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EDITORIAL

Open Letter to Our Readers

I apologize for the long interruption in the publication of this issue of the “Cybernetics Forum.” This was due to a number of factors beyond my control, including a change in the editor and publisher. Unfortunately, for personal reasons Dr. Milton Katz, whose skillful editorship did so much to improve the Journal, felt compelled to resign. In the search for a new editor I was recommended. After some consideration I accepted the position.

As the new editor of the “Cybernetics Forum,” I would like to express my views about what I think would be a desirable relationship between the Journal and its readers. I feel that the Journal should have as close a contact with its readers as possible. It should be realized that we are a relatively small society and that this Journal should bring us closer together. Therefore, I invite you to write me about your professional activity involving cybernetics, publications, awards, promotions, etc.

The major function of the “Cybernetics Forum” should be to serve as your forum. To promote this role, I intend to publish regularly articles on topics which would hopefully inspire creative discussion. I expect that these articles would stimulate controversy and interest and thus increase reader-Journal interaction. Such articles would include the various views on cybernetics, reductionism vs. anti-reductionism, cybernetics and teaching-learning processes, cybernetics and the solution of social problems, cybernetics and religion, cybernetics and the arts, and the philosophy of cybernetics. It seems to me that in the past, these potentially controversial and exciting issues have been somewhat ignored.

Finally, I would like to explain the focus of cybernetics in the “Cybernetics Forum.” In this issue, the article “The Different Meanings of Cybernetics” points out the two rather opposing views about cybernetics. According to Norbert Wiener and Gordon Pask, we should limit cybernetics to mathematically describable systems and their corresponding models. On the other hand, Stafford Beer argues that cybernetics should deal only with the exceedingly complex systems such as society, the brain, etc. which cannot be mathematically described. Since the first point of view is represented in our sister journal, “Journal of Cybernetics and Information Science” (editor Kumpati S. Narendra), it seems to be only logical that the “Cybernetics Forum” should focus on the latter. Thus, this journal would concentrate primarily, but of course not exclusively, on the cybernetic approach to extremely complex systems. I feel that the most surprising, interesting and useful development of cybernetics will take place in the domain of such systems.

V. G. Drozin, Editor
From the Desk of the President

The past year has been a difficult one for ASC but one which has presented opportunities as well. Since my election in early January, 1976, I have seen my role in this organization to reestablish means of communication concerning cybernetics. The Forum of the ASC has been reestablished on a regular basis with this issue. Dr. Drozin has become the new editor and the Western Periodicals Company has become the new publisher. This same company is the publisher of the new Journal of Cybernetics and Information Science, whose second issue is ready for distribution. It has been inexcusable for a society devoted to information and communication not to have an ongoing basis some means of communication with its members and the general public. Such efforts to reestablish the journals have now been successful but can remain successful only with the continued contribution of material.

The communication of ideas concerning cybernetics also depends upon the presence of the ASC in conferences and other symposia. A full scale conference is now being planned for the Spring of 1977 under the auspices of ASC for the first time in several years. This meeting is in the context of the ideas expressed by Norbert Wiener in the field of cybernetics leading to a more human use of human beings. At this meeting, the value of cybernetics has been to highlight the interaction between the individual and large scale systems to emphasize the enhancement of human control. I believe that cybernetics as a method of thinking has enormous potential for the humanization of systems and it is to that purpose that I believe that ASC should provide leadership.

With the renewal of both the journals and meetings as the rationale for ASC, there is the potential for the renewal of membership which supports such activities.

Mark N. Ozer, President
The Cybernetic Thesis and Mechanism

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I. The Problem of Mechanism
A. Historical Roots of Mechanism

The belief that man may be some sort of "organic machine" is anything but new. The idea received its first precise formulation in the mid-eighteenth century by Julian Offray de La Mettrie[1] but allusions to the "Man-Machine" doctrine are evident in the writings of Maupertuis, Voltaire, Hobbes, Descartes and many others of the seventeenth century.[2] As far back as the thirteenth century we find the motions of man being compared to the movements of a clockwork[3] and, if we care to make the connection between mechanism and materialism, we can find evidence for the origins of mechanistic thought in the atomism of Demokritus and Leukippus.[4]

The concept of mechanism underwent a peculiar development in the hands of the Cartesianists. While Hobbes, the materialist, argued that "mental experience" was to be understood wholly in terms of corpuscular movement,[5] Descartes, the defender of immaterial substances, was convinced that the human body was nothing more than a machine. Descartes, in fact, went into far greater detail than Hobbes to examine and explain the nature of the bodily mechanisms which formed the foundation of sensation, emotion, and so forth.[6] The apparent inconsistency in the Cartesian doctrines of "body-machine" and "immaterial soul" is easily resolved once we recognize that, for Descartes, the powers of sentience, cognition (ratiocination), and volition, etc., are properties of the soul and are, therefore, completely autonomous with respect to the mechanisms of the body. A study of the latter, therefore, revealed the nature of physical movement but said absolutely nothing about the intrinsic nature of the former.

In a sense, it was this attitude which set the stage for all future debates between mechanists and anti-mechanists. Following Descartes, many natural scientists, especially neuro-anatomists, neurophysiologists, etc., felt that a study of bodily-mechanism could be pursued without relinquishing a commitment to the existence of the "soul" or some sort of "elan vital." On the other hand, the mechanists viewed their task as one of accepting the Cartesian "body-machine" and augmenting it by showing how the immaterial "residue" of sentience, cognition, etc., could be analyzed and incorporated (by reduction) into the mechanistic model. Thus, we find that both vitalists (anti-mechanists) and mechanists alike claim Descartes to be their intellectual progenitor.[7]

B. The Cybernetic Revision

The mechanical hypothesis seemed to emerge from obscurity each time an advance in neurophysiology was made but, by and large, it remained as a philosophical fantasy. The reason for this was that the micro-complexity of the central nervous system seemed to preclude the sort of empirical investigation which would provide concrete support for mechanism. Freud, for example, speculated on a mechanical model of psycho-physiological activity, but soon despaired of the project when he realized the experimental obstacles to brain research.[8]

In 1948, however, a new approach was taken to the question of mechanism and "mentalism" by Norbert Wiener. While research in neurophysiology seemed to have bogged down because of technological barriers, pure mathematics was taking a sudden forward leap with the introduction of the electronic, digital computer. Wiener outlined a new path of study of "control and communication" in organic and artificially created systems which he called "cybernetics."[9] The concepts of feedback, goal-oriented homeostasis, programming, hierarchy of control, etc., which formed the jargon of cybernetics, soon kindled the imagination of the mechanist-philosopher, and the cybernetic thesis was born. Essentially, the thesis asserts that man is indeed a mechanism. It breaks with tradition, however, in denying...
that man may be understood according to the model of a clock (the mechanical paradigm of Descartes, La Mettrie, et al.) and likened him instead to a computer.

The cybernetic thesis came under heavy philosophical fire almost at once. Turing's classic paper, "Computing Machinery and Intelligence," has been the subject of discussion and criticism in hundreds of books and articles. Yet comparatively little has been said about the nature of the cybernetic revision of the mechanical hypothesis. The differences, if there are any, between the clock-paradigm and the computer-paradigm have either been ignored or taken for granted, with the result that both proponents as well as critics of the cybernetic thesis have been arguing about the wrong things. What I shall do now is briefly examine the criticisms of the anti-mechanists, the cybernetic response, and the errors in both positions. I should like then to offer some desiderata for future research and modifications of the cybernetic thesis.

C. Critique of the Mechanical Hypothesis

1. There are numerous sorts of objections which have been leveled against mechanism, but I would like to note what I take to be the four most important kinds. The first, which is now considered somewhat passe, is that of the vitalists. The essence of the objection is that man (and to a lesser degree, all living organisms) possesses a "vital principle" or "soul" which distinguishes him from the rest of nature. The arguments adduced for the traditional varieties of vitalism are often based on religious considerations, such as the need for an immortal soul, and may stand or fall with the soundness of the religious premises.

Present-day humanists often raise the vitalist claim without the attendant religious undertones by simply appealing to the requirement of "human dignity," "Freedom of the will," and suchlike. Apparently, the belief that man can aspire to creativity, poetry, moral worth and responsibility is taken to be incompatible with the notion that man is a machine. The implicit assumption, of course, is that a machine must be unfeeling, non-cognitive, in short, something like a clock. While the vitalist appeal is based more on emotional than deductive grounds, it is nonetheless an important consideration. I believe, however, that the real thrust of the vitalist claim is to be found in the third and fourth objections and that the cybernetic thesis has a plausible response for each.

2. The second sort of objection is the semantic one. In general, the claim is made that man cannot be mechanism because there are terms which we use to describe the "mental" life of human beings which cannot be translated into the language of mechanics (or physics). A typical example would be the use of the term "purpose." A machine can have a "goal" (or terminal state) or possibly even a "derivative purpose," in the sense that is has the function of executing the purposes of its designer. If not (so the objection goes) the machine has its own purposes because it lacks the appropriate concomitants for purposeful existence; i.e., sentence, cognition, and consciousness.

While the objection has a prima facie plausibility, I think it rests on a somewhat dogmatic view of meaning inspired by the Wittgensteinians. While the meaning of a term is indeed established by its usage, the usage itself is in turn influenced by conceptual evolution. If empirical science tells us that the pancreas, and not the brain, is the real seat of cognitive activity, then we may expect that one day the idiom of "pancreas-child" or "pancreas-storm" or "racking one's pancreas" will be altogether ordinary, however absurd it may sound at present.

The real question is the conceptual analysis which accounts for the usage; in other words, what, specifically, is packed into (or excluded from) the concept of mechanism?

3. The third and fourth objections focus on this analysis. The third objection states, in effect, that man cannot be a mechanism because the latter is incapable of intelligent behavior, rationality, intentionality, and so forth. A machine, as understood by the anti-mechanists, operates blindly, according to the laws of physics. The movements are not governed by any comprehension on the part of the mechanism itself and an exhaustive explanation of those movements can be given without any reference to "reasons, purposes, beliefs, desires," etc. The ability to cognize the world from a certain perspective, to manipulate symbolic representations of reality, to generate experiences into concepts and linguistic structures, are all excluded from the concept of mechanism and included in the concept of man.

The anti-mechanist argues that, no matter how intelligent the behavior of a machine may appear (and even in Descartes' time there were robot-like mechanisms capable of sophisticated behavior, e.g., flute-playing) true intelligence depends on understanding. How we are to interpret this requirement is a problem which I shall consider in a moment.

4. The final objection, and perhaps the most telling, is that machines lack a crucial quality which man possesses, namely sentence. However sophisticated the workings of a machine may be, the anti-mechanist argues, no increase in complexity will ever be able to account for feelings and sensations (i.e., consciousness). Sentence is taken to be an irreducible property of living organisms and one which plays an integral role in the description and explanation of our mental life.

It is important that we notice the distinction between sentence and cognition as aspects of human mental life. When we seek to identify and analyze "thoughts" or "thought processes" we may have varying success in unpacking their "cognitive content." We can dissect "reasons," fill in missing steps to "deductions," probe into hidden "motives," and so forth; virtually nothing is adequate, however, as an analysis of primitive sensations, such as "color," "pain," etc., except insofar as we can extract the cognitive content which resides in the sensory experience itself. Thus we can, for example, characterize a pain as "cutting," "stabbing," "dull," or "burning," but these terms only convey the faithful quality of the experience to one who has undergone similar sensations described in a similar manner. They do not serve to give us further insight into the nature of the primitive sensations themselves.

Let us now see how the cybernetic thesis attempts to deal with these criticisms of traditional mechanism.
II. The Cybernetic Thesis

A. Response to Objections

1. In the first place, the cybernetic thesis is committed to supplying an explanation of human activity, such as poetry, composition, problem-solving, etc., and not to "explaining these things away" as illusions. In answer to the outcry of the humanists, the cyberneticist would be likely to say that he takes these sorts of activities as primary data from which to draw his conclusions. The bone of contention may be that the cyberneticist finds the appeal of these data to be undiminished if we learn how they come about, while the humanist requires an aura of magic and mystery in order to appreciate human creativity.

To put it another way: for a humanist, part of the beauty and power of an aria by Mozart lies in the fact that the manner in which the aria was composed is unknown. Were we to be able to discover the method (or mechanism) which underlies its construction, the beauty would soon pall and Mozart’s musical genius would be re-cast as a neural assembly-line of musical symbols.

The cyberneticist is somewhat indifferent to this concern. Learning that there are pain centers in the brain which are aroused through internal, psycho-genic processes, diminishes our sensations of pain not a whit. Similarly, learning that there are neural assemblies and cognitive structures which operate to produce the explicit forms of consciousness we are acquainted with will cause no direct alteration in consciousness. The only possible effect of such knowledge on our consciousnesses will be the (gradual) conceptual evolution towards a new, cultural self-image. In other words, the music will still sound just as good.

2. The more serious objection is how the cybernetic thesis handles the problem of cognition. Let us imagine a hypothetical device, built in the seventeenth or eighteenth century, which is constructed of levers and gears and pulleys, and so contrived that it will "play" checkers with a man. By "play," I mean that when a man moves a red piece the machine will respond by pushing a black piece. If we open the machine up we find that there are metal connections between all the checker-pieces and that the motion of the red pieces causes the motion of hidden counter-weights which in turn result in the motion of black pieces.

We should not, except in jest, suppose that the machine is actually playing (without quote marks) checkers, even though it is making moves, and possibly the appropriate moves for a successful game. The reason we deny that the machine is actually playing is that it fails to have any understanding of the situation, any recognition of the rules, any purpose in "winning," etc. The explanation of its movements can be exhaustively given in terms of mechanics and physics.

But now, let us suppose that we take our original machine and hook it up to a computer. Between the input state (i.e., the board which results from the human move) and the output state (the machine’s move) we interpose a sophisticated set of programs which can analyze the comparative value of the machine’s possible moves, and execute the most advantageous one. In order to do this, the program will have to include a symbolic representation of the rules of the game, an internal representation of the current game itself, a method of recognizing game advantage, and a direction to execute only those moves which are conducive to winning the game. How would we now answer the question of whether or not the machine was "playing" checkers?[16]

If we want to discover why our mechanical checker-player makes a particular move, we cannot simply open it up and trace the connections between its internal parts; the physical or mechanical analysis will only provide an answer to the question of why such-and-such a movement occurred at some particular time. If we wish to discover the explanation for a particular move, then we must look at the machine’s programs, at its heuristics and evaluation procedures, at its method of representation, and so on. In short, we must ask why it made such a move (in terms of cognitive strategies) and not how it did so (in terms of relevant mechanical conditions).

The critical difference between our hypothetical clockwork checker-machine and our real checker-playing program is that the latter employs and manipulates symbolic information whereas the former responds in a purely non-symbolic, non-cognitive manner to mechanical inputs.

A cybernetic device is therefore a machine (or organism) which is capable of receiving, storing, manipulating, and acting upon information. A clock, the traditional mechanical paradigm, is incapable of such behavior.

A second aspect of the cybernetic type of model is that it has the capacity to adaptively change its behavior. A striking feature of the checker-playing program written by Samuel is that it is able to learn from its games. When it was first run in 1959 Samuel himself was able to beat it. After thousands of games (and some program modification) it succeeded in playing and beating an accredited master.

A third feature of the cybernetic model is that it employs decision-making techniques in order to execute its behavior. The "input" of a cybernetic machine is not simply a physical stimulus, but rather a function of the world impinging on it, together with its own internal states. In other words, information is synthesized by the machine, rather than simply fed to it. It then processes the information in order to determine its subsequent activity (if any is called for). The resulting action is, therefore, a product of both the "internal logic" and the "perspective and past history" of the mechanism, not simply a law-like relationship between a one-dimensional input and a one-dimensional output.

This means that, if we are to fully understand the nature of cybernetic behavior, we must examine its cognitive structure, its decision-making techniques, its method of assigning differential values to input in terms of its hierarchical program structure, and so forth. We cannot except to understand the behavior (though we may achieve a limited amount of success in predicting it) by simply employing behavioral analysis. Were a behaviorist to employ his observational techniques on a truly sophisticated cybernetic machine, he would have as little success in extrapolating its law-like structure as he
has in determining the law-like structure of human beings.[17] Unlike the traditional mechanism of a clock, the internal transformations of a cybernetic device are far too complex to be explained without reference to the program (or cognitive) level of analysis.

3. The cybernetic thesis has a different sort of response to the final objection, concerning the lack of sentience of machines. Neisser,[18] Putnam,[19] Dennett,[20] and others have adopted the view that if we take sentience to be "raw feels" with the emphasis on the word "raw," then excluding them from our account of cognition and action will do nothing to diminish the explanatory power of our account. For example, once we extract all the cognitive content of an experience of "pain," that is, once we say all that can be said about it in terms of its relations to the world and to persons, the primitive, experiential content will add nothing to our explanatory schema. Thus, if we know what causes the pain, how it is apprehended, the value it has for the subject, the role it plays in decision-making, action, and so forth, we shall have all that we require as far as our explanatory needs are concerned.

This leads to the sort of position Hamlyn takes[21] concerning cognition, action and consciousness, namely that with regard to sensations per se 'epiphenomenalism' is entirely plausible. In effect, then, sentience as a primitive quality of mental processes is taken to be irrelevant to explanation. Putnam further emphasizes the point by saying that the logical (cognitive) structures of our mental life could be effectively modelled in any physical form,[22] without any need for the sentience which seems to be empirically attached to a special sort of matter, i.e., protoplasm.

B. Difficulties With the Cybernetic Position

1. A persistent problem with artificial intelligence research has been the predisposition to a behavioristic account of cognitive activity. Inspired perhaps by the Turing Test, AI workers have often sought to build computer simulations which operate on superficial, behavioral similarities to natural intelligence, rather than on the underlying cognitive structures. A good example of this is Weizenbaum's "ELIZA."[23] ELIZA will, at least for a short time, give the impression of a sophisticated semantic analyzer-and-synthesizer. After a while, however, the impression will diminish as ELIZA repeats stock phrases in order to acquire more syntactic information. In fact, ELIZA is simply a clever syntactic device, a "conversation-continuer"[24] which lacks a semantic interpreter altogether.

A good deal of the early simulation attempts in game-playing, problem-solving, and pattern-recognition suffered from the shortcoming that, because behavioral similarity was given precedence over (cognitive) structural similarity, they could not deal with diverse, complex or vague situations. Each program addressed itself to such a narrow slice of cognitive behavior that its ability to mimic real intelligence was quite small.

2. The charge was subsequently made that "computers could only do what they were programmed to do, hence it was the intelligence of the programmer, and not the machine, which solved problems." To deal with this sort of objection, the attempt was made to build programs which could deal with a variety of situations, and could develop its own strategies and techniques. The AI star of the '60's was the program GPS (General Problem Solver) developed by Newell, Simon and Shaw.[25]

GPS was designed to extract key features from problems, analyze the logic of the problem, generate procedures for dealing with the problem, and then attempt to solve it. The focus was on the generality of GPS, i.e., its ability to handle a wide range of situations, and on its capacity to develop its own heuristics. Unfortunately, a careful examination of the major routines of GPS reveals that the key-feature analysis depends on the logic found in the "table-of-connections" which is preprogrammed, and the technique-generator depends on a selection, by GPS from its "main-methods" table. In short, the critical features which would emancipate GPS from the stigma attached to traditional mechanism are obscured but not removed. Given a vague problem to solve (or one which fails to fit into the 'logical schemata' GPS uses for key-feature extraction) GPS is at a loss. Moreover, increasing the size of the table-of-connections or the main-methods group would not help to answer the initial objection, that the program fails to actually "cognize" its environment, although it would serve to increase GPS's ability to appear cognitive.

3. The real problem lies in the fact that the task environment for GPS and other AI programs is only an "internal representation" of the world in a limited way. GPS does not produce its own symbols and values, but merely manipulates the symbols and values according to its preprogrammed instructions. Consequently, it fails to "apprehend" relationships and perspectives which are not already present in its explicit, atomistic logical structure. Put another way, its symbols lack "meaning" for it, although they possess logical significance. In effect, it is not dealing with a language proper, but rather an uninterpreted calculus.

Augmenting the symbols of this sort of calculus will not invest the program with meaning. AI researchers who have hoped and expected that the answer to the program failures in cybernetics would lay in higher-power programs have, as Dreyfus has pointed out,[27], been sorely disappointed. What is required is a new direction; ironically, the most promising lead comes from an area which cybernetics has chosen to ignore, the area of sentience.

C. Updating the Cybernetic Thesis

1. Let us imagine a child being born paralyzed from the neck down and capable of receiving sensory stimulation along the auditory channel only. Furthermore, its auditory sensations would be particularly tenuous, admitting of virtually no variation in tone, volume, pitch, inflection, and so forth.[28]

Conceivably, our hypothetical child could be-conditioned to elicit differential responses (of a vocal sort) to auditory input and, presuming that its brain were in good working order, we might eventually train it to perform various sorts of calculations. Could we suppose, however, that this child actually "understood" the mean-
ing of those operations, that it possessed concepts, that it used language? I think not. Yet this is precisely analogous to the situation present in the contemporary approach to artificial intelligence. The end-product of human cognitive development, symbolization, is isolated from its lengthy and intricate origins and expected to, as it were, "stand on its own." It is no wonder that semantic information processing has bogged down: the attempt to get symbols to "speak for themselves" is futile.

The primary question that cybernetics must turn to is how symbolization evolves in the child. Perhaps the most challenging area of research in cognitive development lies in the period between birth and the moment, some twenty-odd months later, when the child first begins to speak. As Piaget has pointed out, one of the greatest mysteries is how the neonate develops from the sensory-motor stage to that of pre-operational thought. One thing seems fairly obvious: the ability of the child to synthesize a meaningful internal representation of the world is contingent on the variety of his sensory experience together with his capacity to act on the world itself. An action-oriented approach to cognition may well be essential to producing a symbol-synthesizing artifact. Equally important, however, is the role that sensory information plays in the initial stages of sensory-motor development. In other words, in order to provide a device with the ingredients required to generate a rich internal representation of the world it may be requisite to give its faculties for sentence similar to our own.

For these reasons I am inclined to agree with Dreyfus' somewhat controversial remark that "intelligent behavior requires that the agent have a body." If the cybernetic investigation is to continue, it must look into the relations between the logical-descriptive account of the contents of consciousness and the genetic-biological account of origins and development.

NOTES

3. A source of this type of discussion may have been Aquinas, cf. Summa Theologica, Quaestio XIII, Art. 2 ad fin.
5. In De Corpore, Hobbes offers an analysis of sense perception and cognition which combines the Aristotelian account of the mechanics of perception and the Democratian account of the atomistic nature of matter. He denies the concept of "mental substance" and refers to mental events as "fancies" or "illusions."
6. A typical example of Descartes' fascination with the mechanics of perception may be found in his work on vision, essays 4-7 of the Dioptric.
7. La Mettrie, for example, expresses his gratitude to Descartes (p. 142 of L'Homme Machine) for paving the way towards the Man-Machine doctrine, although the Cartesianes were bitter critics of La Mettrie's "perversion" of the bête-machine doctrine.
8. In 1895, Freud prepared a lengthy paper entitled "Project for a Scientific Psychology" in which he took up the problem of psycho-physiologcal relations in it, he speculated on the structure and processes of the brain although virtually no attempt is made after 1895 to "carry out" the "Project" or further clarify it.
9a. Turing, A.M., "Computing Machinery and Intelligence," reprinted in A.R. Anderson, Minds and Machines, Prentice-Hall, Publ., N.J., 1964. Anderson states (in 1954) that "since 1950 more than a thousand papers have been published on the question as to whether machines can 'think.'"
12. For want of a better word, I use the term "cognition" to cover the broad category of "mental" words which have discursive use. Thus, I lump "intentionality," "rationality," "decision-making" etc., under the rubric of "cognition." Any mental faculty, state, or process which can be analyzed into descriptive components is spoken of as "cognitive." Anything which cannot, i.e., the variety of "raw feelers," are lumped together in the category of "sentience."
15. This in no way conflicts with Wittgenstein's arguments against private language. Insofar as the "meaning" (qua use) of a word is concerned the Wittgensteinian analysis is generally correct. Indeed, Geach (in Mental Acts) is generally correct in arguing that a blind man can have the proper meaning of vision words even though he is blind. What I am asserting is that the intentional content (in this case the experiential content) is lost although the intentionality is not when the subject has no sensation to relate to certain linguistic expressions.
17. An interesting analogue to this is the problem that faces a programmer who attempts to access and operate a computer for which he lacks the appropriate instructions. An amusing story concerning this problem may be found in M. Apter, The Metaphorical Brain, Wiley & Sons, N.Y., 1972, pp.11-12.


