlled by laws that create a cosmos, not chaos. Einstein's work became a pivotal point. The universe became to be seen as highly unstructured and entropy was the major power. Boltzmann's theory suggests that as time progresses there is an increase of randomness because the energy of the universe is leveled until any order or distinction is annihilated and the system drifts toward inertia. Brownowski's principle of the time and the future illustrates the proclivity towards heightened entropy if systems are left without any regulators. The future is like a

> . . . stream of gas shot from a nozzle: the farther the gas is propelled from the nozzle, the more random the motion of the molecules. The gas diffuses, loses direction. Time can be measured by the loss of structure in our system, its tendency

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[1]Ibid., p. 82.

> to sink back into that original chaos from which it may have emerged.[1]

Life, viewed in these terms, becomes for the individual a struggle to defy entropy.

The nineteenth century romanticism as expressed in literature was founded on the notion that man can ultimately exert his will, his force, over nature and society (e.g., Nietzsche's Superman, Schopenhauer's idea that man can will his world into being, the Byronic dream). In the twentieth century this concept dissipated into the notion that life is a "brief rebellion" against entropy, i.e., nothingness, and is narrated in existential literature. The resignation to entropy is apparent in Camus' The Stranger when Meursault is no longer able to struggle, accepts his fate and succumbs to entropy. The fragmentation of order is apparent in art as represented by Cubism, Dadaism, and modern abstract painting.

Freud's theory of the death-wish is not too far removed from the concept of entropy, "the path of our life is simply our own way of choosing our progress towards death . . . the untroubled security of not-being."[2] Hence existence then, ultimately is an affirmation of the self confronting nothingness.

Thus, the scientist, confronted with the problems of entropy, instituted what has become an efficacious method to control entropy and

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[1] Ibid., p. 73.

[2] Ibid., p. 75.

to predict behavior. The science of cybernetics is a means of organizing the chaos and creating order out of randomness. The cybernetician not only needed to regulate entropy through operative mechanisms but also needed to control the information processed through the system, be it energy, molecules, particles, or words.

The human organism as an open system presents problems critical to the cybernetician and communication theorist. Not only does the living system require operations for "steering" in terms of function but also in terms of communication. Man "transmits" language as information: verbal and nonverbal. The use of language and the problems of meaning discrepancy became critical in understanding the input-output relations in the system. Often human expression eludes examination in such a finite way. Information theory is indicative of the enigmatic questions that evolve in relation to the transmission of information and communication in open and closed systems.

The problem of being able to express oneself through language and to plumb one's existence to the "inner self" is apparent in the shift from the "living room" drama of Ibsen to the Theatre of the Absurd as represented in the works by Beckett, Ionesco, Adamov, Sartre and the like. To use verbal language, to express what one felt, became an anachronism and an "impossibility." T.S. Eliot recognized the importance of experience beyond the word and stated that the necessity of the Mass Service, of "tribal ritualism," provided a means of communication that was incomprehensible when restricted to "the word."

The difficulty of communication through language (linguistic and paralinguistic), the problem of reaching the meaning that is understandable to both speaker and listener, has become one of the most critical problems not only in art but also in scientific disciplines. The recognition of the ambiguity of the word, the problem of the chimerical nature of meaning, the discrepancies between the conscious and the unconscious intentions related through language, have led artists to find other means of communication beyond the word. The scientist, confronting the similar problems of symbol vs. meaning, intention vs. actuality, speaker vs. listener, has directed his research towards a method of quantification. The former has resolved the problem by finding other means of expression; the latter has attempted to solve the problem by dealing directly with it.

In summary the concepts of chance and entropy have led the scientist and social scientist towards developing measures to counteract the lack of structure. Cybernetics as a study of control and steering is a means of maintaining the desired order. Information Theory is also an attempt to control randomness. A system exists through its communication system. Information as communication needs to be understood quantitatively and qualitatively. In social work, one is confronted with these problems of entropy, disorder and disturbed communication patterns.

In evaluating the applications of cybernetics and information theory to social work, four areas arise: the operative mechanisms of man in

his society, the methods of communication, pathologic functioning and disturbed communication within the psycho-social sphere, and therapeutic measures which can benefit the person, family, or group who seek help.