22. In the discussion of Putnam's paper, (op. cit., ftnt. 19) he suggested that if we look at human mental structure as that of a Turing Machine then, in order to understand it, we may concentrate solely on the logic and ignore its physical instantiation. The logical machine may be realized in protoplasm, metal, or even sawdust without any loss in cognitive structure.


28. This example is one I have used before and elaborated on somewhat in M. Ringel. "An Application of Piagetian Methodology to the Problem of Encoding and Recognition," in S.A.T. Document Series, Vol. 75, No. 28, Spr. '75.


Philosophical Precursors of Cybernetics

Kant and Adam, or the Model of Cognition

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Were it far-fetched to claim the esoteric figure of Pascal as a precursor of our discipline, would it be less so to claim the esoteric Kant? But is this a problem for our discipline? And were it to be held as such, what could we learn from it? But is this problem really in the branchings of our family tree, or is it rather in its roots? Not: "Who are to be counted among our precursors?" but: "What is a 'precursor' in any sense we can accept?"

Let me pose this problem drastically: Is Adam—the archetype of the precursor, the father of mankind and thus of philosophy as well—a "precursor" of cybernetics?

Now there are three ways to deal with such a question. We can answer "yes," we can answer "no," we can say simply "nonsense"! Despite the latter way's attractions, in keeping with the kindred spirits of inquiry and whimsy, I would propose we answer "yes" and see what follows from this affirmation.

Adam as Philosopher

Certainly Adam must rank as one of the most successful of philosophers, if not of scientists, for "whatsoever Adam called every living creature, that was the name thereof," but we may consider whether this success was due to his special genius or the favorable environment in which he worked: not only was it his privilege to reside in Paradise at that time but, as its first resident, he did not have to contend with confusions perpetrated by any forerunners or precursors in his field. Be that as it may, the problem remains whether the success of his naming was due to his unique and powerful position as the first namer or rather to his perfect cognition of the creatures' true names—the names which God in creating them had given them? Or in other words, are we to consider Adam the archetypical nominalist (for whom the named precedes the naming) or the archetypical realist (for whom the naming precedes the named)?

Nominalism vs Realism

Over the ages since the Fall, the underlying question has not ceased to exercise the philosophers, as in the famous medieval controversy, largely because of its theological implications. Stepping outside that mode of thought, we may say that the problem—still with us—is this: nominalism implies ultimate contingency; ultimate necessity implies realism. These are the extremes of Hume and Leibniz. For Hume, universals are but names for the mere habit and custom of cognition in an ultimately contingent universe; for Leibniz, ultimate necessity is guaranteed through the composition of the universe out of universals: the nomads. Nominalism, contingency, scepticism on the other hand, realism, necessity, dogmatism on the other comprise the epistemological legacy of Adam from before the Fall on down to Kant.

What Kant was after can be approached from this side also: the reconciliation of nominalism and necessity. As everyone knows, he effected this by making universals the necessary framework of cognition, by making names its "categorical" framework, by giving it to the universals to be not names of classes of objects but of the possibility of those classes. The Kantian cognizer of the world is not its passive recipient (nor certainly its creator) but its active organizer: the act of naming and the act of cognition are for him at bottom one.

Now what is important for us and what gives us the sense that Kant was a "precursor" of cybernetics (at least insofar as cybernetics has turned to the problems of epistemology, which might be called its McCulloch tradition) is that he proceeded not by erecting a system...
of metaphysical statements about the world but rather by constructing, in a double sense, a "model" of cognition. "Model" first of all in the sense of a miniaturization and thus abstraction of our cognition of our own cognition (for every change of scale is an abstraction) into a network of axioms and propositions; second in the sense that for him the set of all entities (all namings) that satisfy these axioms (that "model" it) are at the same time a model (our model) of "the world" (about which nothing can be said except in relation to the model of cognition). Furthermore, the Kantian model of cognition "satisfies" itself; the model can model itself with increasing abstraction but without contradiction, recursively until a single point remains: the point that we can be and are cognizant of our own cognition, that we name ourselves even as we name the things. Every naming names the namer just as he names the thing he names. But the thing he names escapes his naming while he remains its namer and its name.

Which brings us back to Adam and his Fall. You remember that God looked out upon Creation and saw that it was good. Whence then the evil of which the apple gave them knowledge? Answer: through the act creating it while knowing it by naming it. Or for Kant: the world the knower knows by naming it rests upon the ethics of his naming. Or for cybernetics: Ashby used always to say in his seminar, again and again, that the system is what the scientist chooses to call the system (may our choices be good choices.) — May we name "Adam" our "precursor"? We must say "no" not only because "he" is a mythological figure but also because "precursor" empirically makes no sense no matter to whom we give this name; we would say "yes" because consideration of this naming reveals to us the logic and the ethics of our namings. And therefore, finally, we would not say "nonsense"!
Cybernetics and Yom Kippur

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Abstract

This note explores the applicability of a cybernetic paradigm of systems to the religious holiday of Yom Kippur, the annual Day of Atonement in Judaism.

Introduction

In [5] Shakun develops a hierarchical model for purposeful search, adaptation, and self-organization in purposeful systems. This includes a referral process between operational goals and values wherein goals and/or values can be changed. These goal/value adjustments are interpreted in [6] as discontinuous changes in operational constraints and related values associated with discontinuous changes in cognition (more generally, consciousness). We note here that such discontinuities can follow from positive feedback within the cybernetic process. Of course the latter, through the use of negative feedback, also allows for continuous change at both operational and values levels. This view is consistent with an emerging cybernetic paradigm of systems incorporating nonequilibrium and hierarchical concepts [2, 3].

It is within the above context that we shall explore, in part, a religious paradigm. It is for the Jewish Holy Day of Yom Kippur—the annual Day of Atonement. The exploration is of interest in its own right and indicative of the wide class of systems for which the above cybernetic paradigm is relevant.

Cybernetics and Yom Kippur

In modern control theory the basic cybernetic paradigm of control involves three steps [4]:
1. Specification of goals and performance measures influenced by feedback from step 3;
2. Operation in pursuit of the goals through a course of action selected in step 3;
3. Evaluation of performance resulting in respecification of goals and reselection of a course of action for further operation.

In control theory this cybernetic cycle is expressed at the operational level as the pursuit of operational goals. These are goals and means to attain them which are defined by specific, unambiguous operations and performance measures. Thus the cybernetic paradigm in control theory is normally viewed as an operational model. It is, however, also applicable to the non-operational or values level as well. As discussed in [4, 5], the values and operational levels are hierarchically related in a goals/values referral process.

Turning to Yom Kippur, we note this is the annual Day of Atonement for past sins and of turning back to God through repentance. In the Yom Kippur liturgy the word most often used for sin is het, which means "a miss"—missing the target as an archer might miss it [1]. In Judaism the target is to find God. The means is through right deeds. The Hebrew word for repentance, teshubah, means "turning back"—turning back to God. This involves deep sorrow for sins committed and a resolve not to repeat them. Thus the basic Yom Kippur paradigm involves

1. A target—to find God;
2. A means—through right deeds;
3. Missing the target (sin or het) and repentance (teshubah) or correction—a turning back towards the target.

This Yom Kippur paradigm is evidently cybernetic at the nonoperational or values level. We shall develop it in a little further detail and relate it to the operational level as follows:

1. A target—to find God. This is perhaps the ultimate value. The challenge is to translate this ultimate value into more specific values—right deeds—by which to pursue it.
2. A means—through right deeds. The Torah as book and tradition [7] provides guidance to right deeds and operational goals, thereby linking the values cycle to the operational cycle which delivers the values. Thus the referral process is guided by the Torah.

3. Missing the target—sin. It is interesting that this includes sins of commission as well as omission (opportunity costs). Repentance or correction—repentance, prayer, and charity avert the evil decree and lead man back to God. The Rabbis distinguish between repentance from fear (which is acceptable) and repentance from love (the highest form of repentance).

The cybernetic cycle allows for use of negative and positive feedback. Negative or deviation-reducing feedback operates to bring the system on target when the goals remain fixed. Positive or deviation-amplifying feedback permits a system to break out of its present structure and develop new goals [2]. It is interesting that in addition to het, meaning “a miss,” there are two other Biblical Hebrew terms for sin. One is avon, which comes from a root meaning “to be crooked.” The other is pesha, meaning “rebellion” in the sense of a man who sets himself as the sole judge without reference to God, evolution, or laws outside of himself. Avon and pesha may be interpreted as sins in choosing means—i.e., in choosing right deeds (values). They require positive feedback, whereas het is handled by negative feedback.

REFERENCES
Cybernetics Research
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Introduction
In February 1971 a small group of American Society for Cybernetics members met at Arlie House in Warrenton, Virginia to consider the future of the Society and its publications. This paper is a revision of the talk I presented under the title "Agape—The Missing Box on Cybernetic Charts."

In his letter of invitation then-president Dr. Carl Hammer stressed the opportunity that the conference provided to examine how the ASC could assume "its rightful place on the American and international scene for goal-directed research." While I applauded that objective and will contribute to its realization, I wish to advocate a bolder agenda for the Society. It seems to me that the numerous crises about us provide strong stimuli for science, and in particular the American Society for Cybernetics, to make unique contributions to society. We may recognize the belief of some that science and the management of society have little in common. For example, Lee A. DuBridge, Nixon's science adviser revealed that the president insisted that science prove its claim to being an instrument for solving social problems. Nevertheless, it is not true that for the ASC to accept any lesser challenge is to belie the finest boast of its tradition. Said Plato in Cleitophon, "...the art of steering (kubernetikein) men which is the name that you, Socrates, frequently give to politics..." One of Wiener's associates and a participant in the conference stated this boast as follows: "Wiener viewed such subjects as sociology and economics as branches of cybernetics."

These are proud words. Are we ready to start delivering on their implied promise of a total systems approach to human organization? Probably not, yet I believe we should be devoting some of our resources to the task.

Historical Perspective
By way of background to my proposed agenda for the ASC, let us commence by recognizing that the nation is passing through a boundary between two ages and is facing many of the same psychological adjustments that people faced at previous boundaries, such as the Renaissance and the industrial revolution. This new boundary is marked by familiar signs. Technology has achieved its goal of creating a surplus of goods and services yet, even in America too many people live in poverty. While science has answered many of philosophy's ancient puzzles it has failed to inform, much less satisfy the majority of people that these answers are valid. Dramatic advances in health care capabilities have only shifted the problem from death by disease to catastrophe by starvation and pollution. In advanced countries higher education may have become too universal. It has certainly failed to solve the identity crisis for half of the occupants of hospital beds.

Present Perspective
The prospect is that for at least five more years (in 1971 I wrote ten more years) the nation will continue to show the signs of deterioration which so distress us, such as rising crime, low public morality, neglect of the work ethic, and a declining sense of personal responsibility. In agreement with the Judeo-Christian heritage I assume that some agencies can and should intervene to stop this deterioration. Such a moralistic position is arbitrary, of course. It is subject neither to proof nor disproof, and success is in doubt.

At Arlie House I labeled the 1970's "The Decade of Values." Today, I would expand the title to "The Decade of Values and Systems" to recognize the importance of interactions among parts of society. This decade will continue to be a period in which the United States seeks a new consensus on goals, call them values if you wish, following the debacle summarized by the word "Watergate" but encompassing much more than Nixon's wrongdoings. The last formal consensus was published in 1960 by the President's (Eisenhower) Commission on National Goals under the title "Goals for Americans."
The values which I saw in 1971 and still see in 1977 as likely to gain attention in the 1970's are as follows:

1. Recognition of human dignity. Increased freedom, equality of the sexes, privacy of life and records.
2. The ecological vision, but this will not be achieved until the late 1980's because of the energy shortage. Short-term, some forms of pollution will increase.
3. Mandatory family planning. China and India have adopted this policy.
4. High job mobility, multiple careers. Both are common in the United States. It is estimated that some 20% of the population moves each year.
5. Increase in imposed and self-discipline; probably will be delayed to the late 1980's.
6. Guaranteed annual income and a national health plan. These are being discussed but are not likely to be law in the U.S. until 1982 at the earliest.

What is Cybernetics?

Choosing to analyze nothing less than the universe of knowledge and experience, cybernetics can achieve distinction by fathoming the holistic application of resources needed to satisfy human needs or it can be a decaying ripple on a sea of timidity and small purpose. I would like to think it can become the dominant discipline in the interface between the post-industrial revolution and the next period before us which we might call "the age of cybernetics."

There are at least four main areas of cybernetics, only two of which have received much attention. These are theoretical cybernetics, practical applications, boiler plate, and values.

Under theoretical cybernetics I would include most of the presently-available literature, including Golovin's fourth branch of government, international monetary exchange, and the whole field of policy science. Given the backgrounds and interests of Wiener, Bigelow, McCulloch, Pitts, Craik, Von Foerster, and other founders it is not surprising that most developments up to the present time are in theoretical cybernetics.

Practical applications of the cybernetics of inanimate objects, such as control theory and linear programming, is a well-filled class. But when it includes humans, such as in sociology and economics, practical applications is almost an empty set. Unless the ASC fills this set its future will be quite limited. One participant wrote: "We must design a world society which can communicate with and accommodate the seven billion people who will exist by the time we can implement it so they can all co-exist in peace."

A friend added a note of caution to this statement. It is always a question in my mind how much we can design a new world society. We have to understand man's nature and the necessary interrelationships in society (whether we call them sociological, economic, cybernetic or systemic) to do any design. In any case, one cannot consider the human psyche or society infinitely plastic. We must understand the nature of the material we deal with if we are to manipulate it successfully, or at least to guide it in certain directions, or get it to guide itself. This means you must explain your philosophy, proselyte and act.1

This is a wise note of caution. Rather than "design" in the engineering sense I have come to think of the cybernetic process when applied to society as closer to dynamic programming. One does not choose a static goal but rather asks the ongoing question, "Where do we go from here?" All static social designs fail.

Boiler plate is a term borrowed from business to describe the housekeeping and other services that a professional society, such as the American Society for Cybernetics should perform for its members and its discipline. Included are publications, meeting arrangements, and the like. Possibly the most important project this Society could perform in the next few years would be to promote an educational and experience program for future managers. More will be said of this shortly.

A major thrust of this paper, to be discussed further below, is that values should be included in cybernetics. They are generally overlooked.

Proposed Agenda

I propose that the ASC examine the opportunities provided by the crises about us in the perspective of the four areas described above. This can be done by establishing four or more task forces under the rubric Cybernetics Research Applied to National Needs (CRANN). The target of each CRANN task force should be specific recommendations for action (or no action) in its assigned area. A subsequent conference could set priorities, allocate resources, consider strategies for implementation and seek sources of outside support. To provide a focus but not a limitation for each task force a few suggested topics are given in the following paragraphs. The order is random and does not imply a ranking of priorities.

Theoretical Cybernetics

Targets of this CRANN task force would include developing a mechanism for society to make its social wisdom cumulative just as science is cumulative, and to tabulate in the spirit of Berelson and Steiner’s laws of economic and social interaction, with carefully delineated boundaries outside of which each law is invalid.

1. Publish a "Handbook of Cybernetics" with chapters composed by the most knowledgeable authors in each area.
2. With others outside the ASC examine the status of Golovin’s fourth branch of government. Does it now exist in part? Should it be promoted?
3. Develop flow charts showing the many ways that social changes come about.
4. Even though life is non-linear cybernetic charts are still drawn as linear models. There is needed a theory of large, non-linear systems. Such a theory might prove to contain rich insights into bottlenecks which are impeding social and economic progress. In particular there is needed an understanding how initial conditions determine the steady state solutions, how these steady states compete and cooperate, and how they grow, decline or merge with others. If for the term...
“steady state” we substitute the word “nation” the immediate usefulness of this study becomes obvious. Some of the work of this CRANN task force might be supported by a grant from the NSF's RANN program (Research Applied to National Needs).

**Practical Applications of Cybernetics**

As a summary of the importance of the work of this CRANN task force we could use the words that Goethe puts into the mouth of Mephistopheles in Faust: “My dear friend, all theory is gray; the only green is the golden tree of life.”[3]

This is a very important area for the ASC to work in. Here are some possible topics for the task force on practical applications:

2. Must there be a trade-off between full employment and inflation? The Phillips curve.
5. The economic consequences of full employment, a steady-state, a national health plan, and a guaranteed annual income.

**Boiler Plate**

Topics which this CRANN task force could consider include:

1. Prepare grant requests.
3. Form a committee on cybernetic nomenclature.
4. Establish a flexible program to educate national managers. Alternate them between work and training periods. France and Russia already have such programs active.

**Values: Wither Are We Tending?**

From among the numerous stable cultures which have persisted over long periods, or from among new possible cultures, which ones do we prefer? Some famous persons have asked the same question.

If we could first know where we are, and wither we are tending, we could then better judge what to do, and how to do it. (Abraham Lincoln)

There is only one quality more important than know-how. This is know-what by which we determine not only how to accomplish our purposes, but what our purposes are to be. (Norbert Wiener)

A friend has said it rather succinctly in these words.

Cybernetics is concerned with steersmanship but it doesn’t say what your journey should be.[4]

**Agape**

The Missing Box on Cybernetic Charts

For the first time in history man has a temporary abundance of goods, but is destroying by overpopulation the opportunity to develop an equitable distribution system. When that problem is solved he must learn new motivations for service to his fellows which do not derive from competition for scarce resources. That such service is a requirement of his psyche is a clear message from many youth.[5]

The ancient Greeks had a word for it which is still appropriate, agape. Let you have only an abridged dictionary which stops with the meaning “love feast” here is a fuller definition:

Unselfish love of one person for another without sexual implications; brotherly love. A meal eaten in token of brotherly love and charity; a banquet or gathering of persons to promote good feeling, restore friendly relations, honor a special guest.

Agape is an important value and we must learn how to put it into analyses, how to make group interest and self-interest coincide, how to generate feedback error signals which make good social behavior attractive, how to maximize the payout matrix for ethical action. We must learn how to connect a box labeled “agape” on cybernetics charts and realize its embodiment in real life. In short, what is needed is a clear cost statement for agape vs selfishness.[6] There is also a need for a Leontief-type input/output matrix of social values and costs.

Democracy is one of the great values of the West. Since in some cases it is inefficient, slow, and disorganized it is certain to remain under attack for some years while pressures mount for solutions to social problems. Another committee of the ASC should examine the foundations of democracy and how these may be affected by mass communication, synaptic management, electronic surveillance, centralized personal data banks, and new techniques of chemical, electrical, and surgical brain control.

**Perspectives of the Future**

In musing about the Arlie House conference in the intervening six years I’ve wondered how practical the proposals above are for the ASC or for any other professional group. Has the time come for cybernetics? As an aid to answering that question I’ve prepared a series of forecasts extending into the next century. Each forecast is stated without reference to the forces which may cause it, whether controllable or not. The reasons for each are beyond the scope of this paper.

1980's: The Decade of Famine and Pollution

1. Millions die of starvation every year.
2. Dematerialization of values among prosperous nations.
3. End of the protestant ethic and of economic man in developed countries.
4. End of conspicuous consumption.

Comment: I am not as certain of 2-4 as of 1.

1990's: The Decade of Euthenics

1. Rebuilding after the famine.
2. Decline of crime and war.
3. Decay of computer-assisted instruction.
4. Psychological crisis of the West in a plateau culture.
5. Rise of the scholar and the artist.
9. Complete integration of races and groups.
In 1971 Rubin commented on the last prediction as follows:

I do not believe that complete integration of races (as distinct from desegregation) is something we want, because with the removal of specialization and of differentiation there will be more competition. There will always be resources to compete for. Specialization and speciation make for less intense competition.\[1\]

2000's: The Homeostatic World
1. Eugenics by control of genes (DNA).
2. Population of USA leveled at 300 million.
3. Three days of make-work per week.
4. Low productivity, end of the Taylor-men.
5. Low student/faculty ratio in colleges.
6. Philosophy flourishing.
7. Brain control of criminals.
8. Theorems of Goedel, Church, and Heisenberg taught in primary grades.
9. Synthetic life; artificial organ banks (not brains); longer life.
10. The ultra-intelligent machine challenges man at several levels.
11. Long-range planning by decades or more.
12. End of war

Conclusion
I believe today, even more strongly than in 1971 that the time for a cybernetics (systems) approach to social organization is now. While Goedel's theorem may limit the completeness of an analysis there do appear to be extensive areas of commonality between science and the management of society. Professionals should be about the task of exploring those areas.

REFERENCES
3. I am indebted to Edward A. Ruestow for this rendering of the original German, "Grau, teuer Freund, ist alle Theorie und gruen des Lebens goldner Baum." Personal communication.
5. Comment by Milton D. Rubin in 1971: "I maintain that as we reach abundance our systemic relations become more closely coupled, resulting in serious pollution, and there will always be competition for scarce resources like low-sulfur oil. As we use more materials we will have to be more concerned about wastes, so there may not be a cheap abundance."
6. Comment by Milton D. Rubin in 1971: "I think we need to understand trade-off amongst values. In many ways group interest and self-interest may tend to be irreconcilable. We would like to optimize the relationship but we must understand them first."
Cybernetics and the Oil Issue

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The United States is faced with the problem of increasing self-sufficiency in energy in order to reduce the threat to national security stemming from the present U.S. critical dependence on oil imports under the complete control of a wholly foreign international cartel. Proposed solutions to the energy problem have tended to focus on oil rather than on other forms of energy. Arriving at a sound national long-run policy on oil consumption, production and imports has become a highly controversial issue, polarizing the Congress and the President, Democrats and Republicans.

The oil issue is extremely complex. A host of interacting factors must be considered if the problem is to be solved rigorously. Yet, in public discussion, the issue seems to have revolved mainly about only one of the variables, namely the price of oil. This focus of attention on one variable, and the resulting simplistic approach being taken to the solution of the energy problem, has resulted in two diametrically opposite solutions by the Congress and the President—astounding when the Cybernetic approach offers means of identifying a range of optimal alternative strategies.

It might be worth while elaborating how the Cybernetic approach would attempt to contribute to a solution of the oil problem. First, the Cybernetician would insist that a comprehensive view be taken of the whole energy economy, and that all variables for all existing and potential sources of energy and their interactions with each other, be included in the analysis. For the sake of this article let us assume that there are \( N \) different sources of energy available, including oil, natural gas, propane, coal, hydroelectric power, wood, as well as many presently uneconomic sources such as solar power, geothermal power, tides and oil shale. Assume oil is the \( N \)th source. Measure all quantities in energy units.

Then, obviously, at any time:

\[
\text{Oil imports} = \sum_{n=1}^{N} \text{Consumption}_{n,t} - \sum_{n=1}^{N} \text{Domestic Production}_{n,t} + \sum_{n=1}^{N} \Delta \text{Inventory}_{n,t}
\]

Where \( \Delta \text{Inventory}_{n,t} \) is the increase in inventory of source \( n \) between time \( t-1 \) and time \( t \).

This fundamental supply-demand equation can be extended over time by means of functionals so that a dynamic model of future oil imports is derived.

In elaborating this fundamental market equation, the Cybernetician would identify certain economic coefficients which relate demand for each type of energy to its price in the marketplace, domestic production to its price in the marketplace, and imports of each non-oil form of energy to its price in the marketplace. These relationships are, of course, of the normal form. Demand falls with increase in price and domestic production increases with an increase in price.

It is significant, however, that in the first place, Government restrictions on prices of oil and natural gas have created not a single market price of oil and natural gas in the U.S. marketplace, but a spectrum of prices covering imports, old production and new production. And in the second place, no one apparently, has developed the precise shapes of the curves relating demand for each form of “energy” to its market price, or relating production of such “energy” to market price if only one equilibrium price—the free marketplace—were to prevail.
To complete the Cybernetic approach we should also array the whole set of alternative government actions which might conceivably be utilized in solving the energy problem. These consist of: physical control of the volume of imports, tariffs on imports, price control, rationing, taxes on different products which use energy, taxes on consumption, subsidies to energy-saving investment (e.g., insulation), subsidies to various forms of energy investment, subsidies to production, etc.

The Congress and the President, in their proposals to solve the problem, have given passing attention to a number of the basic facts and relationships and possible Government interventions which are involved. However, the Cybernetic approach must insist that every conceivable variable be given its due weight simultaneously. Moreover, we must establish from the outset, a national objective function which will control the optimization of the solution of the problem. We must also introduce constraints which would exclude or confine those areas in which solutions might be found but which are unacceptable for one reason or another.

In the case of the objective function, one simple objective might be "to eliminate oil imports, by some date, regardless of the cost to society." Another objective might be "to minimize imports subject to no additional cost whatever to society," or "to minimize oil imports subject to some upper limit to the cost to society," or "to minimize imports subject to no increase in the price of oil," or if we wished to become more sophisticated, to develop a set of indifference curves of cost to society as a function of a given reduction of oil imports, each curve representing the combinations of cost and amount of curtailment which are subjectively equally acceptable, the higher curves representing the least costly indifference curves.

We can then confront the indifference curves (the objective function) with the opportunity curve, the latter being the curve relating a given reduction of oil imports to the lowest cost to society of achieving that reduction, given the technological and economic relationships and the various constraints. The optimal solution for society at any time would be represented by that particular point on the graph which enables society to climb to its highest possible indifference curve (opportunity curve tangential to the highest achievable indifference curve.) And that point would imply the particular set of Government interventions associated with minimizing the cost of achieving that particular reduction of imports. It is to be noted that such an approach would take account of every feedback and every feedforward of every one of the numerous variables involved in the problem; it would be a truly cybernetic solution.

A variety of political, social and economic constraints may also be imposed in implementing such a solution technique. Such constraints might be that the cost of the reduction of imports be spread over different income groups in proportion to their marginal tax rate, that different areas of the country not suffer a higher cost per capita than others, that employment impacts in different parts of the country be distributed evenly, and so on.

Most of these kinds of constraints are essentially political in nature and their introduction could obstruct any feasible solution to the problem. Discussions of the oil issue in the Congress, by the President and by the media merely ignore most of the complexities and implicitly use intuitive, extremely simplified (and therefore fallacious) models.

If one regards the overall discussion as presented in the media as some indication of the implicit desired objective function of society and the types of constraints which the nation would like to impose on any solution of the problem, two main thrusts seem so far to have been dominant. First, there has been an implication that no solution is acceptable which would raise oil prices significantly or even increase the cost to society in any way. Obviously there can be no reduction in imports, given the technological and economic relationships involved, which can satisfy this condition. The other thrust, which has only been implicit, is a desire in some quarters to utilize the oil problem (and, incidentally, any other problem), as an opportunity to achieve redistribution of the national income. This, of course, is perfectly legitimate so long as everyone is aware that this objective has been added as part of the objective function, but I suspect that since it is implicit rather than explicit much of the disputation and polarization we encounter arises out of the fact that the different parties involved have different views of the degree to which those two objectives should be combined in solving the problem.

Clearly the oil issue is one which might benefit enormously from the cybernetic approach. If the true tradeoffs were only known between all of the various possible combinations of Government action and regulation perhaps even the politicians would amend their rigid stances and narrow the choice to alternative solutions which, while perhaps not optimal, would at least be in the restricted domain of the most efficient solutions and not, as now, at diametrically opposite and, possibly, quite inefficient ends of the spectrum.
Cybernetic Factors in Economic Systems

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Introduction
Many studies have been made to explain the complex behavior of economic systems. One of the most famous is the input-output analysis of Wassily Leontief.1 In this study he showed the interrelationships of consumer inputs and producer outputs. Like many matrix analyses, this one does not fully identify the cybernetic nature of the factors involved. Feedback can be present which has a cybernetic nature. Other factors generally exist that have a cybernetic effect on system response. In his explorations into behavioral cybernetics, John Vroodsky hypothesizes that there are major cybernetic limits beyond which the system cannot continue to operate.2 These are limits where the losses will exceed the gains, if these limits are examined with respect to the communication processing that takes place within all dynamic systems, other cybernetic factors emerge to explain why economic systems behave the way they do.

Behavioral Cybernetic Concepts
Behavioral cybernetics maintains that the response of all organismic systems is the sum of two actions. These are the maintenance of internal and external balance. Internal balance is achieved through a three-step communication process consisting of input processing, response programming and transformation processing. The balance maintained during each step influences the ability of the system to exist dynamically. This internal balance can also be affected by the manner in which external balance is achieved. The ability of the system to sustain external balance is also dependent on the degree of internal balance. The establishment of external balance involves the manner in which inputs are obtained and outputs are transmitted. In economic systems these two steps are termed acquiring and marketing.

The establishment of internal and external balance can be abbreviated into a three-step operation consisting of acquiring, producing and marketing. The capability of the system to properly perform each step will determine the total economic balance. If either internal or external disorder develops, the system will be forced to change its behavioral response. In extreme cases, response may cease altogether. Because of this, these capabilities become the inherent cybernetic limits of the system. This phenomenon is explained by several behavioral cybernetic concepts.

Behavioral Cybernetics recognizes two dimensions of order that influence all organismic systems. These are the physical and biological dimensions of order. The biological dimensions are zero for purely physical systems, but with organismic systems, physical, physiological and psychological dimensions are present. Where restricted to humans these dimensions are commonly termed human factors of order. When applied to economic systems, they are known as the physical, economic and judicial capabilities of the system. The balance between these three dimensions will affect the total well being of the economic system.

Behavioral cybernetics also identifies two major external factors that are important in explaining system behavior. These are the external source of inputs and the external consumer of outputs. Each has a physical, economic and judicial nature that will affect the balance of order in interacting systems. The points of maximum available inputs and outputs are cybernetic limits that cannot be exceeded.

In summation, the economic system is constantly involved with maintaining an internal and external environment. The internal environment is established by proper input processing, response programming and transformation processing. External balance is achieved by acquiring inputs and marketing outputs. The overall process of generating internal and external balance can be shortened to the steps of acquiring, producing and marketing. This process exhibits physical, economic and judicial properties. These properties are internal cybernetic limits which will influence the behavior of the system. There are also two external factors cybernetically limiting the performance of the system. These
factors are the availability of inputs and markets. They too are cybernetic limits beyond which the system cannot operate. Like the internal factors, these factors will have physical, economic and judicial characteristics. The manner in which all of these factors of order influence the behavior of economic systems can be determined through input-output analysis.

**Input-Output Analysis**

When conducting input-output analysis, the general procedure is to chart accumulative inputs consumed versus accumulative outputs produced. Either linear or log-log graph paper can be used. The use of log-log paper makes it easier to analyze large amounts of data and it reduces the significance of minor variations in system response. If each data point charted on linear paper represents uniform passage of time, the variation between points defines the rate of action (reference Figure 1). If the action rate is increasing, the space between the points will be increasing. When a line is drawn through these points, the slope of the line is a measure of the efficiency of the system to produce the response being measured. If the response is constantly 100% efficient, a straight line will be produced with a slope of forty-five degrees. The line 0-100 in Figure 2 is such a response. If the system is only constantly 86% efficient, a plot-like line 0-80 is produced. The straight line indicates that the system has adapted and learned to control the response. A curved line indicates the system has not adjusted.

If the acquirability, producibility or marketability of the economic system is charted using accumulative input-output analysis, a plot similar to Figure 2 can be obtained. All three functions can be plotted simultaneously on one chart without any interference occurring. Acquirability can be plotted showing the ratio of inputs acquired to inputs consumed. Producibility can be plotted showing inputs consumed to outputs produced. Marketability can be charted showing the ratio of outputs produced to outputs marketed. When all three modified functions are plotted on one chart the cybernetic relationships of each becomes apparent.

Assume a simple 100% efficient system in which the inputs are consumed as rapidly as they are acquired and transformed immediately into outputs that are marketed as soon as they are produced. The line 0-100 in Figure 2 is representative of this system. In this simple system all three functions must be matched to maintain economic balance. This may prove to be a difficult if not an impossible task. However, the need to constantly match all three functions can be reduced by introducing feedback. Feedback diminishes the interrelationships to a practical level.

Accumulating inputs and outputs within the system is a form of feedback. It helps the system to develop a more stable balance. Stockpiling inputs allows the acquirability to be less than the producibility. It also decreases the dependency of producibility on acquirability. In addition, if an adequate amount of stockpiled inputs is maintained, the effect of acquirability on marketability is lessened. Accumulating inventory outputs can eliminate the need for the marketability to be matched to the fluctuations in producibility. Sudden increases in production wastes can be absorbed without upsetting the economic balance. The net results of using both forms of feedback is to increase the general economic balance.

The effect of introducing equal acquirability and marketability feedback into economic systems is shown in Figure 3. Studying this chart reveals the nature of these functions and indicates the manner in which the plots should be interpreted. As stated earlier, the acquirability plot indicates the efficiency at which inputs are acquired to the quantity consumed. As the acquirability decreases, the plot will take a more horizontal path. On the other hand, the marketability shows the efficiency at which outputs are marketed to the outputs produced. As the marketability decreases, the path will be more vertical. The producibility is a measure of the efficiency of converting inputs into outputs. Decreases in producibility moves its trajectory toward the vertical and closer to the acquirability limits while increasing producibility moves the path toward the horizontal and closer to the marketability limits.

The amount of feedback that can be developed by the system is dependent on its ability to acquire inputs and market-produced outputs. In turn this capability depends on the physical, economic and judicial order the system can sustain. It is a measure of the external balance achieved and the power to acquire and market. It is also a measure of the control obtained. Profits (the measure of economic order and control) must be realized on the energy invested or a loan must be obtained before feedback can be realized. The degree to which this economic order is successfully applied to maintaining internal and external balance is a measure of the judicial order. A low degree of judicial order may erase the economic order achieved. This will also reduce the power factor of the system. The power factor is the total of the
physical, economic and judicial order established. The area between the acquirability and marketability in Figure 3 is representative of the power factor of the system. It is indicative of the capability of the economic system to establish and maintain the control needed for its own welfare.

The previous graphs do not indicate the effects of the external limits of maximum available inputs and markets. These limits are shown in Figure 4. When acquirability, producibility and marketability are optimally related to these limits, the conditions illustrated in Figure 5 are present. They indicate the economic cybernetics that must be considered to understand economic system behaviour.

**Economic Cybernetics**

The important consideration depicted in Figure 5 is that the acquirability and marketability of the system, coupled with the input and market availability are cybernetic boundaries for producibility. The area enclosed by acquirability and marketability represent the only zone of economic order for production. To maintain economic stability, producibility must be adjusted to this zone. If the acquirability or marketability are approached by producibility, either the producibility will have to be improved or reduced, or the specific capability being exceeded will have to be altered to compensate for the degree of producibility that exists. If this latter condition is not possible and the producibility cannot be changed, a state of disorder will occur and production must stop until order is restored. The losses will exceed the gains.

It appears that improved efficiency of acquirability, producibility and marketability is the only real corrective action possible for economic systems in a non-monopolistic environment. Of the three, producibility seems to be the one factor that the system can most easily control. Acquirability and marketability, as pointed out earlier, are influenced by external factors. The priorities in correcting economic instability become first to improve the producibility and then to improve the system capability being exceeded. Reversing these priorities can lead to disorder.

Most economic systems, however, have not worried about waste. As a result, waste has been accelerating at 3 to 10 percent per year in many businesses. This has been an inflationary force and an economic depressant for many economic systems. If this trend could be halted and reduced, the savings could be utilized to improve the economic stability of the producer or passed on to the consumer. In some businesses this could amount to an increase in income of 5 percent if only manufacturing waste was controlled. There are similar losses in purchasing, marketing, engineering and customer service. Increasing production efficiency, by the 5 percent indicated, would give us time to develop more efficient methods of acquirability and marketability. Obviously, many countries have not been able to determine the amount of feedback needed to maintain economic balance. As most countries have found, you can't solve this problem by legislating how this is to be accomplished. Rather, it appears that our best hope is to borrow from industry and apply some of the principles and methods of quality control.

**Quality Control for Economic Systems**

The first act needed is to establish standards that define what quality level is acceptable. The standard can come from without but the solution must come from within the economic system. It must be permitted to establish internal controls that will assure success but not adversely affect the economic balance of other economic systems. This is not a simple task. The present economic conditions are evidence that we have not yet learned how to develop economic control standards. It is as though we have no controls and have not learned that all systems without control tend toward disorder.

One way to overcome this situation is to perform input-output analysis of acquirability, producibility and marketability to identify the failure factors. In quality control, the type of waste (material, equipment and labor), the manner in which the waste was produced (procuring, manufacturing, engineering, marketing, etc.), the action taken to minimize the effect of failure (restoration and salvage) and the human error that produced the waste (design, planning, equipment selection, equipment maintenance, workmanship, etc.) are identified and costed. With this information, it is possible to identify the group or person responsible for failure and request that action be taken to correct the condition and produced the failure.

**Performance Prediction**

Input-output analysis can also be used to predict system behavior if the system is not changed. The author has accurately predicted manufacturing losses. When the predicted imbalance was identified and the cause was fully defined, the responsible unit corrected itself.

Prediction of failure costs is not difficult provided the method of obtaining data is not changed and the system has not changed its mode of operation. The planned consumption-production can be added to the existing data and the path of past performance can be extended to indicate the unknown parameter.

If input-output analysis can be used to accurately predict manufacturing losses, it is evident that this analytical method should be capable of predicting behavior of national economic systems. Unfortunately, the author has not had all of the information needed to
substantiate this hypothesis. The stock market has been suggested as a valid index of marketability but it appears to be more an index of economic aspirations than performance. What is needed is actual acquirability, producibility and marketability performance data. For those who have access to such national data for the last ten years, it would be interesting to see if, when the producibility was plotted against the acquirability and marketability, the present and past economic conditions could have been predicted and explained. The author would welcome the result of any such analysis.

Conclusions

When input-output analysis is modified by the concepts of behavioral cybernetics, additional cybernetic factors for economic systems can be identified. It is also evident that these factors can be used for predicting economic response and for planning the failure prevention and corrective action needed to maintain economic balance. The degree to which this awareness exist can affect the economic balance obtained.

REFERENCES

Ethical Dimensions in Design and Use of a Socio-economic Model*

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Abstract
This paper describes design assumptions, rationale, and methods used in the design, construction, and ongoing redesign of a thirty-region world model. The model is a practical vehicle for scenario analysis via modeler intervention based on quantified presuppositions. This approach enhances the ability of the decision maker to use computer-based models. This model is also a vehicle through which one can test the feasibility of introducing ethical factors into scenario analysis.

Purpose
Regional World III (RW III) was designed as a working tool to gain insight into the ethical implications of computer modeling of social situations. The model is intended to provide an interface between those in the scientific/technical community who are beginning to apply sophisticated analytical techniques to social/economic/political situations and those whose concerns have traditionally been ethical/humanitarian but are now interacting across a broader spectrum with scientists/engineers and with social decision makers. This project is an attempt to increase awareness of this interaction within the Christian community in particular, but the ethical and value dimensions of the current world situation cut across boundaries of creed and philosophical persuasion.

Regionalization of the Model
The currently operating version of RW III encompasses approximately 99 percent of the earth's population (omitting only the population of a few relatively minor islands in the Pacific). The model divides the world into thirty regions (three times the number of the next most highly disaggregated model). This is not simply an attempt at size; this level of subdivision of the social/economic/political world system permits selection of at least one specific nation within each major type of region as a focus for observation. For example, we have selected Bangladesh as the representative of the Fourth World (resource-poor Third World nations). Other nations represented individually for varying reasons include: Iran, West Germany, Brazil, Indonesia, Nigeria, and Turkey, besides those nations generally regarded as great powers.

We chose to regionalize RW III by nations and groupings of nations because of accessibility of data and relative ease of comparison, especially with respect to validation. Obviously, a much finer breakdown could be offered by increasing the number of regions. However, fineness of breakdown loses some of its significance if the sizes of regions become too disparate, whether measured in people, economic strength, agricultural production or any of several alternative ways.

There are sound reasons for choosing different modes of regionalizing, e.g., linguistic, ethnic, religious, geographical breakdowns, but we have temporarily bypassed these alternatives, in part because of data problems but more importantly because we believe that political considerations prevail in the short run, and political boundaries cut across almost every kind of social boundary. We cite the following examples of political considerations superseding other factors in the short run: The differing economic behaviors of East and West Germany in spite of linguistic identity and ethnic ties, divergences in political behavior between the Islamic community within the Soviet Union and the Islamic nations in general, and geographic anomalies such as the separation between Chinese in Hong Kong and other Chinese or the division of the naturally unified St. Lawrence River basin by the U.S.-Canadian boundary and

the formerly economically integrated Danube Basin by the Iron Curtain.

I have been in frequent touch with Robin Hough of Oakland University, Michigan regarding a river basin model which I respect highly as a long-term descriptor of socioeconomic phenomena but consider less reliable than a politically differentiated model in tracking short-term behavior or the world system. One could make a strong case for the point that the initial endowments of regions determine their history, but I believe a stronger case can be made for the thesis that, given the present nexus of international relationships, political considerations often define thresholds of tension which require a quantum socio-political jump to cross. It seems further that this threshold value has been raised substantially by the threat of nuclear war.

Contributions to the State of the Modeling Art

This project hopes to advance the state of the modeling art in two ways: 1) by introducing new combinations of proven techniques to permit a dynamic simulation which is interactive on three bases: intra-region, inter-region, and year-by-year, 2) by introducing sliding scale social-choice equations into a dynamic model and testing ranges of choices to attempt to predict their effects, and more importantly, to illustrate the relative effect a potential user might experience by increasing or decreasing a chosen social priority. I shall comment briefly on each of these two aspiring advances in the state of modeling.

First, we believe our mix of techniques has the advantage of replacing one type of dynamic representation of the world by a more dynamic representation of the same system. Earliest dynamic simulations tended to represent major socioeconomic phenomena on a world-wide basis. Later simulations represented the same or parallel phenomena on a multi-region, worldwide basis without representing interactions among regions and among various socioeconomic phenomena each year. We believe we have added a third dimension to this effort by tracking similar phenomena on a multi-region basis with year-by-year interaction.

Surely, we know that in the world system there are too many inputs to be dealt with to hope to represent more than a few in dynamic terms. Remaining inputs must be assumed constant and thus either totally external to the model or at best represented by constant coefficients. Some improvement in representation can be achieved by the Delphi method mentioned below. Aside from potential Delphi-related improvements in technique, the best hope in improving our method of dealing with a large number of variables seems to lie with some sort of semi-automated modeling technique. Some interesting groundwork has been laid in this area by James Burns.2

Second, sliding-scale social choice equations offer great promise in that this technique may point to the kinds of change needed to avoid severe problems in a region or series of regions. I must point out at this juncture that while some modelers and model analysts would have us develop a set of world equilibrium criteria, that equilibrium will be only a mirage unless the regions within this world (at least those regions capable of precipitating a holocaust) are also stable.

even computer-based models, depending on one’s frame of reference). For example, in the model of an America in which a dollar I spent created new employment which upgraded the economy which redounded to my economic benefit, I was encouraged to consume an ever-broader range and larger quantity of goods. Conversely, in a model of America which sees this nation as unfortunately dependent on foreign oil for economic well-being I am encouraged to save goods, especially petroleum-based products. The shift in public consciousness from one model to another is occurring at the same time as the causal events themselves. Moreover, differing response times among economic phenomena and social phenomena give rise to many instabilities, some localized but nevertheless with long-range effects, e.g., rising unemployment has altered many emerging economic groups’ perceptions of the hope for long-term justice and shifted the tactics governing their actions.

Obviously, the challenge to modelers dealing with ethics and values is staggering, but people are working in this area.[3, 4] We shall be among these people.

Application Techniques

The combination of techniques we presently use permits us to study the sensitivity of regional/global behavior to selected perturbations. Our method is patterned after the technique of observing control system outputs associated with inputs of known characteristics. We study output of both the total system and the subsystems (nations and relatively homogeneous or cohesive groupings of nations). Industrial economic activity is tracked over eight separate sectors, and natural resources are divided into coal, oil and others (primarily ores). We anticipate further sub-dividing the petroleum resource sector into oil and natural gas sectors and incorporating nuclear electrical generating capacity as a separate industrial sector. The most recent additions have included regional measures of the material standard of living and of waste. Waste and industrial production are used as inputs to an algorithm designed to show relative increases or decreases in pollution.

We have incorporated a special algorithm to deal with a regional shortfall in available oil. The algorithm assigns the shortfall burden to each of seven basic sectors according to a rationing array. The renewable resource production sector is exempted because this sector represents renewable energy production (hydroelectric, tidal power, etc.). Iterative solution of this algorithm is necessary whenever the shortfall is greater than the allowable burden per sector. For example, if consumer demand for oil were 20 percent of normal consumption and there was a 30 percent shortfall, other sectors would have to share the burden even if the consumer sector were cut off completely. This algorithm not only apportions shortfall burdens but provides measures of demand supplied by sector to be used in figuring industrial output and demand for new equipment as well as an energy satisfaction fraction which serves as a building block for use in constructing the measure of material standard of living.
Values assigned in the rationing array are inputs based on subjective modeler assessment of regional priorities. As in the case with many social priorities, better input values can be furnished by panels of area experts using the Delphi technique.

The methodology is a mix of finite difference equations with input/output balancing techniques. Socio-economic priorities of the various regions are presently set by the modeling team, but the application lends itself very well to the Delphi technique of multiple-blind interaction among experts. Provisions are also incorporated for automatic fine adjustment of priorities if target values (which can also be set by the Delphi technique) for selected parameters are not met. For example, if targeted industrial exports from one economic sector, e.g., agricultural equipment, from a region fall short of a preselected percentage of total economic activity within the region, the quotas for the region can be retargeted automatically (or, if the modeler prefers, only at his/her intervention).

Results

Results of this project are primarily in the area of model improvement at this state. Two design emphases have guided development of RW III: 1) modifications to promote greater internal consistency (verification); 2) modifications to enhance tracking of real-world socio-economic phenomena (validation). Since validation based on observed behavior is a prerequisite to use of a model as a credible vehicle for forecasting, successes in tracking empirical socioeconomic phenomena can be classed as results. The following examples represent some of these successes. We have succeeded in tracking population growth/stability of most regions to a degree of accuracy well within the limits of present census reliability. We have been able to demonstrate the rapidly accelerated shift of funds from the industrialized nations to the major oil producers following a quadrupling of oil base price. For example, raising the base price for oil from $20 per metric ton to $80 per metric ton resulted in raising surplus funds of oil exporting Arab nations from $11 billion to $56 billion in the fourth year.

We have shown the parallel but less critical dependence of industrial nations relying on other imported resources on the price of those resources. A simulated doubling of other resource prices results in a rapidly accelerating out-flow of funds, especially from vulnerable regions such as the United Kingdom, but the benefits are more diffuse than in the case of oil. A longer run (10-20 years) shows extreme pressure on oil and other resource deficit nations (Western Germany, Japan).