Issues in Social Work Related to Cybernetics

In relation to Parry's first doctrine, scrutiny of the vocabulary, the use of the term "systems theory" in social work encompasses too broad a scope.[1] Certainly the application of the term "systems" in describing the individual in relation to a family, group, institution, business or community is accurate in that the relationship is a "cohesive unit" in activity with another, reacting and counteracting. Basically, the system refers to the "organized whole." Describing a family's interaction as a system, however, still does not reveal sufficient information that can be helpful for the purposes of treatment.[2] The systems theory appears to remain descriptive of what exists; it is topographical and horizontal in its approach. The family system can be described as bio-social in nature providing growth both in biological and psychological development and socialization. There is an axial division into two generations and two sexes all of which are bound by psychological, sociological and behavioral limits. Each family has a parental dyad and a parent-child triad. Although the family experiences similar crises of cyclical

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[1] Supra, pp. 141-142.

[2] The family is used for an example since it is not only significant in terms of the individuals but also as an intricately transactional group. What is present in the family is also evident in other groups, to a more or less degree.

growth (e.g., birth, marriage, death) the family is still dynamically different for each member.

In understanding the pathological developments in a family, however, the systems approach is not completely adequate, although it still remains a useful descriptive technique. One needs to account for the psychopathology and the degrees of health of each member and of the family as a unit. The operational model used for analysis in accounting for emotional health can consist of a coupling of the cybernetic model with the existing psychoanalytic and psychological techniques. Another example in which the descriptive technique is helpful but not totally sufficient is in regards to the question of poverty as a force or symptom of the breakdown of mental health. In perceiving the client's system, the social worker must incorporate the socio-economic conditions of the client into the general schemata of the client's world. Most often one is working with families and individuals who are from the working class, skilled or unskilled, or persons whose sustenance is dependent on the welfare system of that individual's city, state, and country. A description of the effects of poverty as a force which can erode an individual's strength and mental health (not excluding psychopathology as a function of intrapsychic phenomena as well) is able to clarify the problems particular to the system but does not grapple with the intricate overlapping networks and operations which have perpetuated or intensified the deorganization of the individual.

Cybernetics offers clinicians a means of analysing the dynamics of the system. Questions that can be asked are: what are the problems of the group? what are the possible ways in which the problems could be solved? what are the actual strategies employed? what are the input stimuli that are threatening to the system (e.g., father out of job, mother ill, one-parent family, member of the family is schizophrenic, mixed marriage)? left alone, would entropy tend to increase in the family or group system? how is the problem communicated and demonstrated by each member? what are the rules and codes in the family? is the information-giving process masked or unmasked? how are the intrapsychic phenomena coped with by each member? what information, behavior patterning, and output is fed back to the system as negative or positive feedback?[1]

Cybernetic methods of dealing with a problem are not a substitute for other approaches in analysis as demonstrated in the psychiatric profession. They are a significant contribution to the field of study of psycho- and socio-dynamic problems and need to be synthesized with the present disciplines in sociology, psychiatry, and psychology. Cybernetics, with its emphasis on mathematical probability analyses demonstrated in the mechanizations of the problem in computer programming techniques provides the researcher with a discipline which attempts to ferret out the operative mechanisms and generative rules of function

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[1]Supra, pp. 79-80. Lathorpe cogently discussed the importance of the feedback loop in comprehending behavior and providing adequate and appropriate treatment.

and transformation within each system.

One question that still remains enigmatic is the problem of explaining the unconscious. The cybernetic theory does not pretend to offer answers to the "why" of the unconscious — a study attempted by schools of psychoanalytic thought. The metaphoric "Black Box" phenomenon emphasizes that cybernetics attempts to explicate and disentangle the observables. Although generative rules for operative mechanisms could be linked with the unconscious system (as they are inherent principles)in human thought processing they should not be mistaken for the "unconscious forces" as described in the psychiatric literature (e.g. Freud) and social work literature.

The terms "analogic" and "generic" which are used to explain the two different approaches to instituting the cybernetic model in social work are not clarified sufficiently in the social work literature.[1] Optimally one wants a model that can be translated into other forms for the use in varying disciplines without distorting the initial principles of the model or the areas of study. The analogic model appears inadequate to explain the structures and functions of a system. It specifies that one commences observation of a system from a specified point, reflects similarities, and differences in the model with other models and applies the model to various hypotheses. The feedback loop principle in cybernetics and the perception of interaction as a schemata of network

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[1]This use of the term "analogic" is not to be confused with the thesis of cybernetics which offers a system of organization which has been referred to as "analagous" to human thought processing discussed in Chapter I and as witnessed in the computer simulation models.

circuits eliminate the possibility of being able to specify the proper starting point. Only within a closed system can one make an accurate specification as to the origin of the process. The open system is never static. Perceiving the system as a cyclic interweaving hierarchical matrix which is continuously compounded in complexity through more input be it via feedback mechanisms or virgin data entering the system, eliminates the possibility of delimiting the starting point. If one does arbitrarily select a starting point, perception from that point of entry can effect, distort, confuse or camouflage the apperception of the total system. This problem is especially evident in observing the family or group system; for example, when there are strong vectors from many sources, or when what is said or done restricts the ensuing choices of behavior for the next moves by the others as evidenced in the principle of punctuation in communication patterns, or when one cannot distinguish the symptom as a cause of other reactions or having been caused by preceding events or intrapsychic phenomena.

Berne diagrammed nine possible transactional exchanges in a family system and indicated the impossible task of finding the locus of origin.

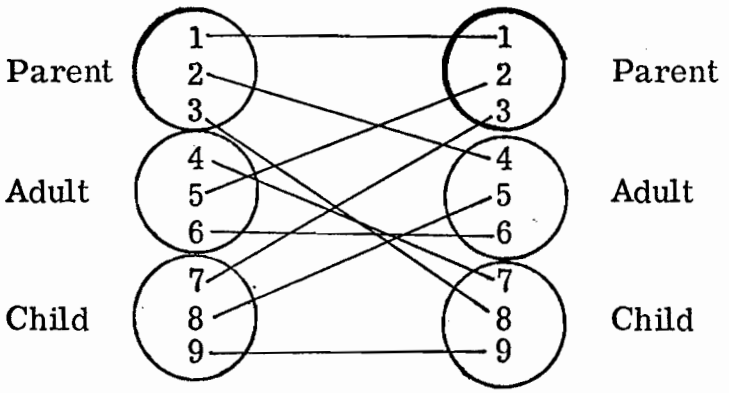


Fig. 22 Berne's Model of Transational Exchanges in Communication

There can be either complementary transactions in which the two are psychological equals (adult-adult, parent-parent, child-child) or crossed transactions in which the roles are confused and the interaction produces pathological patterns (parent-child). There is never a starting point in such a system; it is a continuously reinforcing system which either breaks down, remains constant or improves.[1]

The "generic" model appears to be a more viable method for applications of cybernetics for the purposes of diagnosis and treatment. The use of the "generic" model facilitates the possibility of making a cross-sectional cut (on the sagital plane) of the system, penetrating all levels to reach the intrinsic principles of the operative mechanisms, the generative rules. An employment of the "generic" model could be fashioned in the following manner: Given a problem in a family, an individual, or in mental illness in relation to poverty, one would cut through all levels of the system, vertically, such that all the features of the critical issues would be disclosed. This would mean considering issues in psychiatric, social, and economic realms as well as manifest behaviors in decision-making, problem-solving and communication. One would not attempt to describe the etiology of the pathologic behavior and symptoms only in terms of one of the above or in terms of observations similar or dissimilar to another system observed. Nor is one concerned with a specific point of entry into the system. The significant exigencies

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[1]Berne, Eric, Games People Play : The Psychology of Human Relationships (New York: Grove Press, Inc., 1964), p. 32.

are the rules, the "universal grammar" for the operations of transformation change, control, and feedback, all of which are context-free.

Chomsky defined "universal grammar" as the inherent and generative rules upon which a system operates. Piaget has also presented a "generative" schemata to assist the psychologist in explaining the acquisition of knowledge, the construction of reality by the individual, the development of personality and cognitive growth, and the causes for affective expression and interpretation of experience particular to the individual. The "generic" model, viewed in these terms, provides a master model which can be applied to numerous diverging systems; it is the base axis for all systems.

Another disputable issue represented in the social work literature is Gordon's use of "matching" for "coping mechanisms."[1] Matching and pattern-recognition are methods for coding data into a unified language so as to be able to quantify the "bits" of information. This information often must then be decoded before it is "ejected" from the system (in this case the computer) as output information. The creative analysis and heuristic processes occur only after the matching is completed. Matching is not an end in itself nor a means for projecting solutions of what "could become." Matching in the cybernetic sense would be the first step in a sequential schemata that would benefit the worker and patient in working through ways of "coping."