Additional Notes

The model is coded in FORTRAN using just under 800 lines of active instructions with a number of nested loops accommodating the multiple interactions among regions and sectors of economic activity. Execution in the batch mode requires about 100K on an IBM 370/158. As the model has grown we have gradually increased use of the batch mode and decreased testing in the TSO (Time Sharing Option) mode using interactive debug. This change was necessitated as the program reached the size limit provided for the TSO mode in our computer installation. However, we still use the TSO mode to make data entries and to submit program changes and test results. Moreover, we are committed to continuous review and improvement of data to enhance model performance.

REFERENCES

3. Barry B. Hughes, Case Western Reserve University, Cleveland, Ohio, June 1974, "An Approach to UTOPIA," a working paper, prepared in conjunction with Hartmut Bosse (see Reference 4).
The Different Meanings of Cybernetics

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Introduction
As we know Cybernetics has different meaning for various experts using this term. It should not disturb us. After all, the meaning of physics was also ambiguous for a long time. It took time for natural sciences to establish themselves as sciences independent from natural philosophy under which name they were originally taught. It is possible that at its present stage Cybernetics plays the same role for future sciences of control as natural philosophy played for natural sciences. Conceivably, a number of new disciplines may emerge from cybernetics, each dealing with a special kind of control. However, we should carefully follow the development of Cybernetics to identify its various directions and degree of success in each direction. Particularly we should refrain from excessive claims so common for any new branch of knowledge and promise only that which we can deliver. Otherwise we run the risk of losing reputation among our fellow scientists and confidence of the general public.

The major disagreement exists about the nature of Cybernetics. Is Cybernetics a science as the majority of cyberneticists think? The argument for this point of view is presented by S. Beer. [1] Is it an art to assure the efficiency of action, as suggested by Louis Couffignal? [2] Is cybernetics a method?

Two Extreme Views
If cybernetics is a science, then the next question concerns the systems dealt with in cybernetics. In answering this question, Ivakhnenko [3] discusses two extreme points of view.

One of them stresses the mathematical description or the algorithmization of controlled systems as a precondition for the system to be treated in cybernetics. "Cybernetics is first of all the algorithmization of the controlled system." Correspondingly, cybernetics should deal primarily with deterministic systems such as computers, systems of automatic control, etc. or simple probabilistic systems. Being himself a mathematician, Wiener [4] is the most outstanding representative of this point of view. In his first book, Cybernetics, he defines cybernetics as the "theory of control and communication in the animal and the machine". (It seems that the term "communication" in this definition is redundant since no control is possible without communication.) The book is rather mathematical in its content. Wiener [5] claims that "Cybernetics is nothing if it is not mathematical if not in essé then in possé" (p. 88). This requirement effectively excludes social systems from cybernetic consideration: "... social sciences are a bad proving ground for the ideas of cybernetics...." He suggests that social application of cybernetics be delayed until sufficient progress is achieved in the technological use of cybernetics.

Somewhat coherent with Wiener's views are those of Pask. [6] "Cybernetics is primarily the science of constructing, manipulating, and applying cybernetic models which represent the organization of physical entities (such as animals, brains, societies, industrial plants, and machines) or symbolic entities (such as information systems, languages and cognitive processes)".

Ashby's [7] definition reflects similar ideas. According to him, "Cybernetics deals with all forms of behavior so far as they are regular, determinate, or reproducible". The subject matter of cybernetics is the domain of "all possible machines.... What cybernetics offers is the framework in which all individual machines may be ordered, related and understood" (p. 2).

The second extreme view is that "Cybernetics begins where the possibility of algorithmization of the controlled system ends." Beer [1] is the best known representative of this view. According to him, cybernetics is the science of exceedingly complex probabilistic system such as the economy, the brain, or the company (p. 18). Such systems are self = organizing and self = learning. Beer claims that "operational research" should deal with problems in less complex probabilistic systems such as the efficiency of a firm.

Ivakhnenko [3] suggests that cybernetics should deal with both kinds of systems. According to him, "cyber-
netics should be a science of combined deterministic and self-learning systems requiring minimum instructions from a person. Cybernetics is a science of recognition, organization and most effective control of complex dynamic systems. In the forward to the Russian edition of S. Beer's book, A. L. Berg (quoted in 3) criticizes the exclusion of deterministic systems from cybernetic consideration, claiming that "such discrimination is analogous to exclusion of arithmetic from mathematics." Ivakhnenko feels that there are also attempts to substitute the whole field of mathematics by arithmetic alone. He holds this situation responsible for what he considers as a very slow progress in cybernetics. However, he limits the application of cybernetics to complex engineering systems alone.

Some cyberneticists want to restrict their science primarily to one field or to one aspect of this science. For example, Cherry [8] considers cybernetics as the "theory of feedback" and George [9] suggests that "one theme more than any other seems to fairly recommend itself as representing the fundamental theme of cybernetics and that is the problem of artificial intelligence".

**Definitions Stressing Information**

Kolmogorov [10] whose work on information theory parallels that of Wiener, accepts Wiener's definition of cybernetics but expands it by stressing the informational aspect in cybernetic systems. "Cybernetics studies machines, living organisms and their combination exclusively from the point of view of their ability to receive certain information, store this information in memory, transmit it through the channels of communication and process it into signals directing this activity in a certain way." In a more concise form, he defines cybernetics as "as science of the methods of processing and use of information in machines, living organisms and their combination.

Steinbuch [11] considers cybernetics "a science of informational structures in technical and non-technical domains" where the term informational structures means control, data transmission and data processing (p. 325). He claims that cybernetics allows "an exact scientific analysis of mental functions" (p. 353) where the mental functions are understood as an expression of "receiving, processing, storing and transforming of information."

According to Frank, [12] "Cybernetics is the theory and technique of systems which transform messages" (p. 30). He differentiates general mathematical cybernetics, material cybernetics (information science, bio-cybernetics, engineering cybernetics) and cybernetic machine techniques. Cybernetics strives to relate "the various scientific disciplines. This is accomplished by means of unifying points of view especially by the use of terminology of control and theory of information as well as common methodology" (p. 11).

Cube [13] distinguishes between cybernetics in a narrow sense which is "the science and technique of information transforming machines" and cybernetics in a broad sense which is "mathematical and constructive treatment of general structural relations, functions and

systems, common to various domains of reality."

Klaus [14] considers cybernetics to be "the theory of interconnectedness of possible dynamic self-regulated systems with their subsystems." Using Wiener's warning against application of cybernetics to social systems, he refuses to apply cybernetics to social problems since they are in the domain of Marxism.

**The Cybernetic Method**

I presented in this journal [15] the point of view that cybernetics is a method—the only method of purposeful activity. The cybernetic method consists of the following steps: 1) identifying the goal or the desired state of the controlled system expressed in certain parameters, 2) obtaining feedback information about the actual state of the system using the same parameters, 3) comparing both states, 4) making decisions directed towards the elimination of the discrepancy between both states; 5) executing these decisions. Steps 2-5 are repeated until the goal is reached or modified. The scientific method is a special case of the cybernetic method when the goal is not to create a particular state of a system, but to learn about all possible states of this system within a certain range of its parameters. Naturally, one should know the possible states of the controlled system in order to select the desired state. Thus the application of the scientific method should precede the use of the cybernetic method.

When an economist is learning about a given economic system, he uses the scientific method and he is a scientist. When however he tries to transform this system into a desired state he uses the cybernetic method. A psychologist can try to change the mental state of a subject by influencing the parameters of the person only after learning these parameters and their interdependencies. Thus a person working in a field dealing with controlled systems should wear two hats: one of a scientist and another of a cyberneticist. In the second capacity he uses the cybernetic method.

The scientific method as such is applied to systems in every science although the findings belong only to the science studying this system. In a similar way, the cybernetic method is applied to controlled systems in many sciences (biological, psychological, engineering, social) and the results of its application belong to a particular science and therefore do not constitute the science of cybernetics. One, however, can make a point that the study of control as such, i.e. the common properties of all controlled systems, can be done in one science—cybernetics. This raises the question about the possibility of the application of this general theory of control to systems with special kinds of controls. Let us look for the answer to this question by analyzing various textbooks on cybernetics.

**Textbooks on Cybernetics**

The content of textbooks on cybernetics reflects the prevailing view that cybernetics is primarily a science of information and information processing machines.

Ashby [7] is the author of the first textbook on cybernetics published in 1956. The titles of three parts are: Mechanism (the determinate machine, stability, the black
box, etc.); Variety (its quantity and transmission) and Regulation and Control (regulation in biological and in very large systems, requisite variety, error controlled regulator, amplifying regulation). The text stresses the mathematical description of systems and offers many exercises.

Flechtner’s[16] textbook deals almost exclusively with information theory and its applications. Its chapters have the following titles: Communication, Information, Transmission of Information, Treatment of Messages, Behavior of Systems. No exercises are included in this textbook.

In his textbook, Sachsse[17] defines cybernetics as the science of systems, parts of which are mutually connected through direct interaction. As examples of such systems he gives a clock, a human organism, a business, a stock exchange. Complete title of his textbook is Introduction to Cybernetics with Special Consideration of Technical and Biological Systems. The chapters of the book have the following titles: Basic Concepts, Theory of Information, Closed Loop Control, Open Loop Control, Learning, Sensory Perception, Bipolar Systems, Achievements and Limits of Cybernetic Approach.


Glushkov[19] in his textbook states that the modern cybernetics deals with the “general theory of the transformation of information, and... the theory and principles of building various transformers of information”. The text contains chapters on Theory of Algorithm, Theory of Discrete Automata, Theory of Discrete Self-Organizing Systems and Mathematical Logic. Thus, its contents overlap somewhat with that of Computer Science as taught in our country.

As we see, these textbooks deal primarily with technical, deterministic systems, so that geneticists or social scientists would not gain many new insights into their controlled systems by studying cybernetics from these books. At the same time they cannot avoid using the cybernetic method in their research. Their major problem is how to apply this method to their particular system.

REFERENCES
2. Couffignal, Louis, Essai d’ une definition generale de la Cybernetique.
On Dissipative Structures in Both Physical- and Information-Space

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The aim of this essay is to draw attention to common features of two types of structures, dissipative structures in physical space-time and event-structures-like fairy tale, myth and narrative fiction-in information space. Let me retrace the genesis and describe the nature of event-structures and their re-presentation. I will start out with simple structures and then go introducing gradually more complex ones.

On Physical, Chemical and Biological Structures and Their Re-presentation

How do structures arise? This question is anchored to the 2nd law of thermodynamics (formulated by Carnot 152 years ago) the thrust of which is that instead of building up, the universe as a whole is inevitably running down. Living structures, however,—i.e. dissipative, non-equilibrium, self-organizing structures (Prigogine, Katchalsky, et al.)—given large enough flows of matter and energy and suitable energetic conditions can locally and temporally reverse this trend. The appearance of these living structures is the "way of life" of the 2nd law; or in other words it is a characteristic of matter-energy to pay a price for becoming alive and conscious of itself. That price is called heat-death.

The first example of structure formation and structure re-presentation should be illustrated from hydrodynamics. What happens when a pot of water is heated by a flame? First, heat will travel by conduction but from a certain critical gradient on there is an abrupt onset of thermal convection leading the system to a higher state of organization. There is a more even and somewhat delayed thermal propagation in form of mostly hexagonal, convection cells. This is the Bénard instability phenomenon, i.e., the appearance of dissipative structures and their re-appearance under similar conditions of heat-transfer. Let the hexagonal structures be a model of living organisms, while the pot of water and the flame model the earth and sun respectively.

Such dissipative, non-equilibrium structures are also formed when, for instance, malonic acid is oxidized in the presence of cerium sulfate and potassium bromate. Zhabotinsky has been able to observe in this system sustained oscillation of the cerium ions in the +4 and +3 states. They represent a symmetry breaking, well defined and stable dissipative structure, illustrating the ability of a chemical system to undergo self-organization under non-equilibrium conditions.

Another example should illustrate structure formation and selective (in-) formation on the molecular level, when, for instance, silica gel is prepared in the presence of a quinine solution. By forming the gel in the presence of quinine molecules the gel will be imprinted with the molecule structure of this organic compound and will "remember" it. After removing the quinine by extracting it from the gel, the latter may be desiccated to a powder and stored in a refrigerator. Even after weeks of storage, the powder when re-made to a gel—through addition of water—will do (lo and behold) "remember" the quinine structure by being able to selectively absorb stereoisomers configurationally related to quinine (such as cinchonidine) but not cinchonine (configurationally related to quinidine). Evidently quinine made an unforgettable impression on the silicagel; the "active-site" footprints re-present an engram or informational matrix (Fischer, 1967). This is then a classical short story of structure formation and re-presentation, [1]

An even more complex but familiar example refers to the information stored in DNA which consist exclusively of instructions for the synthesis of the very agents responsible for the implementation of the program. One of the main "aims" of the program stored in DNA is to reproduce unchanged the structure of DNA itself. The medium is indeed the message and hence the DNA structure may be a model for self-referential consciousness.

Self-reference, in analogy to the "chicken and egg" in modern biology, may well be compared here to "protein and nucleic acid," or in more abstract terms, to function and information. The question "which comes first" is
meaningless (Eigen, 1973) because function—in order to evolve—needs to be represented by information, this information acquiring all its meaning only through the function for which it is coding. Indeed, in all living systems proteins and nucleic acids are linked up in a complex hierarchy of feedback loops and hence a causal first would have as little meaning as beginning and end in a closed cycle.

In "consciousness" or con-scientia both meanings "to know with" and "to know in one self" refer to the domain of self-description, i.e. self-observation. The DNA-like, self-referential structure of consciousness is reflected in Maturana's (1970) description of consciousness:

... if an organism can generate a communicable description of its interactions and interact with the communicable description, the process can, in principle, be carried out in a potentially infinite recursive manner, and the organism becomes an observer. It can describe its interactions and communicate its descriptions to others or to itself, and through the very same process it can describe itself describing itself.

So far we have traced the evolution of structures (or the structure of evolution) through representative examples from physics, chemistry and biology and conclude with Eigen (1973) that an evolutionary feedback in form of a succession of instabilities or catastrophes (Thom & Zeeman, 1975) may have moved a system further and further from thermodynamic equilibrium and thus enabled the amplification of fluctuations until a (macromolecular) co-operative structure arose which was stable enough to withstand its own fluctuations. The self-referential nature of structure formation, in information space rather than geometric space, is clearly reflected in the "structure" of consciousness since we perceive it as another self-referential creator of self-referential creations or structures.

Structures of Consciousness Reflected in Narrative Fiction

Being conscious of the world in and around us implies the making of distinction (yes-no, similar-dissimilar) and then associating these distinctions with already perceived-conceived structures, or gestalts.

Things that are in a single world are not parted from one another, neither the warm from the cold nor the cold from the warm. When Mind began to set things in motion, separation took place and all that Mind moved was separated (Anaxagoras, as quoted by Jammer, 1974)

And God said (Genesis 1, 6). Let there be a firmament in the midst of the waters, and let it divide the waters from the waters.

Our concepts, like branches of trees allow us to grasp and hold on to them. Concepts (from the Latin conceptio; con-captum, grasp or con-cept) refer to the structure of both fact and fiction with no sharp distinction between them. Their language obeys the same grammar, the universal grammar of our self-referential universe. This structuring and structured universe of hopes, intentions and expectations has to be recreated from moment to moment, re-affirming its structure by re-presenting it time and again.

Let me illustrate the nature of this grammar by illuminating the structure of a particular genre of narrative fiction—one firmly rooted in mythology—the fairy tale. Analyzing a collection of a hundred fairy tales, Propp (1970) found that though the personages of a tale are variable, their functions in the tales are constant and limited. Describing function as "an act of a character, defined from the point of view of its significance for the course of action," Propp discovered that

1. Functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled. They constitute the fundamental components of a tale.
2. The number of functions known in the fairy-tale is limited.
3. The sequence of functions is always identical.
4. All fairy tales are of one type in regard to their structure.

In comparing the functions of tale after tale, Propp found that his total number of functions never surpasses thirty-one, and that however many of the thirty-one functions a tale had (none has every one) those that had always appeared in the same order (italics mine).

Propp's discovery is born out, I believe by the way children subject a fairy tale to reality-testing. A fairy tale—when told to children [2] may not be altered but must be re-presented day after day in the original sequence; otherwise the child would not fall asleep. The slightest alteration would alert the child and to soothe him into sleep the tale has to be retold in its original form. The sequence of functions does not obey the Aristotelian logic of our life of daily routine, but the structure of a master tale abstracted by Propp is the same one we have all encountered in our reading of fiction from tales to novels. I would call the structure of such a master tale "archetypal" (Goethe's Un-Form) and define archetypal structures as those in which (like in DNA) the medium is the message.

In an independently conceived project Lord Raglan (1936) described the twenty-two persistent and recurring features in the life of a typical mythic hero. The first and last five features are listed here so as to give a general idea of Raglan's "features":

1. The hero's mother is a royal virgin;
2. His father is a king, and
3. Often a near relative of his mother, but
4. The circumstances of his conception are unusual, and
5. He is also reputed to be the son of a god.
18. He meets with a mysterious death,
19. Often at the top of a hill.
20. His children, if any, do not succeed him.
21. His body is not buried, but nevertheless
22. He has one or more holy sepulchres.

Raglan uses his pattern of features to score certain famous heroes (Scholos, 1974). Theseus, for instance, gets twenty points, Heracles seventeen, Jesus, rather pointedly omitted, would obviously score well. Raglan's analysis suggests therefore, the existence of a law of composition, or some fundamental grammar of narrative over a wide range of humanity. Some of the main structural elements of the hero journey are the self-consistency of the hero, his adaptation to and sur-
mounting and over-compensating of difficulties, justice and victory over villains and intrigue (all pertaining to wish fulfillment), repression of ultimate defeat and transfiguration. These event structures may come into being, i.e., are re-presented again and again like dissipative structures are evoked during heat transfer when a critical gradient has been reached. They gradually delay and structure the dissipation of "heat".

On the Stability of Biological and Narrative Structures

We have analyzed the structure of narrative fiction and may now compare it to that self-referential primordial (macromolecular) structure which through the evolutionary feedback of successive instabilities or catastrophes became stable enough to withstand the fluctuations it itself was producing. In man, and in neurophysiological terms, stability refers to the closed unity of perception and behavior to maintain internally generated reference levels.

A cognitive system is a system whose organization defines a domain of interactions ... relevant to the maintenance of the system itself. (Maturana, 1970)

Thus God created the world so that he might keep on creating. (Meister Eckhart)

We perceive, in other words, only that which is appropriate to our behavioral repertoire. The organism's stability requires that certain internally generated levels be maintained in the face of perturbations; hence behavior is the compensation for those perturbations. Or in the formulation of Powers (1973) "... we know nothing of our own behavior but the feedback effects of our own outputs. To behave is to control [what is sensed as] perception..."[3] And this pertains to the fighting of dragons perceived as real or fictitious ... It pertains to the declaration of wars, the liberation of holy graves, here journeys, myth, fairy tale and narrative fiction in general.

And since we behave only to control our perceptions—in order to compensate against perturbations or to provide stability, we may say that our structure, which is made up of self-referential inter-actions is closed for computation and information (Varela, 1976).

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. (Ashby, 1955)

Being, as it were, our own captive audience, we have no choice but to grasp the consequences of our informationally tight structure. The sameness of fairy tales and myth, the standardized nature of works of art, re-written, re-structured around the same stereotyped, stable archetypal pattern ... all fall into a pattern. Hence structure formation and the re-presentation of event-structures recall the heating up of a pot of water ... and at a critical gradient the appearance in that hot water of regular convection patterns, the mostly hexagonal dissipative structures ....

One would be tempted to theorize that myth, fairy tales and narratives which contribute to the survival of our species, survive, i.e., are selected as behavioral templates to be re-written and re-composed time and again, to assist in the survival of the next generation.

In this evolving creation and re-creation within a system which appears to be programmed and is at the same time self-programing: chance and necessity are not alternative but complementary forces.

Mutation, sexual recombination and natural selection—and in higher organisms 'free choice'—are linked together in a system which makes biological evolution the only process apparently lacking in foresight which is nevertheless creative. (Thorpe, 1975)

Biological evolution or Bergson's "evolution creatrice" may then be compared with the evolution of myth, drama, poetry and narratives in general. The literary genres correspond to various biological species who's functional or phenotypic language shows many analogical correspondences to our phonetic language. The 20 amino acids of the protein language may be contrasted with the 30 phonemes and the letters of our alphabet abstracted from them. Let's consider the way in which the twenty amino acids are coded by the natural genetic code of nucleotide triplets. Each amino acid is coded by a triplet of quaternary digits and hence—as in the I Ching—there are 64 codons. There is a correlation, as Mackay (1967) has shown it, between the frequency of occurrence of an amino acid and the number of triplets coding for it.

And how do we perceive structure in language? Here is the concise story of what I have nicknamed as the Zipf code. If English (or Chinese, or Latin, etc.) words of a vocabulary are ranked in their order of frequency on the ordinate and the reciprocal of their frequency, i.e. the period of a word, on the abscissa: the periods turn out to be multiples of ten, or in Zipf's (1935) words "we are speaking in terms of harmonic series." Simon (1935) developed a stochastic model of information theory which accounts not only for the distribution of word frequencies but for the distribution of authors by numbers of papers published and the distribution of biological species by genera (Fischer & Rockey, 1968).

The phenotypic re-presentation of a genetic remembrance of things present is the creation and re-creation of selective information. The "word becomes flesh." And while I am uttering these words, I too am creating selective information (selecting creative information) from a vast pool of available knowledge, a knowledge of which I am co-consciously amnestic. Incidentally, we have just witnessed the birth of my own thought, or: the flesh became word.

Why do we see everywhere structures? It could be that our own structure is the reflecting mirror which we hold up to Nature and therefore we have no chance at all for generating or noticing random events or processes.

One of the principles which "works" against randomness is the processing mechanism of our nervous system. At its periphery the nervous system extracts non-random features from its own excitatory processes and transforms these inputs to coded interpretations or outputs.

The non-random outcome of the matching of output and input, or the transformation into perceptual states according to unique numerical base systems is represented, for instance, in Stephens' "power law," says
Baird (1975) who notes that subjects when generating random numbers clearly “prefer” certain frequency categories over others. Apparently the subjects employ cognitive strategies with numerical stimuli similar to those they use with ordinary stimuli. They seem to perform a “spacing along an internal response scale.”

What we call Laws of Nature, are the functional limitations imposed by our own structure, i.e. the laws of our own nature (Fischer, 1974).

NOTES

1. For other examples in structure-formation see Fischer, 1967 pp. 472-5.
2. Until about 200 years ago fairy tales were told by adults for adults (Heuscher, 1966).
3. For example, asthmatic attacks can be precipitated in patients who are allergic to horse dander by having them view a picture of a horse—or patients allergic dust by exposing them to the view of a sealed glass tube containing dust (Dekker & Groen, 1956). Wolff (1953) did not use symbols but provoked arousal in chronic rhinitis patients by reminding them of anger-provoking material; they developed nasal hyperfunction and almost complete obstruction of nasal passages.

REFERENCES

Benard, quoted in Prigogine [loc. cit.]

Analysis of Brain Software: A Cybernetic Approach

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Introduction

One of the germinal ideas of cybernetics is the brain-computer analogy (Wiener, 1948). While this analogy is often criticized (Dreyfus, 1972; Weizenbaum, 1976), it has inspired and guided the work of a number of investigators (Arbib, 1972; Colby et al., 1971; Loehlin, 1968; Simon, 1969; Minsky, 1968; Schank and Colby, 1973), and may be regarded as basic to work in such fields as artificial intelligence and computer simulation of personality.