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[1] Supra, pp. 59-62.

The principle for coping mechanisms, rather than being a matching phenomenon, appears to be a function of equifinality and multifinality in which the possibility for growth is an integral feature of these transformational concepts. The "matching" mechanism maintains the status quo and allows a method for penetration into the system, to observe what exists. Since the environment is a dynamic force continuously changing and extremely diverse, to state that one can match potential and capability to the environmental structure and to refer to this as "a coping technique" indicates a misunderstanding of the operative principle.

Coping involves more than "matching" the capabilities of an individual with the demands of the environment; it is not only an equalizer to reduce tension but also a method for growth and creativity, for being able to extend the means of dealing with a problem beyond matching and beyond the restraints of the impinging environment, often a way of changing the environment to benefit the individual or group. Coping is a mechanism that can help an individual free himself from his involvement in a defective system. Certainly one cannot ignore reality and the responsibility of existing within reality; however, this responsibility can be directed towards creative and positive change, the progressive hierarchy of steady-states, not merely towards a stabilization and matching which is controlled by the demands of the environment.

The concept of steady-state suggests that man is "equilibrium tropistic" on an hierarchical evolutionary scale. The principle of control

and steady-states in cybernetics is not value-laden; it does not indicate that man tends to reach healthier or more positive levels. Regulatory mechanisms can maintain organization to the detriment or enhancement of the system. This is evident in the maintenance of pathological and destructive (e.g., sado-masochistic) units. Similarly, negative or positive feedback can operate to the impairment of the system. Given an individual or group, and a noticeable thrust and reaction in a specific direction, analysis of the behavior (be it noxious or improving) in terms of the principle of feedback and regulation permits one to investigate causal factors which are free from the value-laden structures.

The "family myth" is a good example of negative feedback which serves as a thermostat and calibrator for the family. The myth can be the imaginary child as in "Who's Afraid of Virginia Woolf," by Edward Albee or the myth of Willy Loman in "Death of a Salesman" by Arthur Miller, or in more abstract terms, the myth of the puritan ethic in The Puritan by George Santayana or the quest to reach the Castle in Kafka's The Castle. As in these illustrations the myth always breeds disillusionment and destruction once it is dissolved. Ferreira described the homeostatic function of the myth in the following statement:

> Seemingly, the family myth is called into play whenever certain tensions reach predetermined threshholds among family members and in some way, real or fantasied, threaten to disrupt on-going relationships. Then the family myth functions like the thermostat that is kicked into action by the temperature in the family. . . . It tends to maintain and sometimes even to increase the level of organization in the family by establishing patterns that

> perpetuate themselves with the circularity and self correction characteristic of any homeostatic mechanism.[1]

Negative and positive feedback are critical for calibration. The former can be both harmful and helpful; harmful as a means of maintaining a pathological system, helpful as a stabilizer for the system against threatening crises and disorganizers. The positive feedback which instigates change and upsets the equilibrium can also create destruction or improvement. One needs to be able to understand these various levels of functioning within the treatment framework to know what will occur if certain "step-functions" are introduced. "Step-functions" are the changes in calibration such that one might lower the thermostat or reduce the pressure and therefore lighten the burden of the furnace or person, respectively. The family might be able to tolerate certain behaviors beyond which certain "righting" mechanisms are triggered.

> At one level these systems are quite stable, for a deviation in the form of behavior outside the accepted range is counteracted (disciplined, sanctioned, or even replaced by substitute, as when another family member becomes the patient). At another level, change occurs over time which we propose is at least in part due to amplification of other deviations and may eventually lead to a new setting for the system (step-function).[2]

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[1]Ferreira, Antonio J. "Family Myth and Homeostasis," in Archives of General Psychiatry (9:457-63, 1963), p. 462, as cited in Pragmatics of Human Communication, edited by P. Watzlawick, et al., p. 175.

[2]Watzlawick, Paul, et al., Pragmatics of Human Communication, p. 148.

Problems Related to Information Theory in Social Work

Communication and information theory have postulated areas of concern and relevance to the social worker. Understanding the rules in information transmission, commodity capacity, transformations between sender and receiver, and the role of noise and cue-suppression help a social worker in dealing with disturbed communication patterns. Metacommunication is critical for the therapist as a means of stopping outside the disturbed communication patterns.