In a previous article, I applied this analogy to the mind-body problem (Coulter, 1974). It was suggested that, if the brain is a computer, then it must have software, to enable it to function effectively. If this is true, it is reasonable to ask: what is the software of the brain? A simple answer is: the mind. While this conjecture cannot be vigorously proved (or disproved) in the present state of our knowledge, it seems at least as reasonable as the various other "solutions" to this puzzle that have been offered (such as Cartesian dualism, Berkeleyan idealism, materialism, psycho-physical parallelism, double aspect theories, etc.).

Those of us who are intrigued by this analogy are (almost!) always aware that it is only an analogy and should not be taken too literally. It is useful if it suggests new ideas, new approaches, new scientific paradigms (Kahn, 1970). But differences between brains and computers are as important as similarities, and should be duly noted.

Similarities and Differences Between Brains and Computers

1. In a computer, the basic element of activity is a binary number, usually called a word. A word may either represent data, or, according to some code, an instruction. The instruction tells the computer to perform a particular operation upon data.

Similarly, in a mind we can distinguish between contents—sights, sound, smells, body sensations, feelings, ideas, images, desires, etc.—and operations upon contents, such as looking, listening, comparing, recalling, etc. We cannot at this time identify a mental content with a particular brain state (such as a pattern of nerve impulses), and we are far from a knowledge of the instruction code of the brain. But from the standpoint of brain software, this is not necessary.

A computer programmer does not need to know the details of a computer's circuitry, or even its instruction code, in order to write programs that work. Similarly, to understand brain software, it is sufficient to identify contents and operations; the neurophysiological details are not essential for such an understanding.

2. A distinction is usually made in computer science between application programs, designed to handle particular problems, and computer software. Computer software consists of special programs designed to make it easier for the applications programmer to write programs.

A similar distinction can be made in the case of brain software. The conscious Ego performs various operations upon contents, in a manner similar to the activity of an applications programmer. The software of the brain consists of an incredible variety of programs which facilitate the actions of the Ego.

Indeed, the conscious Ego may itself be regarded as a special component of brain software. Just as computer software requires a special component—sometimes called the Supervisor—to direct all the other software, so does brain software require a similar component. The conscious Ego clearly performs this function.

3. An important distinction, however, needs to be made. A computer is designed to do what it is told to do; it is controlled by programs fed into it from outside. A brain, however, has been designed by evolution to survive, in an uncertain and sometimes hostile environment. In contrast to a computer, a brain is a teleogenic system (Coulter, 1968; Locker and Coulter, 1976) capable of generating its own goals. While under some conditions a brain may be controlled by outside goals or forces, it necessarily includes a self-determined component. Some implications of this self-determinism will be considered below.

4. The concept of a Supervisor of brain software provides us immediately with a new, operational definition of consciousness. Consciousness may be defined as the reception and manipulation of data by the Supervisor. It should be noted that this definition does not require conscious processes to be located at any particular part of the brain, since the Supervisor could function from a number of equivalent locations.

*In a delightful response to this probe, Fischer (1975) suggested that the mind might be regarded as the software of the whole living organism, not just the brain. This is at least as reasonable—and unprovable—as the viewpoint I proposed. In this article, I will confine my attention to that part of organismic software associated with the central nervous system and sense organs.
In accordance with this definition, an unconscious content or process does not involve the Supervisor.

5. The brain-computer analogy also provides us with a new operational definition of intelligence. Intelligence may be defined as the set of software programs which enable the Supervisor (or Ego) to acquire, create, and execute application programs.

This definition has a number of important implications:

a) From this perspective, the genes provide the basic instruction set of the brain. Since (except for identical twins) no two individuals have a completely identical set of genes, it follows that each person has a unique instruction set from which application programs and brain software may be developed. But, while some instruction sets may be superior to others in particular ways, the instruction set for a particular computer is adequate for writing programs to solve almost any solvable problem. Just as the basic moves of chess permit an infinite number of different games to be played, so does an instruction set permit an infinite variety of programs to be written.

b) That part of brain software which constitutes human intelligence may, in principle, be increased. Basically, this is simply a matter of adding new software components and improving the quality of existing components. Of course, a great deal more needs to be known about these components before this intriguing prospect can be effectively realized. But the old “nature vs. nurture” controversy over human intelligence is outmoded by this new viewpoint. Instead, new techniques of cybernetic analysis may now be developed and used to study brain software and to create, test, debug, and make available new software components which people can then add to their existing intelligence. Similarly, the existing intelligence software of a mind may be examined, analyzed, debugged, and improved.

Programming Computers and Reading Brains

As mentioned above, the self-determinism of brains is one fundamental difference between brains and computers. This means that a brain can only be programmed by its own Supervisor-Ego, or with the Ego’s consent. From a humanistic standpoint, this is both fortunate and ethically right.

Another important difference is that the instruction code of a computer is known, as well as the rules governing use of high level languages. The task of a programmer, when coding an algorithm, is relatively simple and straightforward.

Suppose, however, a programmer were confronted with a strange new computer of advanced design. No manuals are available and, while readout is in English, the instruction code and programming language or languages are unknown. The computer, however, will accept English input. The problem is to determine the computer software.

(This problem differs, it should be noted, from that confronting an electrical engineer who is asked to construct a set of wiring diagrams and schematic diagrams of the computer, by tracing its circuits and connections.)

Difficult though his problem is, it is not insurmountable, however. A clever and experienced systems programmer, given sufficient time, would sooner or later be able to solve it.

A similar problem confronts an individual who seeks to determine the software of the brain. The most important difference is that the brain is self-determined, and cannot be programmed, without the consent of its Supervisor-Ego.

In acknowledgment of this distinction, I refer to the efforts of an outside observer to understand brain software as reading the software. An evolving set of reading techniques are under development. These are essentially techniques for analyzing the verbal output of a human brain, for the purpose of understanding the brain software (and application programs) producing this output. One of these techniques—Reading Procedure RP-1—is described below.

Experience to date with reading has enabled us to ascertain certain basic characteristics of the brain’s software.

1. A distinction needs to be made between individual characteristics, which express the unique individuality of each person, and common, social or public attributes which are more or less the same in all minds, or at least in all minds of a particular population (or culture). It is desirable to separate the two. Other approaches tend to regard these differences as “statistical fluctuations”, variations from a mean or “norm.” We consider them instead as expressions of the unique individuality of the person.

For example: each person has a Personal Cognitive System (PCS), a repertoire of programs used to acquire and/or to apply knowledge and skills. While there are similarities among PCS’s, each is unique as-a-whole, and best regarded as an individual characteristic. Appreciation of this is helpful in teaching and communicating new ideas.

2. In reading the verbal output of a mind, a distinction must be made between the verbal expression per se and the nonverbal content or system of contents that the verbal expression represents. To emphasize this distinction, we refer to the non-verbal content as the primary process. A particular primary process can be described verbally in a large, perhaps infinite variety of ways. We are so accustomed to communicating in words that there is a natural tendency to identify a verbal expression with the primary process it represents. In reading, the distinction between the two soon becomes evident.

Typically, what happens is that the primary process occurs, often in a fraction of a second. The result is stored, temporarily in a register. Verbalization then proceeds at slower tempo, guided by the content of that register. The actual process of verbalization is itself a very complex one, of interest primarily to the linguist or the psycholinguist. Our main interest is in the primary process itself, and related processes which may not actually be verbalized.

3. Associated with any verbal representation of a primary process, and the process itself, there are a variety of other contents which are not represented by the verbal expression, but which are nevertheless an important part...
of the mental events associated with the primary process and its verbalization. We refer to these contents as tacit contents. In ordinary conversation, for example, verbalization is often incomplete; but the receiver understands what is meant anyway. The search for tacit contents can be very fruitful.

Reading Procedure RP-1

"In its purest form, a cultural-relativity position views all behavior as relative to its particular cultural context."

First Step. Re-state the verbal expression in canonical verbal form.
Much or perhaps most written or printed verbal output is a compound of simple verbal expressions, and reflects the "style" of the author. It may include metaphors, humor, or idioms. Since any content or set of contents may be represented verbally in many different ways, it is convenient to use a simple format which is equivalent to the actual sample, but easier to analyze.

This is the canonical verbal form. It consists of simple sentences, with idioms, metaphors, etc. eliminated. Even here, more than one canonical verbal form is possible. But this need not concern us, for our interest is in using this to reconstruct the primary process that is being verbalized.

In this case, we obtain the following:
A. All behavior is relative to its particular cultural context.
B. A cultural-relativity position has a purest form.
C. "B" views "A".

We can now analyze each simple verbal expression in turn.

Second Step. Identify contents, operations, and modifiers which correspond to the primary process.
The primary process consists of operations applied to one or more contents, with modifiers specifying contents and/or operations. The result of the primary process is a complex content stored in a register for verbalization. In this case, we obtain the following:

A. Content 1 —Behavior (all)
Content 2 —Context (cultural [particular])
Operation —is relative to. This operation assigns attribute A2 to A1.

There is a crude similarity here to diagramming a sentence to show its syntax. However, our purpose is different. We are not studying language, but a mind—the software of a brain that produced a verbal expression representing a primary process. In the above, we have identified two contents, to which we have assigned verbal labels. Each content has one or more modifiers, which we also label.

A content is analogous to a word in a computer. A word consists of a set of binary digits—e.g., 100 010 110 001. We don't know exactly what a content consists of; it might, for example, be a pattern of nerve impulses. But just as a word, in an assembler language, may be represented by a mnemonic code, so may we assign a verbal label to a content.

Similarly, a content modifier is analogous to, for example, a base address in a computer word, or a displacement from that address. Again, we assign a verbal label to the modifier. We bear in mind, however, that the content itself, and its modifier, are non-verbal. We use parentheses here to indicate that what is enclosed is the verbal label of a modifier.

In a computer, a word may represent either numerical data (expressed as a binary number), or it may be a code for a computer operation. The number 100 000 000, for example, might be a code for the operation: "Load the accumulator". The mnemonic for this operation might be LDA. Similarly, there are operations in the mind, which may do various things to contents. In this example, we have identified an operation which we describe verbally as "Assign attribute A2 to A1". This corresponds to the words "is relative to" in the canonical verbal form of the verbal expression which represents this operation.

What we end up with, then, is a simple mental process: the application of an operation to two contents. The operation, which we may label "Assign content_ as attribute to content_", may be included in a List of Operations.

(Actually, the situation may be more complex than we have indicated. The operation may not be a simple basic operation, but a complete program composed of a number of basic operations. At this stage of analysis, we cannot be sure. However, we won't pursue this further.)

In a similar way, simple verbal expression B may be analyzed as follows:

B. Content 1 —Position (cultural-relativity)
Content 2 —Form (purest)
Operation —Has. This operation assigns attribute B2 to B1.
Note that a different word, "has," in the canonical verbal form corresponds to the same operation as in verbal expression A.

And expression C:

C. Content 1 \(-B\) (This is a label for simple verbal expression B)
Content 2 \(-A\) (This is a label for simple verbal expression A).
Operations

- Views. This operation is one in which B affirms the validity of A in a perspective B1.

We have identified a second operation to add to our List of Operations.

Third Step. Search for software components which would be required in a computer simulation of the mental process that has been identified.

There are (at least) two processes involved in the foregoing. The first is the primary process that we have identified. The second is the verbal representation of that process, originally in the form of the sample quoted from the book. It is evident that the verbal representation process has not yet been analyzed at all, even in the equivalent canonical verbal form.

We won't undertake that analysis here. But we can assert that the primary process as a whole would have to be stored in a register in order for the verbalization process to be executed. Such a register is an example of a software component.

Other software components that would be needed for a computer simulation are:

1. Search routines for selecting words to use in the verbal representation.
2. Grammatical and syntactical subroutines for processing the words chosen to represent the primary process in the verbal expression.
3. Registers for holding words so that letters may be chosen in correct order in writing or typing the words.

Fourth Step. Search for tacit contents that are involved in the various mental processes but which are not represented by verbal expressions.

In this case, the context of the statement was a consideration of various theories of normality, of which the cultural-relativity position was one.

Tacit contents are more easily detected in other types of verbal output. However, they are almost always present, and while a search may lead to erroneous identifications, the search itself is instructive.

Fifth Step. Construct trees of plausible primary processes that might be associated with contents.

We have seen that a mental process may be stored as a whole in a register, as a content. Indeed, each content may be regarded as a telescoped coded representation of a variety of mental processes. It is instructive to start with a particular content and to construct a mental process that may have produced the content. This mental process, in turn, consists of contents, operations, and modifiers. Each of these contents may in turn be the result of another mental process; and so on. In this way, a "tree" may be constructed with the original content as the "root." The tree may or may not have been present in the original mind; various different trees are possible. But the exploration of trees sheds light on individual differences among minds, and can be the basis for better understanding of misunderstandings and improved communication.

The verbal representation of a process of tree construction may take the form of a definition of terms. Thus, for example:

**Behavior (human) consists of overt actions and verbalizations. The actions may be reactions to stimuli or purposive (voluntary acts). The verbalizations may be vocal, written, or typed.**

Without reading this verbal expression in greater detail, it is evident that a tree of contents is being described, as indicated in the diagram. In comparing two minds which are using the same verbal expressions to represent a content, the trees in the two minds may well be different.

Constructing a tree is often useful in clarifying an idea. And definitional trees are not the only kind possible; association trees, and trees corresponding to emotional connotations, fantasies, images, incident chains, etc., may also be constructed.

It is evident that other "sweeps" of the verbal output of a mind might be added to the foregoing. It is also evident that other "reading procedures" are possible, which may supplement or even supplant RP-1. These may be expected to emerge as our experience with reading grows.

In the foregoing example, RP-1 was applied to printed material, and it is immediately apparent that, since all printed (or written) material (except computer output) has been produced by human minds, a considerable amount of data are available for analyzing the software of brains. The prospect of applying RP-1 to the verbal output of geniuses is especially intriguing. However, this reader has much that is unique to the individual filtered out, as well as the self-correcting and exploratory processes that characterize the work of a careful writer.

RP-1 may also be applied in other contexts. The verbal report of individuals describing their thought processes while solving a problem or performing other clearly defined tasks, is one. The verbal output of patients undergoing psychoanalysis or other forms of psychotherapy is another. Recordings of conversations, group meetings, and other forms of verbal intercourse provide still another source of data. In all these contexts the verbalization process is usually incomplete and often
grammatically incorrect; however, the data are much closer to the spontaneous thought processes of brain software than is printed matter.

Discussion

There are similarities and differences between reading and two other approaches that are worth noting. These are: psycho-linguistics and psychoanalysis.

Paradigms of psycho-linguistic research have been extensively discussed by Reber (1973). He distinguishes three perspectives: an Associationist position with behaviorist traditions, a Process approach with origins in general cognitive theory, and a Content approach which has evolved along with the resurgence of a nativist position in linguistic theory. The basic interest of all these perspectives, of course, is language. From our standpoint, we may formulate the difference as follows. Psycho-linguistics is primarily concerned with the verbalization process (as well as with other aspects of language). In reading, our focus is on the primary process, which is non-verbal.

The Associationist position, of course, excludes the mind as such from its paradigm of explanation, and seeks to explain all verbal behavior in terms of stimulus-response sequences, hierarchies, and mediation systems. Our position is in basic conflict with the Associationist position, since our primary interest is the mind, regarded as brain software.

The Content orientation is closest to our own position. This orientation has emerged with the development of generative grammars in modern linguistic theory by Chomsky (1957, 1965, 1968), Katz (1964), Perlmutter (1971) and others. Chomsky (1965, page 8) defines a generative grammar as "a system of rules that in some explicit and well-defined way assigns structural descriptions to sentences." In the syntactic analysis of a sentence, such a grammar is held, must specify not only a surface structure, which determines the phonetic interpretation of the sentence, but also a deep structure, which determines its semantic interpretation. Consider, for example, the sentence, "A wise man is honest." The surface structure, familiar in the traditional analysis of syntax, might be represented in the form (following Chomsky, 1968).

The deep structure, on the other hand, would be represented by

The surface structure can be produced from the deep structure by applying the following operations:
1. Assign the marker who to the most deeply imbedded NP, "man"
2. Replace the NP so marked by "who"
3. Delete "who is"
4. Invert "man" and "wise"

The significance of the deep structure can be appreciated by the following example. Consider the sentence: "Flying planes can be dangerous." It may not be immediately obvious that this sentence is ambiguous. However, this ambiguity is exposed when we consider that the sentence can be produced, by simple operations of the type just described, from either of two sentences:

"Flying planes are dangerous."
or
"Flying planes is dangerous."

In ordinary verbal intercourse, a reader/listener determines the "correct" interpretation from the context in which the sentence appears. He is able to do this because he has what Chomsky calls "linguistic competence"—the ability to determine the underlying deep structure which corresponds to the correct semantic interpretation.

Chomsky (1968) emphasizes the distinction between linguistic performance and linguistic competence. The latter, he believes, is an innate characteristic of the human mind; and he insists that introspective data are both valid and necessary for linguistic insight. He is, in short, a mentalist—which, he points out, does not necessarily imply a philosophical dualism, although it is not inconsistent with dualism.

We need not pursue this further here. Clearly, Chomsky's approach is similar to ours, but the goal is different. For Chomsky, the goal is to understand language—in one aspect, the verbalization process. Linguistic analysis, accordingly, deals with words and phrases in a very precise way. In reading, our goal is the analytical reconstruction of brain software. We use verbal output essentially as clues to the primary process, which is non-verbal and antecedent even to the deep structure. Our use of words and phrases in this analytical reconstruction is somewhat slapdash from a linguistic standpoint, because we use them merely as convenient labels, analogous to the mnemonics of an assembler.

The Process approach in psycho-linguistics is similar to the Content approach, but differs mainly in attributing a much greater role to learning. Linguistic competence is regarded as a particular expression of general cognitive mechanisms. Both learning and biological development are involved in the development of these cognitive mechanisms. The focus of interest is still on language behavior—the verbalization process per se.

Psychoanalysis also deals with verbal behavior, and like reading, its focus of interest is the human mind. There are, however, several important differences.

1. Technique. Psychoanalysis is based on the technique of free association. In classical (Freudian) psychoanalysis, the patient lies on a couch, and freely reports whatever comes to mind, without censorship or critical evaluation. A special relationship emerges—the
transference relationship— in which the patient “transfers” unconscious feelings originally directed toward parents in childhood to the analyst. At critical moments, the analyst provides interpretations of phenomena to the patient. (This is an admittedly highly oversimplified description, for purposes of comparison.)

RP-1 can be used, of course, on recordings of psychoanalytic sessions. It would not, however, be feasible to apply it during a session, since the “sweeps” take time to execute. And, of course, these sweeps are clearly different from the intuitive analyses, based on psychoanalytic theory, made by the analyst. They constitute a major investment of effort to understand precisely a relatively short segment of verbal output.

2. Orientation. In psychoanalysis, the patient usually, though not always, has serious neurotic, psychotic, or psychosomatic disorders. He seeks help from the analyst. The goal, in other words, is therapy for what is considered mental illness. To accomplish this, the analysis seeks to bring into consciousness repressed unconscious material, by means of the techniques described.

In reading, the goal is to identify and to characterize the components of brain software. “Bugs” in the software are of interest, but primarily because analysis of these “bugs” may contribute to an understanding of the software. It is, of course, possible that readings may lead to new techniques for diagnosis and treatment of mental disorders, but much work needs to be done before this prospect can be evaluated.

3. Theory. The psychoanalytic model of the mind, originally topographic (conscious, preconscious, unconscious), later evolved into a structural model which views the mind as composed of three main components. These are: (1) The Ego, largely but not entirely conscious, which perceives, thinks, guides voluntary actions, maintains contact with reality, etc. (2) The Id, which is the unconscious repository of instinctual drives. (3) The Superego, mainly unconscious, representing the ego-ideal and conscience, which forms in the resolution of the Oedipus complex.

A comprehensive theory of the mind, based on the cybernetic concept that the mind is equivalent to the software of the brain, remains to be developed. Concepts derived from computer science may be tested and evaluated. A systematic program of reading verbal outputs, using RP-1 and other procedures as they emerge, may provide the basis for the gradual development of such a theory.

One further distinction: the primary process in reading is not the same as the primary process of psychoanalysis which governs unconscious mechanisms. Interestingly, the primary process of reading is “unconscious,” in the sense that it does not involve the Supervisor (Ego); but it is not repressed.

The cybernetic concept of the mind as brain software thus provides the basis for a new paradigm for investi­developed, and how fruitful its applications may be, remains to be seen. One feature of this paradigm is worth noting: it facilitates the formulation of algorithms for computer programs which simulate brain software components. This may be of value in efforts to develop natural and artificial intelligence.

REFERENCES
A short time ago, William Powers [1] published a book entitled *Behavior: the Control of Perception* (Powers, 1973) in which he set forth a global, integrated theory of brain. Considering, as Lindsay (1974) pointed out in a review of that book, that there have been few such theories in recent years, this attempt at comprehensiveness is welcome despite in a science that says less and less about the subject matter in which it professes interest. In my opinion, Powers' theory is a very good attempt, primarily because it confronts the most fundamental but (perhaps for that very reason) least discussed problem of models of brain—the problem of knowledge. Just what role, we may ask, does the brain play with respect to knowledge? What does the brain "know?" How does it come to know? In *Behavior: the Control of Perception* we are given a theory of knowledge which faces just such enduring questions as these, and the answers are provocative. Unfortunately, however, the theory of knowledge comes to us unsystematically, in bits and pieces as it were, so that its significance tends to remain in the background, overshadowed by the more concrete discussion of the workings of various brain mechanisms. Therefore, it is my purpose here to explain Powers' epistemology more systematically and to evaluate how well it comes to grips with the problem of knowing. Whether or not the reader agrees with the substance of what follows, I would hope that he or she will at least come to appreciate, if the appreciation is not already there, how intimately linked are a theory of knowledge and a theory of brain. I begin with a brief overview.

The theory of knowledge implicit in Powers' brain model may be understood as built around what William James called the "cognitive relation;" i.e., the distinction between *subject* and *object*. The subject I shall regard as the knower—that side of the distinction which can know or apprehend. By object, I shall understand that which can be known and which, in virtue of the distinction, is independent of the subject. In addition, I shall treat *mind* and *brain* as equivalent to subject and to each other, and *environment* and *real world* as equivalent to object. For those who may wish to take exception to the equivalence of mind and brain, I have treated the two as identical, not only because I think Powers does, but because the activities of mind and brain can together be regarded as belonging to a knower; for present purposes, therefore, I do not think they need to be distinguished.

Everything that follows is concerned with the two sides of the subject-object distinction and in what manner they might be related. There are, as we shall see, three aspects of Powers' model which need to be considered here: I. Control system theory; II. Neural computation; and, III. Hierarchy. Control system theory refutes three dicta commonly held in the sciences of mind concerning the subject-object relation, while neural computation and hierarchy are more directly concerned with the nature of the distinction itself and the problem of the origins of knowledge. These last two are, therefore, of greater importance for a theory of knowledge.

**Control System Theory**

A control or negative feedback system is the basic unit of organization in Powers' model. Let us quickly review the basic elements of this system.

A control system in the present context is a closed loop involving a subject in interaction with its environment. The part of the system which is subject contains three functional units in interaction with its environment. These three units are *input*, *comparator*, and *output*. Information which is sent to, or received by, each of these functional
units is in the form of a “neural current,” which Powers takes as the basic measure of nervous system activity. The input is a neural computer, and what it uses as computable information are neural currents from “below,” i.e., from control systems located lower in a hierarchy (the nature of which I shall describe later), or from neural currents generated by a sense organ transducer at the subject-environment interface. The computed product of the input is a neural current The computed product of the input is a neural current called a “perceptual signal.” It is transmitted to the comparator, another neural computer, whose function it is to sense a difference proportional to the algebraic sum of the perceptual signal and a “reference signal.” The origin of the reference signal is from “above,” i.e., from control systems higher in the hierarchy. If the perceptual and reference signals are not equal in magnitude, a neural current called an “error signal” is transmitted from the comparator to the third of our functional units, the outputs, where neural energy is transduced and amplified into non-neural (“physical”) energy at the subject-environment interface.