Watzlawick presented a game in which two people communicated by reversing the meanings of yes and no such that "I don't want" means "I want." To stop the game one would have to say "I want to stop" which would only continue the game. In order to actually bring the game to a halt, one would have to step outside or provide a metasignal for stopping (e.g., the word "blue" would mean stop). The distortion in communication, paradoxes, double binds, illogical logic and other reversals of meaning are often found in the exchanges in marital couples, or families. The game must be governed by metarules for a change to be initiated. "The therapist as outsider is capable of supplying what the system itself cannot generate: a change of its own rules."[1] In terms of the social worker's performance as therapist, the accuracy of the transmitted symbols, the degree to which the symbols can carry the intended message and the catalytic components of the message so that the meaning influences conduct effectively, are three aspects to which the social worker

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[1]Ibid., p. 235.

must address himself to be able to evaluate the effectiveness of his services.

The introduction of content-analysis reflects the desire of the clinician to develop a more reliable measure for evaluation of therapy sessions and communication patterns. Although all three methods delineated (classical, pragmatic, and non-quantifiable) depict specific problems in tackling the methods of communicating, the analysis of linguistic and paralinguistic exchanges in the therapeutic session ought to be integrated rather than segmented. Therefore the three separate approaches, although they offer particularizing constructs, are not completely valuable unless considered as part of the total schemata. One cannot ignore anxiety levels, patients' or therapists' personalities, the varying assessments by different therapists of what causes change and the numerous ways of manifesting change of each patient, or the role of learning theory in the therapeutic process.

The emphasis in information theory on channel capacity and overload alert the social worker to the individual's or group's ability to cope with treatment and problems and can help to explain the reason for the employment of defense mechanisms, and resistance in the patient. One needs to weigh the values and costs of the information input and the method of evaluation and rejection of information to comprehend why certain modes of behavior and means of expression are chosen in lieu of others. The merits of psychoanalytic and psychological and social work studies and analysis of behavior in relation to defense mechanisms,

resistance unconscious drives, needs and the like are not to be undermined. Cybernetics is not a substitute for these disciplines but can be used for the enrichment of the approaches that now exist.

In summary, in computer systems the impact of the message occurs only if the receiver is matched to the sender. In human systems, messages have impact but they cannot be equally matched. Each message has a unique value and intention which changes the referential property of the symbols and meaning. One needs to account for the "who" and "to whom" and the patterns are unpredictable. Information theory cannot be applied in the strict sense to human exchanges because of the unpredictability of the communication transactions. All that is communicated remains important whether or not it is accidental or intentional, conscious or unconscious. Although the actual amount of information transmitted is not known (a primary factor in information theory), this should not deter one from applying the methods devised to approach the problem of information transmission in the human system.

Application Extensions Through Education

The potential changes in the social work profession which are a function of cybernetic and information theory perspectives can be instituted through two major channels: 1. the students and educators, and 2. the professional social workers in the field.

In reference to the student training programs, the educators of social work need to recognize the import of the study of cybernetics and information theory and integrate the discipline into the existing

curriculum. This not only means providing the student with an opportunity to study the basic tenets of cybernetics and information theory within the original scientific framework but also means aiding the student to be able to understand the rationale for incorporating the approach and to become sensitive to scientific discipline and methodology. The curriculum would consist of a relationship schemata in which the theories of sociology and psychology and the clinical approaches to casework, group work and community organization would be understood as a cohesive unit and respected as an interdependent matrix. The student needs to be sentitized to the complexity of the social structure and the varying probable means of coping mechanisms or destructive forces. A redefinition of the "environment" is necessary such that the reality is not perceived as a polemic of contradicting powers but rather an enmeshing system which is constantly employing methods of compensation and recalibration to sustain an organized whole and/or to propel change.

In regards to extending the significant implications of cybernetics and information theory to the professional workers at-large, it is evident that the profession is becoming increasingly self-critical and is attempting to strengthen and understand the role of the social worker in a very pressurized society. Agencies are questioning their role in the community and the relevance of their services to their clients, social services linked to hospitals, forensic clinics, and mental health programs are examining their contributions to the multi-disciplined treatment programs; educators are re-evaluating earlier schools of thought

in relation to methodology in casework and groups work and in reassessing the similarities and differences in the representative knowledge of the various disciplines which social work theory has integrated. This climate of inquisitiveness suggests the readiness to learn new methods of approaching the critical problems one is confronted with in social work. The methodology of cybernetics and information theory can be made accessible to the professionals in the field (to agencies, hospital units, community mental health teams and other programs in which the social worker is involved) via publications, schools offering post-graduate seminars, social work conferences and work-shops.