The part of the system which is environment is the world of physical energy. The subject is affected by this physical energy through (a) what Powers calls a “disturbance,” i.e., physical energy whose source is independent of the organism’s behavior and (b) its own behavioral output. The net effect of the disturbance and the subject’s output is the physical energy that the sense organs sense; it thus provides the raw material that the input makes into a perceptual signal. Hence the system, as I have already mentioned, is a closed loop. The function of the system as a whole is to maintain the level of the perceptual signal at the level of the reference signal. The reference signal is, therefore, a goal, and within the appropriate time framework the system may be considered goal maintaining.

As Powers explains to us, this control system can be given a formal description which is, as we shall see shortly, revealing. An abbreviated form of this description is presented below. Let us disregard the “transient” effects of a control system, i.e., those short-lived events which precede the stabilization or “settling down” of the system. Let us also assume that the system equations which bring together the important variables of this system are linear. The assumption simplifies exposition but does not affect the integrity of the argument. The equations are as follows:

\[ p = k_i q_i \]  
(1)

where \( p \) is the perceptual signal, \( q_i \) is the “input quantity,” i.e., the magnitude of physical effects impinging on the subject’s sensory apparatus, and \( k_i \) is the “input function” (a constant) relating \( p \) to \( q_i \). (1) is the input equation and shows quantitatively how the environment affects the subject.

\[ e = r - p \]  
(2)

where the \( e \) is the error signal and \( r \) is the reference signal. (2) is the comparator equation.

\[ q_o = k_0 e \]  
(3)

where \( q_o \) is the “output quantity,” i.e., the magnitude of physical effects produced by the subject and \( k_0 \) is the “output function” (a constant) relating \( e \) to \( q_o \). (3) is the subject equation and shows quantitatively how the environment affects the subject. Let us disregard the non-neural (“physical”) sources of amplification, which is the case in a subject-environment control system.

Let us now see what the above analysis means for the three dicta to which I earlier alluded and which are part of the stock-in-trade of scientists who study mind. In order to avoid ambiguity in what follows, I will need to make precise three common terms in the language of behavior: stimulus, response, and behavior itself. Because there is, as Gibson (1960) once pointed out, little consensus as to what these terms mean, I will not suppose that the definitions I offer here will please everyone. They are, however, the definitions that Powers himself uses, explicitly or otherwise, and are therefore necessary to an understanding of the implications of control system principles as he employs them. By stimulus I mean physical energy, in whatever form one chooses to refer to: (4) states that the physical input affecting the subject is the net effect of the subject’s output and some physical effect dependent of the subject. Now is the equations are solved for \( r \) in terms of \( D \) and the four constants \( (k_i, k_e, k_o, k_d) \) of terms the “loop gain” \( (k_1, k_e, k_o) \) is assumed to be large, the resulting equation can be simplified to:

\[ p = r \]  
(5)

We must assume, of course, that \( k_d \) is not large enough to overwhelm system and \( k_e \) and \( k_o \) are the primary sources of amplification, which is the case in a subject-environment control system.

1. **A stimulus causes receptor activity.** Is this statement true from the perspective of control system theory? According to system equations (1) and (4), the perceptual signal is a function of the stimulus and the behavior of the subject. Therefore, the onset of, or change in, a stimulus alone does not affect receptor activity. In fact, according to equation (5), the subject will behave in such a way as to counteract or oppose the potential effects of the stimulus so that the perceptual signal remains un-
changed (at the level of the reference signal). Thus we may say that a stimulus does not cause the activation of receptors. Any theory which asserts that such a causal link does exist is incorrect within a control system framework.

2. The subject controls its behavior. According to this dictum, that “higher” part of the brain which is connected with volition has the power to command behavior. In other words, when a subject wishes to achieve a goal, it “orders” a specific set of muscle tensions. Let us see what control theory says about this. System equation (3) states that behavior is a function of the error signal while equation (2) states that the error signal is a function not of the reference (“command”) signal, but of the difference between itself and the perceptual signal. Let us assume that the subject is behaving in a specifiable way. If a change in a disturbance occurs, equations (3) and (2) predict that behavior will change. This may happen, however, with no change in the reference signal. Conversely, it is possible that both a disturbance and the reference signal may change in a way that will produce no change in the error signal and hence no change in behavior. We see then that since behavior can change without a change in the reference signal and the reference signal can change without a change in behavior there is no direct causal link between the two. Therefore, the statement that the subject controls how it behaves is incorrect. Freedom to act in any way is not possible. That, however, is of little consequence to an entity for which purposes, not specific muscle tensions, are important. Interestingly enough, this conclusion was reached more than 30 years ago in the classic paper by Rosenblueth, Wiener, and Bigelow (1943) when they stated “…we do not command certain muscles to contract a certain degree and in a certain sequence; we merely trip the purpose and the reaction follows automatically” (p. 19).

3. A stimulus causes a response. It is upon this statement that the whole of the mechanistic philosophy of the subject-environment interaction is built. Organisms are pricked by the environment and behavior follows in a reliable way. Again, we may ask, what does control system theory have to say about this? The theory says that it is wrong, and for precisely the same reasons we found for criticizing the second dictum above. As system equations (3) and (2) show, specific behaviors are a function of error which, in turn, is a function of the relation of perception to goal. It is entirely possible to introduce a disturbance (stimulus) without a concomitant change in behavior (response) if the reference signal changes in such a way as to maintain the identity between itself and the perceptual signal. Conversely, it is possible to produce a change in behavior without a new disturbance if the reference signal changes. The new behavior would be such as to bring the perceptual signal into line with the new reference signal. A causal link between a stimulus and a response, therefore, cannot be forged under these circumstances.

Some might argue that this third dictum, which in its strongest form implies that the stimulus is a sufficient cause of the response, is a Watsonian relic very few moderns would now entertain. Recognizing the role of the organism in the act of behaving, these individuals would almost certainly invoke the concept of “mediation” or “intervening variable,” in light of which the stimulus would more properly be considered the occasion for a response or, in other words, necessary but not sufficient for a response. But this contemporary view will not do either. For as we have just seen, control system principles allow for the occurrence of a response without any stimulus if the reference signal happens to change. Thus, it is not even true that a stimulus is necessary but not sufficient for a response. It is neither necessary nor sufficient.

If these three dicta are not correct when control system principles are applied, what, if anything, can be said definitely about the subject-environment interaction within such a framework? The title of Powers’ book answers that question. According to control system theory, the subject controls what it perceives. In the model, the reference signal determines the magnitude of the perceptual signal, as is evident from equation (5). When a control system is functioning properly, the perceptual and the reference signal are equivalent. Since the perceptual signal is yoked to the reference signal, any change in the latter will result in a corresponding change in the former. In the final analysis, then, the way the world appears is the way the subject commands it to appear.

Neural Computation

To understand the significance of what is to be said in this section, we need to draw a distinction between the terms “control,” which mechanism was described in the last section, and “construct.” Control is what control systems do; such systems govern the magnitude of a perceptual signal so that it matches the magnitude of a reference signal or goal. The subject, then, is free to perceive in a variety of ways, those ways defined by the range of magnitude of the reference signal. In essence, control simply means the regulation of magnitude. Now to say that something is regulated implies that it may assume any of a number of values, i.e., it may vary or is variant. Yet, the very fact that we refer to it as “it” or “something” implies that the something being regulated has also a permanent aspect about it, i.e., has a characteristic that remains constant or is invariant. This persistence of something must, too, be accounted for, and there are, broadly speaking, two ways to do it. The first is to treat the invariance as originating in an external world. The invariance would then be thought of as a structured item existing quite independently of the subject. This item would be mapped on to the sensory apparatus whose function it would be to re-present what is “out there.” By means of control systems, the organism would be able to vary the way the item might appear, thus giving a veridical perception of it. When understood in this way, the result is a form of realism (the philosophers would, perhaps, call this “representative realism”) with control principles taken into account.

The second way to explain the invariance is to treat it as constructed within the subject. Powers (1973), like other
“experimental epistemologists”, has opted for the latter approach. In his own words:

To speak of recognition implies tacitly that the environment contains an entity to be recognized, and that all we have to do is learn to detect it. It seems far more realistic to me to speak instead of functions that construct perceptions, with the question of external counterparts to these perceptions being treated with much skepticism. (p. 114)

The result in his model is the mechanism of neural computation. Neural computation may be defined as the construction of invariances by means of neural mechanisms. When these invariances are assigned a name and given significance or meaning within some framework, they become what Powers calls “controlled quantities.”

Neural computation works in the following way (for present purposes, I focus on those computing devices located at the input of a control system, for it is these, which make contact with, and thus must in some sense make use of the physical energy of the environment). Neural currents generated “locally,” i.e., by individual sensory endings at the subject-environment interface, or from control systems lower in the hierarchy of control systems, are combined by means of weighted summations to yield a neural current that becomes a perceptual signal either for a comparator or for part of the input to the next highest control system. This “solution” to the neural computation, which Powers represents as the direction of a vector in n-dimensional space, is the invariant outcome of the ever-shifting inputs into the neural computer; it is what, by virtue of the organization of the computer, stays the same.

From a phenomenal perspective, neural computation provides the subject with whatever it may regard as the persistent items of its experience: sensations, objects, relations, systems, and so forth. For example, the output of a particular neural computation may appear to a subject to be a particular object whose “form” and “substance” remain unchanged no matter what the attitude of that object may be in three dimensional space, or whether that object is in full view or is hidden. It is, despite transformations, still that object. (The example used here is precisely what Jean Piaget regards as the “Copernican revolution” in cognitive development, namely the construction of the permanent object by the young child; Piaget & Inhelder, 1969). The object may, of course, appear differently to the subject depending on the perspective from which it is viewed. The appearance, in this case, is what can vary, and is, therefore, what is under control. But the object qua object, stays the same.

By defining neural computation as a constructive activity occurring within the subject, the epistemology in Powers’ model is already apparent. But let us develop it a little further. Consider, first, a set of sensory receptor firings caused by inputs to the nervous system. Neural currents derived from these firings cannot be directly equated with the firings because, as I have indicated, the activation of sensory endings is punctate in character. The complex invariances the subject regards as part of its world obviously cannot be represented at one or another of the sensory endings. nor even by a mosaic of such endings considered as a collection of elements each independent of all others. But these invariances can be established in neural computers by means of weighted summations of neural currents arising from the activities of many endings. Hence the invariances emerge as a result of neural computation and are not simply identical to, or transformations of, structures presented ready made to the nervous system. They are, in Gestalt terms, “wholes” that are more than the sum of their “parts,” more than the innumerable local effects of sensory endings. To use an example by Powers the taste of lemonade is the experiential product of computations that must certainly make use of the effects of various chemical components upon numerous chemoreceptors; but the taste of lemonade, the invariance, is not the same thing as those effects taken as individual events. Similarly, an experienced visual object is based upon the firings of enormous numbers of photoreceptors but, again, it is not identical to the activities of those sensory endings. In these examples, it is the neural computers that create the objects of taste and vision, respectively, by operating on the individual sensory events, giving each their due according to a given set of weightings. Thus, as Powers makes clear, the requirements of his model are such that the items of experience do not necessarily have any physical significance. They are, in brief, of and by the subject.

Consider, now, a second argument if these invariances the subject constructs out of its experience are solely the products of specific neural functions, then other functions will yield new constructions, new ways of experiencing that may or may not have anything to do with what the subject, at that moment, regards as part of its reality. There is, in fact, an infinity of possible neural functions, which means an infinity of possible constructions; and this, in turn, means an infinity of possible worlds, none of which may be considered more “real” than any other. Though the subject may attach ontological significance to the items it knows, those who see the subject-environment relation within the framework of neural computation believe differently. Au fond, each of those items is to be found, not in a structured real universe, but in a computation of mind.

Hierarchy

Thus far the discussion has centered for the most part around the properties of single control systems. Powers, however, has constructed a model that includes many control systems organized in a special way, namely hierarchically. In this section, I would like to say something about the arrangement which is of relevance to his theory of knowledge. in Powers’ model, a control system located at one level of the hierarchy receives a neural current from the output of a control system located one level above, and sends a neural current to a control system located one level below. The neural current which it receives from above is its reference signal; the current which it sends down is its output and is the reference signal for the control system below. Thus, the goal of a control system is dictated by what is above and its output dictates the goal of the system below. The hierarchal arrangement as a whole is designed to carry out
the highest order goals of the organism; lower order goals are simply means to this highest end.

In the model, the hierarchy serves two functions. The first is the obvious one: coordination. Even the simplest skills require the cooperation of innumerable control systems, and the bureaucratic arrangement is a very efficient way to achieve this cooperation since a control system acts only on orders from above. The second function is one of construction. As we saw in the discussion on neural computation, a neural computer at the input of a control system receives signals from below and produces an output which is sent either to a comparator or to the input of the next highest control system. Thus, from an experiential perspective, new items are constructed at each level, the items at the higher levels representing, in some sense, synthesis of items at lower levels. The experience at the lowest is the primitive one of “intensity,” i.e., the experience of changes in degree or magnitude and nothing more. As we move higher in the hierarchy, experiences become increasingly sophisticated; we know objects, sequences, concepts, principles, and ultimately, organized entities or systems. Thus, it is within this hierarchy that our experiential world is built.

From an epistemological standpoint, this hierarchical model of brain gives us an unusual perspective on the subject-object distinction. Consider the various ways in which the distinction is usually made. There is, to begin with, the common sense approach. Here a division is made between an organic whole and its inorganic surround, with an envelope called the skin as the dividing line. Everything inside (including the skin itself) is the subject and everything outside, the object or environment. However, instead of drawing the line this way, let us employ the definition set forth at the beginning of this paper. Make the subject the knower and the environment that which can be known. If we do this, the place where the line is drawn will change. The reason is that there is, within the skin, an internal environment (blood, lymph, joints, muscles, viscera, etc.) and a sensory apparatus that acquires information about that environment (proprioceptors and other sensing devices). This second definition would then require that the line be drawn between the sensory apparatus and everything it may sense. Looking at things this way, we see that the subject becomes equivalent to the nervous system, for it appears that only it “knows,” while the environment becomes everything the nervous system may use as a source of knowledge. Whether this definition is the better one or not, it certainly seems more in accord with traditional philosophical thinking and is the one accepted by virtually all psychologists and biologists. Let us now carry this definition a little further. Consider the hierarchical arrangement of control systems within the nervous system that Powers describes. What is the subject and what is the environment in this scheme? If we begin with the sensory apparatus at the lowest level in the hierarchy, subject and environment will be exactly as characterized by our second definition above. The subject is the nervous system and the environment all that lies outside the periphery of that system. However, as soon as we move to the next higher level in the hierarchy, that which is subject and that which is environment changes. In keeping with our second definition, what is now the source of knowledge is no longer than which can be known at the lower level because the input functions to the higher level have operated on that source and thus created new knowledge. It is this new knowledge, and only this knowledge, that can be known at the second level, for the second level has access to nothing but the creations of its input functions. Thus what is the subject, the knower, at the first level vis-a-vis the physical environment becomes itself an environment vis-a-vis the next higher level. This argument applies with equal force to the level above that one, and to the next, and so on.

The point of the discussion is this: for every shift in level, the domains of subject and environment shift, since any particular level can only “know” what is given to it from its input functions. The subject-environment distinction, then, becomes relative; where one decides to draw the line depends on where one happens to focus in the hierarchy. Now the fact that a permanent dividing line is not possible is not a very comfortable state of affairs, especially for those who, for one reason or another, need it in their respective theories of knowledge. For example, assume a claim is put forth (the classical “realist” claim) that what we regard as belonging to environment exists independently of the knower and would persist were there no knower to know it. But how could one possibly make this claim if the boundary between knower and known is a relative matter, a matter of a particular focus in the hierarchy? Those permanent, independent, “ontic” items that are initially counted as environment might on one occasion be part of the knower and on another a source of knowledge. Assertions of an ontological sort, therefore, would be difficult, or perhaps impossible. Be that as it may, Powers in fact merely courts, he never does wed, the implications of this relativistic scheme. Rather than hold solely to the second definition, he simultaneously invokes a third: the subject is to be considered the entire hierarchical network of control systems, and the environment the world of physical energy outside that hierarchy. With the addition of his mechanism of “awareness,” a device that moves throughout the hierarchy, scanning all levels but not beyond, this criterion very firmly, though arbitrarily, establishes the boundary between subject and environment. Powers does not abandon the second definition, but he makes use of it only after first employing this third one in order to establish a fixed boundary. By doing this, he is able to make the argument of the sort we encountered in the section on neural computation; to wit, that what we regard as environment in the model is a structureless physical world, and what we regard as subject is the originator of structure. An argument like this could not be made if the model did not have a stationary demarcation between subject and object.

Powers; Realist or Subjectivist?

In what has been said to this point, I have tried to interpret for the reader the connections between Powers model and various issues surrounding the subject-object distinction. As I indicated at the outset, I believe this description to be useful since the purpose of Powers' book is to explain the brain model itself, and only
secondarily to explore its epistemological implications. Before concluding, however, I should like to elaborate further on Powers' theory of knowledge, point out what I regard as a contradiction in that theory, and finally suggest ways by which that contradiction might be resolved. In order to accomplish the first, I should like to ask, for rhetorical purposes, the following question: does Powers' model imply realism or does it imply subjectivism? In the traditional way, I take realism to mean that there are structures which exist independently of the experience of a knowing subject and, moreover, that these structures are the cause of the subject's knowledge of them in virtue of the mechanisms of perception. I take subjectivism to mean that structures do not exist apart from a knowing subject's knowledge of them; that these structures belong solely "in" the mind of the subject [2]. From what has already been said, I think Powers' model implies subjectivism, but, as I shall explain, of a special sort. The relevant part of Powers' model is neural computation. As we have seen, objects, relations, and other items of experience are, according to the model, the products of neural computation. Hence, the properties of the input functions are such that, given their flexibility, there are no structural constraints necessarily exerted upon them by the environment. The position is therefore subjectivist, at least insofar as it locates the source of structure to be "in" the subject. What is more, the assertion that structures embodied in the neural computers can be other than they are, i.e., can be organized in innumerable ways, suggests that the model is constructivist—all sorts of structures are possible and whichever of these a subject possesses is independent of the structural properties of a material world should the latter happen to exist.

Now if, in fact, neural computation implies subjectivism, one may then ask what an environment is doing in Powers' model at all? Why not, as some do, simply dispense with that side of the distinction and leave only a mind composed of neural computers? The reason is that the model is not skeptical with respect to an unstructured external world. To show that this is the case, I again quote Powers:

This is a good opportunity to emphasize a "philosophical fact" that emerges from this theory: perceptual signals depend on physical events, but what they represent does not necessarily have any physical significance... (p. 113)

For purposes here, the important word in the quotation is "depend." To Powers, the real world may or may not have structure, and even if it does, the structure of the mind may or may not be correlated to it; given the nature of neural computers, if such a correlation exists, it is coincidental. The model does, however, insist that there is an environment, and that it does cause the mind to perceive. That is what Powers means when he says that perception "depends" on physical events. Now one may ask what can possibly be meant by "depend" if not bring about a mental structure in some correspondence with a real structure? Apparently, Powers means nothing more than that the environment supplies the raw material for the neural computers at the lowest level in much the same sense that alliment is the raw material organisms use to construct biological structures. Unstructured physical energy, like food, is necessary for the making of structures, but the raw materials do not correspond to those structures. In sum, the model may be characterized as subjectivist only with respect to the origin of meaningful structures; Powers makes room for a material world, but one whose role in the model is as supplier, not of real items, but (to continue the metaphor) of unprocessed cognitive nourishment. In this respect, his ideas bear resemblance to Piaget, the "early" Karl Marx, and possibly Kant as well.

These remarks lead naturally to another question, the answer to which, I believe, reveals an inconsistency in Powers' model. The question is this: If it is assumed that an organized system of neural computers has some kind of history, what, we may ask, is the course of that history? How, in short, does the system get to be the way it is? If it is correct to assess Powers' model as subjectivist (at least with regard to the origins of structure), then consistency would demand the following kind of answer: the genesis of the organization of the computers must be a wholly internal affair; there can be no external structural standard to which the organized hierarchy must ultimately conform. Since Powers takes pains to show the flexibility of neural computers, and argues that the organization of each of these is no "truer" than any other, we might have expected him to account for the development of any particular organization in purely intrinsic terms. One such approach would be some sort of internal dialectic, driven by goals of coherence and the attainment of ever higher orders of invariance. Powers, however, takes another position, namely that knowledge is acquired which permits the subject, or more correctly the physical organism belonging to the subject, to remain alive. In the model itself, a conceptually separate control system accomplishes this by guiding the organization and reorganization of the hierarchy. It informs the hierarchy of an "intrinsic" reference signal, the former indicating the current physiological state of the organism and the latter the desired physiological state, the one which keeps the organism alive. If there is a mismatch, the neural computers in the hierarchy reorganize; at all levels of the hierarchy incoming perceptual signals are reinterpreted—given new meaning—and outgoing error signals are given a new family of goals. In effect, the subject comes to understand and to cope with a physical world in new ways, ways which will change the organism's physiological state so that it will remain alive. As Powers points out, this aspect of the model is an extension of the concept of "ultrastability" by the cyberneticist W. Ross Ashby (Ashby, 1952), which idea, like kindred others in traditional views of learning and motivation, is an attempt to account for the plasticity of mind in an ever-changing and threatening environment. It is, as I shall now try to show, inconsistent with the rest of Powers' model.

Consider the following quote from Power's book in which he attempts to clarify the distinction between the hierarchy and the reorganizing system:

We must therefore consider that any behavior has two major classes of effect. One kind of effect is sensory: behavior alters the state of the world that affects sensory
endings, and by this means (ideally) keeps all levels of perception at their respective goal states. The other kind of effect is physiological: behavior alters the state of physiological intrinsic quantities through physical and biochemical processes not involving the nervous system at all. (p. 187)

The classes of effect he calls sensory refer to a process already discussed in detail, namely that in which the joint physical effects of both disturbances and behavior affect sensory endings. It is at this interface that the first structural interpretations begin. From the modeler's point of view, what is considered "physical" can be thought of as nothing more than a set of energetic point elements, each affecting individual sensory endings. There need be no appeal to structure outside of the mind.

However, the classes of effect Powers calls physiological refer to processes both structured and outside the nervous system. One cannot talk about physiology without at the same time invoking certain biological and chemical objects and their relations. Hence, that part of the reorganizing system which is physiological is structured. And since physiology does "... not involve the nervous system at all," it must be part of the environment. Herein lies the contradiction. On the one hand, Powers claims that when we are concerned with sensory effects in the hierarchy we do not need a structured environment as part of the model. On the other hand, when we are concerned with the process of reorganization, the model tells us we do need a structured environment. Obviously, we cannot have it both ways. The inconsistency could be resolved by making a structured environment an integral part of the model or by eliminating it altogether—in other words, by taking either a realist or subjectivist position. Since this would necessitate revision of the Powers' model, it is certainly reasonable to ask which position, if either, would be the better. At the same time it would, perhaps, be presumptuous for me to discuss the issue here because the problem, as old as philosophy itself, cannot easily be given due consideration in a few pages. If the reader will permit me, I should like, nevertheless, to risk presumption because I believe the matter can be clarified, if not resolved, by taking a perspective that is, to my knowledge, little discussed in epistemology. Thus the following.

Coda: Some remarks on the subject-object distinction.