Not only is it necessary to educate professional workers in terms of cybernetics and systems theory but by so doing, they in turn can help to alter the existing sociocultural schemata such that it can benefit from the changed perspective. Buckley suggested that the society is not yet prepared to integrate cybernation because of a "lack in these societies of informed, centralized direction and widespread promotively interdependent goal behaviors of individuals and groups."[1] The question of regulation in social control, flexibility, and stability needs to be dealt with through the following means.

> 1. A source for the continuous introduction of "variety" into the system, which may refine or revitalize the pool of commonly usable information and the set of common meanings and symbols, that by and large, represent adequate "mappings" of the physical and social milieu . . . .

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[1]Buckley, Walter, Sociology and Modern Systems Theory, p. 206.

2. Maintenance of an optimum level of tension in the system, but also a relatively high level of satisfaction of member's needs . . . society is not tension reducing — tension is produced by the normal impulses to action, the "role-strain" of everyday social relations, cognitive dissonance, incongruence of interpersonal matrices, and the like . . . .

3. A full, two-way communication network extending throughout all parts of the system to provide adequate linkage of components and to make the possible and various feedback loops essential to effective goal attainment . . . .

4. A selective, or decision-making, system that is sensitive not only to changes in the external environment but also to those in its internal state . . . which is capable of learning or allowing for changes in its goals and values.[1]

The readiness of society for "cybernation" is a controversial issue and beyond the scope of this study; however, education is a two-way process in which both the observer and the observed, the analyser and analysed, contribute to the propagation of new methods for appreciating the matrices of the psycho-sociological structures and functions within society. Whether the social worker is involved in therapeutic treatment programs for individuals who are mentally ill, in group programs for individuals who are functioning well but who have a common localized problem, in social action and community development planning with citizen groups, in school systems, youth groups or civic organizations, the professional worker can instrumentalize the dynamic principles of cybernetics and information theory as critical methods for understanding and working within the psycho-socio-cultural system of the individuals and society in which he is involved.

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[1]Ibid., pp. 206-207.

# CHAPTER VI

## SUMMARY

The purpose of this study is to examine cybernetics and information theory as methodological approaches to the analysis of behavior with specific reference to clinical applications to social work. The applications are in four areas: 1. the development of new approaches to therapy (e.g., functional casework and reality therapy as opposed to dynamic casework); 2. the emphasis on working with groups and families and the promotion of community mental health programs; 3. investigations in linguistic and paralinguistic expression in therapy sessions as illustrated by research in content-analysis; and 4. educational programs to provide accessibility of these approaches to the practicing social worker and integrating these concepts into curriculum training programs. An analysis of the inclusion of cybernetics and information theory in the social work literature, subtitled "systems theory," reveals certain oversimplifications and misconceptions of the two disciplines.

Cybernetics and information theory present means of controlling and regulating entropy and information transmission and transformation. They provide the underlying generative rules for operations within a closed or open system. Man is perceived as an open system, interdependent with his psycho-sociocultural environment. The cybernetic

concepts of feedback and network circuits offer a schema for explaining the transactional system of man and his environment. Information theory provides a means of analysing communication, verbal and nonverbal, and methods for devising efficient transmission. Consideration of the operative mechanisms of man in problem-solving, decision-making, and general cognitive areas reveal similarities to the operative mechanisms in cybernetics and information theory as simulated in computer programming. Contemporary theories in psychology, sociology and communication (syntactic, semantic, and pragmatic) illustrate the integration and influences of cybernetics and information theory in the social sciences.

The social worker is concerned with the breakdown of the system and the disturbed patterns of communication exchanges (cognitive or affective). Understanding man in relation to his self and society and perceiving the problems of regulation, stability and processes of change help the professional worker to improve methods of coping with a system that is unstable. The application of cybernetics and information theory is not a substitute for other approaches in social work, psychiatry and psychology; rather these are significant models that, once incorporated into the existing therapeutic schematas, could benefit the clinician. Examining cybernetics and information theory in their original framework offers a means of appreciating the complexity of the disciplines, a measure for evaluating the validity of the applications to social work, and an opportunity to discover areas for further research.

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