As a preliminary, let us consider, in turn, the realist and subjectivist positions to see if, from a logical point of view, either or both can stand firm. First, according to the realist position, the subject, or knower, in some way learns about a world of objects independent of and prior to the subject. The subject is thus nothing more or less than a mechanism for representing what already exists. To know, then, is to represent. The obvious query is how this representing takes place. Since every known model of brain takes a mosaic of sensory receptors as its starting point for this process, it seems reasonable to assume that if real structures exist independently of the subject, they are (as I pointed out earlier) disassembled at the subject-object interface. The reason, of course, is that receptors cannot individually represent external structures. The subject is thus faced with the task of reconstructing those structures, i.e., putting together the individual receptor firings so as to create a pattern or structure that is identical to, or some transformation of, the "real" structure. Now any act of reconstruction, as Plato understood a very long time ago, must involve the following: (a) that which is to be reconstructed (in this case, it is the mental structure), (b) a model or standard on which the reconstruction is to be patterned (here, the standard is the real world structure) and (c) a comparator or observer, by which I mean something that compares the reconstruction and standard to determine the veridicality of the former with respect to the latter. Within the framework of realism, it must be assumed that the subject compares its own structures to the real world standard so as to effect a match. Doing so, however, carries with it the additional and often hidden assumption that the subject has prior knowledge of the real world standard; how, otherwise, would a comparison be possible? Yet acquiring knowledge of the standard is the very problem the realist set out to solve, so that he has involved himself in a perfectly vicious circle (see e.g., Hirst, 1959). There is a simple way out of the circularity, of course, and that is to establish a meta-subject in whose field of experience both subject and environment are to be found. Since the meta-subject knows both subjective and real world structures, appropriate change in or additions to the former can easily be made. But while this approach would complete the requirements for reconstruction, it simply replaces the problem of how the subject gains knowledge with the identical problem of how the meta-subject gains knowledge. For what we really wish to know is how a knowing entity acquires knowledge by its own devices, as it were, and not by recourse to some deus ex machina. I shall return to this point.

What the argument, therefore, comes to is that a realist perspective must, for logical reasons, fail to account for the acquisition of structure by a knowing subject. It is remarkable, in light of this, that the realist position is so thoroughly pervasive among scientists who construct models of mind.

Now what of the subjectivist position? According to the earlier definition, subjectivism means that the subject is in some sense primary and that structures exist solely within the mind. What the subject knows, it knows within and not outside itself in some independent domain of existence. On the face of it, this point of view would seem to resolve the difficulty we encountered with the realist position. If everything that can be known is already within the mind, the sort of verification process we required between internal structures and external ones would not be necessary for the simple reason that true knowledge does not have to be transmitted from one location (external reality) to another (the subject); it already reposes "in" the subject. But as Moore (1922), Russell (1959) and others pointed out, this solution does not work. For if we have structures in the mind, we can mean only one of two things: either that known becomes knower (i.e., the known takes on the function or meaning of knower), or that knower and known are still to be distinguished but are together to be regarded as mental. If the former, then we have simply defined away the relation.
between knower and known rather than coming to a deeper understanding of it. If the latter, we have not, in fact, solved the problem of circularity thought to be the falling of realism because we still have the two sides of the cognitive relation—knower and known—even though we may have relocated them "in" what was originally the knower. Since the distinction still remains, it also remains for us to determine how the "knower-within-the-knower" learns about the "known-within-the-knower."

It is by now apparent after these rather lengthy prelatory remarks that the problem of knowledge devolves upon the subject-object (knower-known) distinction itself. I should like now to give a brief analysis of that distinction and to set forth what I believe to be the implications of the analysis for any of the sciences of mind.

Logically, the "sides" of any distinction have what can best be described as a "complementary parity." By this I mean that one side of the distinction cannot take on any sort of meaning without the existence of the other (or others); they are, in this sense, "equal" in the relation. The reason is that the act of distinguishing has behind it an intent (conscious or otherwise) to divide a heretofore uniform whole into mutually exclusive but complementary domains. In perception, a paradigmatic case of a distinction would be the figure-ground relationship. Here we have two sides to the distinction: "figure" and "ground." Each has parity with respect to the other and the parity is complementary because neither can exist without the other. It would literally be impossible to experience a figure without at the same time calling forth a ground, and vice versa. At the same time, each serves a quite different function in the relation. Figure is that which is prominent in the perception; ground is that which forms a backdrop or a contrast to the figure. Thus, while the two sides "support" one another, they are also independent of each other. The same holds for the preeminent case in epistemology, the subject-object distinction. Again, the sides of this distinction have a complementary equality or parity; each is necessary for the other. But, again, neither can be said to have primacy; by the very nature of the complementary relation each side serves a function independent of the other. The subject apprehends, the object is that which is apprehended. Neither can take the role of the other without destroying the very nature of the distinction.

Thus it is that realism and subjectivism get us into logical difficulties: both violate the inherent properties of the subject-object distinction. Realism establishes a primacy of real world structures over a knowing subject. Such structures, according to this position, exist independently of and prior to any knower; known exists before knower. Realism, therefore, transgresses the meaning of the distinction, for if there is a real world before there is a knower, one side of the distinction is made to exist without the other, which assertion is not permitted by the logic of the distinction. Or alternatively, the realist assumption that knowledge gets "in" the knower (i.e., that the knower "learns") fails to keep separate the functions of knower and known since, as I have pointed out, the distinction makes the knower an apprehender, not a repository, of knowledge. Formally, the same argument applies to subjectivism. Here it is assumed that the knower is prior to the known, which again violates the logic of the distinction by giving priority to one side of it. Or alternatively, if it is assumed that whatever is known is "in" the subject, the functions of knower and known are not kept distinct, which again is a transgression.

In answer, then, to the question of which orientation, realist, or subjectivist, would be the better one for Powers (and, indeed, all scientists of mind) to take, I must conclude that neither will do. As long as we insist on partitioning experience by means of the subject-object distinction and, simultaneously, embracing either realism or subjectivism, we shall encounter traps at every turn because realism and subjectivism are in essence opposed to that distinction.

If all this is true, the reader may well wonder what path we are left to pursue for building models of mind. The only alternative I see is to dispense with the subject within the model itself. Everything we regard as "physical," as "neural," as "physiological," etc., in short all we take to be the data of science, must in consequence be characterized solely as that which is known, while we who stand as observers outside these domains of observation must be the knowers. We may, of course, continue to think the concepts and talk the language of science as we have in the past. For example, brain theorists may continue to think in terms of the "transduction of energy" or the "transmission of information" from one part of our experience (as observers) to another, furthermore, these theorists may, for example, name one part "neural" and another "physical." But in no circumstances, under penalty of those difficulties I have already discussed, may they be permitted to treat the brain or the organism as the knower.

At the same time, we should caution ourselves that this injunction creates certain limitations that we may be unwilling to accept. By forbidding a knower to be part of what we observers experience, we exclude the possibility of understanding, in the way we have traditionally defined them, those unique properties of organisms that have been the foundation of the sciences of mind, videnlicet: learning, attention, and development. For each of these properties contains implicitly the very special premise that the organism itself is the primary agent in the knowing process; that the organism itself, without the aid of an observer, can come to know. Consider learning, for example. To say that an organism can learn about its environment independently of an observer is to say that it can autonomously come to know something outside of itself. But we have seen the circularity to which this premise leads. Only the observer can decide whether the organism learns, which is to say that only the observer can sense a correspondence between parts of its experience. For that reason, without our deus ex machina—the observer, learning and other related processes, when understood as the autonomous properties of a subject, must remain beyond explanation.
NOTES

1. I acknowledge gratefully William T. Powers and W. Michael Tomasello for their critical reading of the manuscript, their stimulation, and their encouragement; and also Ernst von Glasersfeld whose constructivist epistemology has influenced my thinking on the central ideas expressed here. I also wish to thank the members of my Seminar in Cybernetics class for their criticisms and their enthusiasm in connection with this piece. Of course, I am entirely responsible for any deficiencies that may be contained therein.

2. What I call subjectivism has been known traditionally as idealism, but since the latter has very many distinctly different meanings, I prefer the former. The word "subjectivism" has fewer meanings and also the merit of containing within it the root word "subject" over which the novice in philosophy is likely to become less confused.

3. Students of the contemporary philosophy of perception will recognize the similarity between this problem and the debate over whether it is "sense data" or "real objects" that we perceive (see e.g., Machamer, 1970). Sense data are "in" us, real objects are "outside" us; but formally both fall on the side of the distinction we call the known. Since sense data and real objects are formally identical, the debate amounts to the argument that x is true, or x is true, which, is obviously trivial.

REFERENCES


Conference Calendar, 1977

25-27 July 1977:
TIMS XXIII INTERNATIONAL MEETING, co-sponsored by European Operational Research Societies within IFORS, on Contributions of Management Science and Operations Research to Functional Areas of Management, to Industries and Public Concern as well as Methodologies, Athens, Greece.

13-15 September 1977:
MAX INTERNATIONAL SYMPOSIUM on Extremal Methods and Systems Analysis, University of Texas, Austin, TX.

7-9 November 1977:
JOINT NATIONAL ORSA/TIMS MEETING, covering applications, methodology and critical problems of our time, Peachtree Plaza Hotel, Atlanta, GA.

Notices

A comprehensive guidebook has been developed by San Jose State University to explain their Cybernetic Systems Program. This guidebook was written to acquaint interested parties about program subjects and requirements beyond what appears in the university catalog.

The contents include detailed course descriptions and outline, syllabi sheets for all courses, example questions in the required comprehensive written examination, thesis writing instructions and procedures, lists of previous graduates showing occupation and thesis presented, past and present faculty indicating their fields of expertise, and a bibliography. There are also sections that explain how the program started and the administrative problems overcome. The editor's personal experience and opinions formed in administering the program complete the guidebook. Thus, the guidebook should be of value to the many individuals and those institutions having or considering such programs.

Copies of the guidebook are being offered for sale at the cost of reproduction. Inquiries of cost should be directed to the Spartan Bookstore, Textbook Department of San Jose State University, San Jose, California 95192.
The liberal and Marxist concepts of unilinear progress have no basis either in contemporary reality or in history. All civilizations are finite, time-bound and mortal. All social orders are marked by conflict and contradiction and driven by a negativity that is sooner or later bound to destroy them. All things in history move toward both fulfillment and dissolution, toward the fuller embodiment of their essential character and toward decline and fall. Nothing is evergreen, each source of life is eventually exhausted and each concentration of energy eventually dispersed. All life suffers from the deepest estrangement and animosity which exists between man's creative processes and their content and products. The cultural products which man creates become the enemy of their creator. Every civilization thus carries within itself, as if by an intrinsic fate, something which is determined to block, burden and distort, to obscure and defeat its innermost purposes. Decay and disintegration, ruin and defeat are as inherently interwoven into the plan of the world as success and progress.

A Coherent Design for Society's Functioning

Taking the broadest possible view it is possible to understand all civilizations as being shaped by a “master design” of class relations, ideology and productive forces. This design constitutes an assemblage of forms, a coordination of patterns. These include: a system of government and laws; an ideology or a way of thinking; a set of property relations, manual habits and technological skills; a style of art and architecture; and rules for social and personal relations. Taken all together, these styles, ways, attitudes and rules, though rent by conflict and incongruity, by paradox and ambiguity, add up to a more or less coherent design for a society’s functioning. We can thus construe a civilization as something that achieves a precocious unity, that works from a start of more or less haphazardness toward greater coherence, and that moves from amorphousness toward definition and from fumbling trials to decisive acts.

This process of cultural growth from chaotic, groping beginnings, through growing commitment to particular forms or patterns and growing control of these forms or patterns until they are achieved and their potentialities realized, seems to be basic in the history of civilization. Its unfolding constitutes what we call the rise of civilizations; its cessation or reversal, their decline or disintegration. Any civilization will thus tend to move in the direction of greater coherence, definitiveness and decisive action as the way toward its culmination; and its peak and apogee can be considered the point beyond which the “master design” no longer shows increase in plastic coordination but begins to fall apart, or to harden into rigidity, or both.

Like every idea, however, this one, too, should not be applied simplistically or mechanically. Not every civilization has a history of simple rise, maturity and fall. Room must be left for complications of structure and development. Some civilizations destroy themselves when they are young; some are undermined in their maturity; and some continue to live a death-in-life for hundreds of years in their decline. Others may seem to attain a realization of the patterns which they had gradually achieved and shaped; but then, instead of either stereotyping or smashing these patterns and thereby dissolving their civilizations they may experience a renaissance and make a fresh start with reconstituted or partly new patterns. We have in such a case a renewed pulse of activity within the same society. Yet this new pulse of activity does not save the civilization from ultimate decline or disintegration.

Every “master design” or cultural style or system thus imposes certain ineluctable boundaries on every civilization. Every notable cultural achievement presupposes adherence to a certain set of patterns; that the patterns to be effective must exclude other possibilities and are limited; that, while certain revisions of and deviations from them are possible, these can never transcend the broad framework established by these patterns; that with successful development they accordingly become exhausted; and that a culture can go on to new achievements only if there is a breakdown or abandonment of a revolutionary reformation of patterns. The master design thus forms, develops, matures, decays and either dissolves or atrophies into a dead petrification.[1]

Every civilization is therefore ruled by a few general inescapable laws. Though it is very difficult, if not impossible, to predict the exact duration of any civilization or the sequence of its phases, it is yet possible to see civilization unrolling like the consistent plot of a tragedy,
inevitable and irreversible. And irreversibility, whether of entropy in physics or of human destiny, carries implications of fate and doom.

What Drives Society?

In the first place every society is driven by the will to power. Impelled by passion and appetite men seek to impose their will upon the world and upon other men and to fulfill their personal needs. Insecure and anxious, threatened by meaninglessness and absurdity, men seek to overcome these eternal existential agonies by accumulating power. Sprung from chaos and pervasive flux, caught in that blind and involuntary war which is existence, men seek to provide something to their distracted lives by striving to appropriate, dominate, increase and grow stronger. Striving is therefore nothing other than striving for power. All human life is involved in the sin of seeking security at the expense of other life. Men always live at the expense of others and history is, as a result, always appropriation, overpowering the foreign and the weak and at its very foundation—exploitation and injustice. The inability of liberalism and Marxism to understand the demonic character of power makes it impossible for these ideologies to comprehend the nature of the human condition and stamps them as shallow and false guides to the enduring problems of history. Driven by the will to power nations, empires and civilizations are subject to decline, ruin and revolution. And this for a number of reasons.

A factor of supreme importance which has throughout history brought about or contributed to the decline of civilizations has been the very character of power itself. The struggle to magnify itself is of power's essence. Being a species of egoism it tends naturally to grow. Every center of force and power is propelled by the will to grow stronger—not self-preservation, but the will to appropriate, dominate, increase, grow stronger. States are not merely interested in self-preservation but are centers of inordinate ambitions, lusts and desires. Polities are not essentially tame, cool and calculating collectivities but are motivated by expansive desires and vitalities. Imperialism is hence an inherent component of all inter-state relations. Originating in blind desire and human freedom and vitality imperialism is an expression of the fact that human desire, freedom and vitality have no simple, definable limits. Goaded by the imagination, puffed up with self-love states desire to expand, to accumulate force, to break limits, to universalize themselves and in these ways to give their existence a significance beyond themselves. Striving unceasingly for power and glory states not only seek to impose their will upon each other but find the sheer intoxication of ruling overriding every other consideration.

Impelled by the blind will to power nations are sooner or later destroyed by their inability to manage or control the power they have so feverishly accumulated. Deluded by power, nations can rarely correctly evaluate their own power as against the power of other nations. Nations have fallen because they have tended to believe in the absolute character of their own power. A nation which has been powerful in one period of history is tempted to believe that this superiority is a kind of natural gift that exists irrespective of the power of its rivals and competitors. This tendency to look at the power of one's nation as a kind of absolute, to take it for granted, and not to realize that it is the result of comparison, leads to those miscalculations regarding the distribution of military and political power between nations which usually end in disaster.

Another typical error which is frequently made in evaluating the power of a nation lies not so much in believing in its absolute character but in believing in its permanency. In this case the nation refuses to see ahead, loses its powers of adaptiveness and flexibility and regards the power which it possesses at a particular period of history as a permanent characteristic which is not subject to change in itself. Idolizing itself or some particular form of military organization or technique it is unable to respond to new changes and challenges in its environment. Obsessed with its own superiority and "choseness," attributing all the good qualities to itself and depriving all other nations, especially the enemy, of all good qualities, a nationalism which has turned into chauvinism tends to overestimate its own qualities and by underestimating the qualities of other nations so weakens itself as to produce catastrophe. Throughout history nations have fallen because they believed too strongly in their own superiority and because they committed the great error of refusing to look at themselves and at their competitors with that critical faculty and detachment which is required for creative statesmanship.

The Demonical Character of Power

The most fateful consequence of possessing power lies, however, in its demonic character. The ruling groups and collectivities which hold power can never know how to use power with wisdom and prudence for too long. It is in the very nature of power to overextend itself, to expand beyond its natural limits, to become inordinate and oppressive. It greedily and ruthlessly demands objectivation. The will to power is avid to weaken its desire and thus it becomes divided against itself. Striving against itself, seeking its own well-being at the expense of others it constantly sets its teeth in its own flesh.

Though power is the impulse to action and growth it is nevertheless ultimately impotent. It is roiled in its blind agitation and devours its own strength in its all-embracing fury. All our large human units, political and social, are tragically transitory. The law of nature at bottom would seem to be that power steadfastly ignores the means of conserving itself, that power destroys itself once it goes beyond its natural limits; that the physical expansion of power is always accompanied by social disintegration; that wars and the preparation for war subtract the strength of societies and that man's vital liberties are smothered and defeated by contrary powers.

The ruling groups that wield power are thus destroyed either by lethargy or stupidity or by outrageous behavior. The are either spoit by success or they lose their moral and mental balance. Their temporary achievements either induce them to passively "rest on their oars" or provoke unbalanced men into attempting the impossible and by
so doing bring catastrophe upon themselves; or filled with folly, among the worst diseases, they have their judgment corrupted, incur the enmity of their friends or arouse the murderous hostility of their rivals and soon enough total ruin and the loss of all their power follows.

Plato has dramatically explained this whole process: If you neglect the rule of proportion and fit excessively large sails to small ships, or give too much food to a small body, or too high authority to a soul that doesn’t measure up to it, the result is always disastrous... Body and soul become puffed up; disease breaks out in the one, and in the other arrogance quickly leads to injustice. [2]

Another law of history which no society has been able to circumvent has been that which determines the rise, growth, decline or fall of ruling elites. All societies are governed by a ruling elite or class of one kind or another and all societies are divided into a ruling minority and a majority that is ruled. All growth is the work of creative personalities and creative minorities. Fired by ambition, and an \textit{elan vital}, possessing new skills and capacities, these creative ruling minorities impose themselves upon the inert, uncreative mass. Hard working and innovative, these creative ruling minorities impose themselves upon the inert, uncreative mass. Hard working and innovative, filled with self-confidence, flexible and responsive, they organize all those institutions which make it possible for men to live a life in common, to maintain a genuine independence, to pursue great projects in common and to compete with other states in the perpetual struggle for power that takes place between them. An elite at the top of its form can lift the society it is governing to new levels of historical existence, can transform the mass into its followers, and can liberate new energies for creative social departures.

\textbf{The Political Class}

The quality of every society is thus determined by the quality of its leadership, that is, of its elite. To lead and to rule require special attributes. It means to decide, to command, to prevail, to advance, to conserve. It involves the creation of a tradition, to bring on others so that the work of the original leader or leadership will be continued with their original pulse and spirit. If this creation of a tradition does not come off, then instead of a coherent ruling stratum we have a congeries of individuals who are helpless when confronted by the unforeseen. If it does, we have a political class, a highly trained, self-replenishing minority with sure and slowly ripened traditions, which attracts every talent into the ruling circle and uses it to the full, and simultaneously keeps itself in harmony with the remainder of the nation that it rules. The art of politics is therefore the art of ruling.

Although every form of rule is shaped by the dialectic of power and the power of the dialectic, by force, cunning, fraud and contradiction, it must, to be effective, be molded by an overriding concern for the society it is ruling. A creative and effective ruling elite will know how to serve the public interest, how to conciliate the diverse and antagonistic groups into which every society is divided into a coherent community, how to rule with both restraint and justice and how to teach a whole manner of life to that community. To rule is to command but also to persuade, to impose one’s will but also to arouse respect and trust, to exercise power but also to act wisely and with self-restraint.

In the hierarchy of variables that shapes every society the political variable is the most important. Politics as the “master science” has the supreme task of managing the social conflicts and contradictions that are inherent in every society. Through political leadership societies can be led either to great achievements or toward chaos and disaster. The qualities and skills of the political class, which is a sub-elite within the ruling elite, therefore determines its relations to the ruled majority. The political class is the political manager for the ruling elite. It is the governor of the country.

In its role as manager for the ruling class, as a whole, the political class has the responsibility for advancing the general welfare. The effective political class has its ear open to the demands of the non-elite groups in the society and attempts to conciliate these groups by giving them legal status and security and well-defined and recognized forums to express their needs and interests. It is able to adjust and adapt to the many and constant changes of its society. It opens its ranks to the most active elements in the society and absorbs those with leadership and governing talents. Through this continuous process of exchange and renewal it keeps its vitality and fitness for the task of ruling and maintains, as well as possible, a certain interaction between the society as a whole and the ruling elite. Practicing a form of dialectical politics, it strives to attain a degree of cooperation between contradictory principles and interests and changes the class that is ruled into a collaborator of the ruling elite. The political class thus becomes the reflector of the society. It holds all the characteristics of that society. If the ruling class is mediocre it cannot produce a great political class. The nature and the capabilities of the political elite mirror the nature and the capabilities of the ruling elite as a whole.

However, all these “ideal” qualities are by their very nature ephemeral and transitory. They are all subject to change and decay. No social or political structure is permanent and no static Utopia is possible. All ruling elites sooner or later, and in no fixed or sequential order, begin to lose the superior qualities that raised them to power in the first place. The forces of humanity and reason are ultimately impotent against the forces of beastliness, militancy, corruption and evil. Selfishness, ambition and the lust for power will derange and exhaust them. The charismatic forces that liberated their creative energies will become routinized and the blight of bureaucratic conservatism and stupidity will spread. The latent cruelty and blindness of all competitive life, the pride of absoluteness in the human soul, the radical ignorance of judgment will all overflow the banks of customs and institutions and inundate the society. Irrational passions will break down the weak ramparts of reason. Blinded by passion and ideology the ruling elites will lose contact with social realities and no longer comprehend or control the major social forces at work in the society. Become hidebound, bureaucratic and unadaptable, they will recruit degenerate elements into their ranks and simply lose the will and ability for governing. The ruling elite will cease to serve and lead the society and will substitute its
Ideology and Historical Decay

Another important factor which disfigures social existence and which ultimately contributes to historical decay is ideology. Every society is shaped by a set of beliefs, myths and symbols which guide and give it a sense of purpose. The beliefs and myths by which every society lives are selected by the dominant group and are acceptable to it. The ideas of the ruling class are the ruling ideas of every age. However, these ideas though rooted in reality, never fully express reality. They always carry with them a baggage of falsehoods and mystifications. The ruling ideology may contain real concepts, scientific insights, yet it must always be inextricably mixed up with rationalizations, apologetics, lies, deceptive representations and self-deception. Every social order shaped by its own specific ideology can therefore only perceive the world through the distorted lenses of its own making, can never totally liberate itself from the bondage of its basic assumptions, can only have a fragmentary and partial conception of reality, and is to a greater or lesser extent immersed in inauthenticity and contradiction.

Contrary to the superstitions of rationalism human reason plays only a small part in human affairs and is subordinate to the blind and unconscious emotions. Most social thought is characterized by illusion, dissimulation, rationalization and mystification. Even the highest form of reason always borders on unreason. Human conduct is not governed by reason but by will, passion, phantoms and material interest. Man’s intellect is above all an instrument in the struggle for existence; the function of thought is to serve the life process and the will to power; and all social thought is socially determined and tainted by class and personal interests. Rational, deliberate, conscious belief does not determine what is going to happen to society and men’s socially decisive actions spring not from logical but from non-logical roots. Men are influenced in every culture and at every period of history not by rational purposes but by their non-logical impulses of taboos, magic, superstition, personified abstractions, myths, gods, empty verbalisms and vague, ambiguous or meaningless goals.

Ideologies are thus ignorant of the exact nature of their relations with praxis. They are an inverted, mutilated and distorted reflection of reality. Ideologies do not really understand their own conditions presuppositions, nor the actual consequences they are producing. They are ignorant of the implications of their own theories and they comprehend neither the causes of which they are effects nor the effects which they are actually causing. Involved in practice, serving as instruments in the struggle between classes and nations, they mask the true interests and aspirations of the groups involved. All social thought is enveloped in a fog of deception and self-deception, is rooted in intellectual pride and is the victim of the ignorance of its ignorance. It is deeply sunk in flattery, falsehood, fraud, slander, pretentiousness and disguise. Ideology plays hide and seek on the back of everything.

The role of ideology is particularly dominant in politics. The basic manifestations of politics never appear to be what they actually are. The struggle for power and position, as the underlying objectives of policy, are always explained away and justified in moral, legal or biological terms. The true nature of policy is always disguised by ideological justifications and rationalizations. Vast collective actions are made palatable to their participants by words which have no precise meaning and that are used to persuade, sway and seduce the participants into supporting these actions. The actor on the political stage cannot help but “play an act” and must hide the true nature of his political actions behind the mask of an ideology. Politicians and their servants therefore have an ineradicable proclivity to deceive themselves and others about what they are doing. The ultimate goals of political action—the lust for power—are always concealed behind false fronts and pretenses. It is the very nature of politics to compel the actor on the political scene to use ideologies in order to disguise the immediate goal of his own action. Blinded by ideology, driven by passion, ambition, avarice and pride the ruling elite will sooner or later commit those follies and crimes that will undermine the very basis of its rule.

Every social order, all political, social and philosophical thought, all political action are thus distorted by ideology. The physical sciences are also fettered with preconceptions and the rigidities of paradigmatic thought. The social world is not ruled by reason, the pragmatic or experimental temper or by objective science. Every society creates an ideology, a certain perception of the world, a system of values and beliefs serving to reinforce and rationalize the dominant political, economic and social interest of its society. The ideology it fashions and the system of interests it serves has some basis in empirical reality. It manifests some forms of pragmatic behavior. It can respond to changing conditions and pressures. Yet it cannot attain that degree of flexibility, it cannot be experimental to the degree where it can transcend itself without a revolutionary upheaval. A stiffening process inevitably sets in. Ideology may be supple and adaptable, but the ring around it is closed. It may bend to suit a certain interest but it cannot supersede it. It changes, but at most only imperceptibly and its ideological character is never lost. It walks the same
ground, keeps its same place and plays its same ideolog-
ical role. Whether the ideology is that of capitalism, democracy, liberalism, conservatism, socialism, or any one of the varieties of communism or nationalism or imperialism, each in its own way denies certain elements of reality from its consciousness and serves as a bar to its perception of reality. The ideologies developed and held by the ruling elites thus never completely embrace the social environment in which they operate. They lag behind societ- real. They come into conflict with that social reality. They are all impelled by overwhelming pride and all become immersed in the illusions, prejudices and mystifications which they themselves had fashioned and which debilitates and ultimately comes to destroy that very social system these had been designed to sustain.

Organization and Conservation

No society can exist without forms, organizations or institutions through which it expresses and realizes itself. However, these forms—governments, parties, bureaucracies, armies, corporations, labor unions, universities, etc.—created by the rivers and rhythms of life assume a character and momentum of their own. Organizations become societies, that is to say, they are not simply places of work but settings in which people live, and sometimes even more important for the quality of their lives than the homes to which they return after work. They provide objectives, formal and informal rules, values, punishments and rewards, styles of personal behavior, identities, a language of their own, and they seek and manage to maintain these characteristics in something like a stable state, even though its members may frequently change. Organizational behavior, built to function on the model of the production process is based on regular, orderly, linear, predictable processes. Each function strives to maintain a constant framework for operation. Organizations want to do predictable jobs under predictable circumstances.[3]

The society of the organization wants to maintain a stable state. Conservatism is thus built into the very nature of all organizations. This effort to maintain a stable state is not only due to inertia and routine but is the result of a policy of active conservatism which all organizations pursue. There is a persistent stress on system maintenance despite the state of oscillation in which organizations always exist. Resistant to change, suspicious of innovation after their initial period of creativity, organizations sooner or later succumb to the "iron law of decadence," that "tendency of all organizations to maintain themselves at the expense of needed change and innovation"[4] They can never maintain that perpetual flexibility and spontaneity which is required for sustaining growth and innovation.

The conservative nature of organizations and institutions has a baleful effect on the development of all societies. For life is not static. It is always in a state of flux and change. The introduction of new dynamic forces, changes in its internal and external environment, the infinite richness of life, all in due course confront the existing institutional order with the dire challenge to reconstruct the whole existing pattern. In any actually growing society a constant readjustment of the more

flagrant anachronisms is actually going on. But because of the "iron law of decadence" every society always tends to keep most parts of the social structure as they are in spite of their increasing incongruity with the new social forces constantly coming into action. All societies come to idealize the ephemeral institutions they have established, become their captives and though they are capable of modifying and reforming some of them in their periods of creativity they soon enough lose their capacities for change and adaptability in their periods of decadence. [5] In contrast with the promethean stature and exuberant activity of their forefathers in the age of social growth the ruling elites of the declining society shrink into dwarfs or stiffen into arthritics.

Every society consequently suffers from an inherent conflict between life's eternal flux and the objective validity and genuineness of the institutions through which it passes. This contradiction between life and its forms expresses itself in many different areas of social life. In the economic system there is a permanent conflict between the forces of production and the property relations which contain and organize them. All systems of property relations—slavery, feudalism, capitalism, state capitalism or state socialism—either obstruct the development and extension of the new economic forces they have developed or are unable to adjust to the problems they have generated. In time the rigidity of the property system either stifles these new forces or being unable to adapt them leads society to social revolution or catastrophe and decline.

The same contradictions exist in the political sphere. Thus the Greek city-state which were initially responsible for a magnificent outpouring of energies could never transcend the rivalry which the system of sovereign city-states angendered and finally ended in the anarchy and degeneration of the Peloponnesian War. Thus, too, Rome, though it solved the problem of rival and contending city-states, for a time, through the establishment of a Roman empire, was finally overwhelmed by decline and fall by pursuing a policy of immediate greatness and by corrupting its own ruling institutions. At the end the Roman empire never had any genuine juridical form, authentic legality or legitimacy. The empire became a shapeless form of government, a form of state without authentic institutions, and its chief of state went back to being—just anybody. The same debilitating disharmony exists between the anachronistic modern nation state which has been one of the most powerful institutions of growth and power and the international environment of multi-national corporations and global technologies, problems and challenges. We build up our power only to see it the better overturned. Every institutional order, of whatever character, carries within itself its own congenital poison and is the cause of its own extermination.

An Historical Turning Point

It ought to be more than obvious by now that we have entered one of those decisive turning points in history which separate whole eras from one another. We live in the midst of an epoch comparable to those which saw the passing of the city-state and the collapse of the Roman empire. The capitalist order has entered a period
of prolonged crisis. Wildly unstable prices, erratic currencies, scarcities and famines, climbing rates of unemployment, the plight of the cities, failures of economic policy all indicate some of the symptoms of the disease. The shift in economic wealth from the industrialized countries to the underdeveloped countries through the price increases imposed by the Organization of Petroleum Exporting Countries (OPEC) and other raw material producing countries and without any effective response from the so-called Western world constitutes a phenomenon of portentous significance. It is unquestionably clear that mankind’s inordinate consumption of energy, its obliteration of animal, plant and insect species and the disruption of regional balances of natural processes by chemicals and other works of man will, sooner or later, bring about such profound changes in natural systems that it will probably endanger life itself. And when we study the present growth trends in world population, industrialization, pollution, food production and resource depletion and project them into the future, it is obvious that practically all these trends lead to catastrophe.

The democratic governments of the West are everywhere in decline. They lack the intellectual capacities to master the complexities which have emerged as a result of heedless economic growth and chaotic political development. Authority lacks confidence and the people lack confidence in authority. The demands on democratic government for leadership and management have grown immensely while the capacities of democratic government have everywhere disastrously shrivelled. Government incompetence and corruption is everywhere spreading like a plague. The men and women who attain power are neither willing nor able to change thoughts and values or to play lofty historic roles and are subservient to the unexamined prejudices and preferences of the multitude. Image-making replaces policy. Everywhere powerful sectional economic and political interests subvert any coherent view of the public interest. Dominated by powerful economic interests, swayed by mass tastes and standards, torn by exhausting and murderous factional conflicts our democratic states suffer from a breakdown of community, a loss of all sense of civic obligation and cooperation and a universal pursuit of self interest. Nobody seems to know where they are going, because strictly speaking, they have no fixed road, no predetermined trajectory before them. The captains are on the bridge but they cannot find the rudder and the ship of state drifts toward the rocks of breakdown.

The West’s position in the world is also in decline. Not only has the power of the United States decreased relative to that of its competitors and adversaries but its whole foreign policy is in disarray. Its humiliating defeat in Southeast Asia, its obsession with military security, its overextended commitments, its failure to understand that the great threat to the West lies not in any danger of military attack but in the political, economic, social and intellectual weaknesses which beset it, all stamp its foreign policy with an indelible imprint of triviality and irrelevance. The Atlantic Alliance is in the process of disintegrating. The national rivalries between its members transcend any common interest that they might have had in the past. The myth of European unity and power finally collapsed not because of Russian antagonism or harassment but as a result of the oil weapon wielded by Emir of Kuwait and the Sheikh of Abu Dhabi. Europe’s decadence springs from a collapse of will, a kind of “European Buddhism” which Nietzsche long ago foresaw as a pernicious form of nihilism. The West is now in full-scale retreat not only because of increasing Communist strength, both within and without, but also because it has been unable to confront the economic blackmail practiced by its erstwhile allies—the King of Saudi-Arabia and the Shah of Iran. The growing self-confidence and arrogance of the world’s slum countries, particularly the Arab States, is only surpassed by the confusion, the mediocrity, the division, the antagonisms and the self-destructive forces at work in the West. The whole balance of power is shifting against the West and there is no force in the world that can prevent this from continuing to its own ineluctable end.

History as Drama

To understand history we must therefore see it as a mighty drama, as an awe-inspiring tragedy. Driven by the blind will to live, avid of life, greedy to wreak his desires, man is impelled by an irresistible lust for power and gain, by an inescapable impulse toward the fulfillment of his blind will to live, avid of life, greedy to wreak his desires, everything in the light of seeing, an impotent rebel man is riddled with flaws and contradictions. History is dialectical as well as dramatic.

History as Dialectic

Driven by necessity and yet capable of freedom and creativity, limited and limitless, weak and strong, blind and far-seeing, an impotent rebel man is riddled with flaws and contradictions. History is dialectical as well as dramatic. On the one hand man produces himself by his own labor, driven by necessity and yet capable of freedom and creativity. Authority Iacks confidence and the people are neither willing nor able to change thoughts and values or to play lofty historic roles and are subservient to the unexamined prejudices and preferences of the multitude. Image-making replaces policy. Everywhere powerful sectional economic and political interests subvert any coherent view of the public interest. Dominated by powerful economic interests, swayed by mass tastes and standards, torn by exhausting and murderous factional conflicts our democratic states suffer from a breakdown of community, a loss of all sense of civic obligation and cooperation and a universal pursuit of self-interest. Nobody seems to know where they are going, because strictly speaking, they have no fixed road, no predetermined trajectory before them. The captains are on the bridge but they cannot find the rudder and the ship of state drifts toward the rocks of breakdown.

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the things he has produced with his own hands—more accurately the abstract things—tend to turn him into a thing itself, just another commodity, to be bought, sold and discarded.

Though living in a world created by his own labor and knowledge, this world is no longer his but rather stands opposed to his inner needs—a strange world governed by inexorable laws, a “thingified world” in which human life is frustrated. This is a world marked by a loss of coherence and liberty, by the numerous conflicts that abound in human living, especially in the conflicts between man and nature, and man and man. This conflict, which has turned nature into a hostile power that had to be mastered by man and which set man against man, class against class and nation against nation has led to an antagonism between idea and reality, between thought and the real, between consciousness and existence. The institutions man founds and the culture he creates develop laws of their own and man has to comply with them. He is overpowered by the expanding wealth of his economic, political and social surroundings and surrenders to their way. Men in striving to perpetuate and establish culture perpetuate in the process their own frustrations. The materials that could serve life come to rule over its content and goal and the consciousness of man is made victim to the relationships of material and social production.

Everywhere we see opposition and dissonance in human affairs. The will to live strives against itself, seeks its own well-being at the expense of others and so constantly sets its teeth in its own flesh. The lust for power sets man against man and group against group in unending contention. The two basic instincts of life and death are in a state of perpetual war with each other; civilization opposes and represses the individual and builds tormenting discontent into the very culture that he creates; the man and nature are locked in violent antagonism. The demonic and corrupt elements within man are in combat with the moral and ethical elements. God and the devil, light and darkness, good and evil, creativity and tradition struggle for dominance in the world. All social arrangements contain within themselves contradictions and negativities which will ultimately destroy them. Unresolvable discord, contradictions and conflicts are inherent in the nature of things. In the great struggle between man’s understanding and the riddles of the world and his existence each new answer offers only a new question and each new victory only a new disappointment. There is thus no inevitable progress toward the good evident from year to year or from epoch but only unresolved conflict, which sees today good and tomorrow evil prevail.

History as Tragedy

History is then not only dialectical but also tragic. Man’s freedom, confidence and imagination, though capable of achieving great feats, always ultimately collide against his natural limitations. Man is capable of wisdom and creativity, but these qualities are equally matched by his follies and crimes. His own inherent natural flaws only serve to bring to ruin his most impressive works. He can be destroyed by a single virtue, if that is overextended, and plunge into insane acts in the cause of a half truth that appears to him to be noble. His very successes can undermine his most glorious enterprises and his most astounding victories are generally only the progenitors of his inevitable defeat.

It is the tragedy of human history that man must be destructive in order to be creative and that his finest moments only lead him to hubris and nemesis. Human life is permanently at war with itself. There is no ultimate solution to the conflict between man’s constructive-destructive vitalities and the social and natural restraints which these seek to overcome. The tragic view of human existence must show man in all his strengths and weaknesses. It must acknowledge his freedom and his subjugation, his genius and his finiteness, his heroism and his corruption, his virtue and his evil. All human history shows the defects and excesses of all values, reveals tension, imbalance and contradictions as the essential condition of all civilization and the source of both its rise, growth and fall.

REFERENCES

Law of Organization

C: I understand that your basic theoretical work in human behavior, mental illness and therapy is based on your research in cybernetics and general systems. How is cybernetics linked with psychology?

G: Cybernetics and its allied disciplines of general systems research and organization and information theory, are all broadly based interdisciplinary approaches. They are grounded in the idea of holism—the concept of observing complete systems of behavior and the attempt to discover their common and most basic laws and principles. This applies to all systems, atomic, biological, psychological, social and the like. Systems research is the opposite of traditional scientific methods, in that rather than attempting to separate phenomena into specialized parts, it works with a synthesis of the parts together. In the case of psychology, by looking at the whole person as a cybernetic system, one gets an entirely different and broader perspective than has been customary. Also, understanding the seemingly paradoxical behaviors of people is considerably deepened by directly comparing human behavior with the behavior of biological and physical systems. The idea here is to use discoveries in one system to ask new questions and get new answers about another system. The startling result is, that when a study is made, you find that while the human mind is extrinsically different from other phenomena, it is intrinsically the same and obeys the same laws. Thus, in the last few years, this kind of research has revealed entirely new insights into motivation, personality, the nature of mental pleasure and pain and the origins of mental disorders.

C: You talk about general laws that apply to all behaviors, from atomic to human. According to your transformation theory [4] human love or anxiety can be understood through the same principles that are applied to biology or even cosmology. Can you start by defining these General Laws?

G: I think it would be useful at this point to consider the basic, foundation law on which all other laws are built. We can proceed from that point and get into specific sub-principles as we progress. We build on the fact that we can observe through all of Nature, from the smallest sub-atomic particle to the galaxies of the universe, two basic forces at work. The process of ordering—of things coming into organized relationship, and the process of disordering—of breaking things down into unrelated formations. Between these two extremes there exists a continuum, where different ratios or balances of order and disorder prevail. For example, in the physical processes of the body this occurs through anabolosis and katabolosis, the building up and breaking down of bodily constituents. Like and death if you will. In the development of any human physical body, either the breaking down or building up process will dominate and between these forces there is always some kind of balance, or perhaps better stated, imbalance. Another example of this process might be a human invention, such as a game. In any game there is a balance between the rules (the order) and the alternative possibilities of play (the disorder). These two inexorable forces in the Universe, in their unending struggle with each other, produce all the phenomena we observe, including the interplay of forces in the mind. The philosopher, Zoroaster, illustrated this when he pitted virtue against wickedness,

*Since this is a running dialogue between George Land and Christina Kenneally, George Land’s comments will be designated by the letter G and Christina Kenneally’s by the letter C.
love against hate, freedom against tyranny to reflect his
laws of universal principles.

C: But Zoroaster was not the first to come up with these
thoughts. Thousands of years before Christ, philosophers wrote of these principles. In Hindu texts, the concept you stated is shown as Brahma, the creator or organizer, Shiva, the destroyer, and Vishnu, the preser-
ver (who stands between Brahma and Shiva and balances
their forces). These ideas are not new. If they were basic
laws of behavior I think we would have known that long
ago. What new insights do you have into human nature that makes these ancient ideas so much more valuable?

G: We have only begun to see the importance of the
science of organization in the last few decades. For
example, by studying how atoms join and form mole-
cules, and, conversely, how molecules can be broken
down into their atomic parts, the magic of alchemy has
become chemistry and its laws of organization have been
formed. The study of thermodynamics has shown us how
the disorganizing processes work and recent studies in
synergy and negentropy show us how the organizing
processes work. Lately, we have put the ordering and dis-
ordering under a microscope and gained a much better
understanding of the processes. By transferring that new
knowledge back to observations of mental processes it
became possible to establish a new set of basic laws
about the mind.

In reference to your observations about Hindu
philosophy, it is vital in our reformulation of ideas about
the mind to recognize that the "Vishnu" principle on the
planet Earth is one in which the ordering force is slightly
greater than the disordering force. We can observe this by
studying billions of years of evolution on our planet and
realizing that the rate of construction of higher levels of
organization is greater than those which cause disor-
ganization. Atoms have become molecules, molecules
have coalesced into cells, cells have joined together into
multi-cellular organisms and so on, all the way up to the
formation of highly complex human societies. Thus, for
any process to be viable here, it must operate "in tune"
with planetary processes. With time it must become more
rather than less organized. As it becomes more organized
it encompasses greater diversity for organization does not
mean sameness, it means more complexity and
diversity.

C: You refer to "this planet Earth". Are you implying that
the necessary balance is different on other planets?
Following this, are you assuming that human behavior is
"goal oriented" towards more order than disorder?

G: The answer is yes to both questions. From a plan-
tary perspective we see in the Universe, regions where
disorder is much greater than order—such as superno-
avas and stars, where disorganized energy is emitted,
and, at the other end of the continuum, regions where or-
dering is far greater than disordering, such as "black
holes", where energy is absorbed and "frozen" into order.
Earth lies between these extremes, in a zone which per-
mits higher rates of order than disorder. Life rules over
death and the bio-mass continually increases.

The question of human direction as a part of this is
very important, both practically and philosophically. As a
philosophical point of view it means that our ability to inter-
connect and inter-relate is increasing rather than
decreasing, cu-operation gradually dominating com-
petition. The physical evidence of evolution supports this
philosophic orientation. In a very practical way this
natural imbalance of order over disorder affects each one
of us continually and profoundly. Nature supplies us with
very powerful cues as to the direction of our behavior—
psychological pleasure and pain. We experience pleasure
when we make connections with people, things or ideas and we experience pain when we are denied or
lose connections.

C: I can't really accept that oversimplification. Don't
you mean that we feel pleasure when we make a positive
connection and pain when we are denied, lose or make
negative connections. I can make a connection with a
person and through that suffer an unpleasant experience
which causes me anger and pain. It's still a connection,
but a negative one.

G: What do you mean by "negative connection"? Give
me an example of how you felt pain when making a con-
nection.

C: Occasionally I have met and been forced to spend
time with someone I didn't like. It often happens in
working situations. You have a connection of some kind
but it doesn't bring any pleasure.

G: You have really answered your own question. To not
like someone is to be unable to make common bonds.
What you are really saying by your example is that you
have been forced to be with someone with whom you
could not make a connection and this denial of the
natural insistence of making bonds caused you pain.
This is a good example of the vitality of order over disorder
force. One does not have to lose a bond to experience
pain—just being in the position of not being able to make
broadening relationships causes pain, anxiety and
depression. We call it alienation.

C: This sounds so simple, and seems to solve one of
the mysteries that has baffled psychology for a long
time—the origin of mental pleasure and pain and the
reason or rather the necessity for their existence. It
seems to me, through your theory, that pain has as
positive a place in our psyche as its counterpart, and only
the two together can provide us with the balance we need
to survive and grow. I think that we are taught to avoid
psychological pain because it is considered destructive.
By doing this aren't we avoiding a necessary side of
growth and therefore not only stunting ourselves but
taking steps backwards instead of forwards?

G: Yes. A total misunderstanding about the pleasure-
pain principle leads us down the "pursuit of happiness"
path where we attempt to feel good all the time. By un-
derstanding how disorder and order complement each

other, we can begin to realize why pain is necessary for full growth. We must often break and de-structure lower level bonds in order to achieve new connections and integration at a higher level. This is the process of unlearning: the ability to give up as well as to acquire and hold on. Human growth is a constant balancing act of re-organization of connections at broader and higher levels—always with a mixture of pleasure and pain. The greater the leap to broader connections, the more the pain—“agony and ecstasy.”

Principles of Personality Organization

C: Let me clarify a thought I have about people. The worst thing that can threaten us is either total order or complete disorder. Is it this kind of disastrous imbalance that causes mental illness? I remember when people who were mentally ill were described as “unbalanced”. We no longer use this term but perhaps it is more accurate than our more modern terminology.

G: You have hit on the very essence of how we can clarify the workings and misworkings of the mind. With the obvious exception of organic brain damage or disease, all mental illness can be understood as imbalances in a person’s process of organization. In the broadest sense these fall into the category of either attempting to create order, obsessions and compulsions. It appears now that mental illness in its outward manifestations is simply a natural attempt on the part of the mind to balance what is happening inside. As Karl Menninger put it, “Of course one can describe a “manic” or a “depressed” or a “schizophrenic” constellation of symptoms, but what is most important about this constellation in each case? Not, we think, its curious external form, but rather what it indicates in regard to the process of organization, disorganization and reorganization of the personality in a state of attempted adjustment to environmental reality. Is the imbalance increasing or decreasing?”

The “manic depressive” is an example of this. The inner mental structure has become disorganized and alienated or disconnected from reality—thus producing symptoms of severe depression and pain. This quite naturally causes externalized “manic” symptoms, where the affected person maintains a belief that he has extraordinary powers of control over people and things in their environment and can impose his own organization on the world. In this situation, internal disorder produces the need to manifest external order. This and other symptomologies of mental illness indicate that the external symptom is an unconscious, natural attempt on the part of the mind to rebalance itself.

C: If that is true then it would seem that most of the treatment given in therapy and in mental institutions is inappropriate. I read somewhere that 60 or 70 percent of people who go through some kind of mental illness or crisis never receive any kind of formal therapy or medication. They cure themselves, or in your terms, achieve their balance alone. As far as your theory is concerned it would seem that these people are better off. Are you negating today’s forms of therapy and psychiatric treatment?

G: To a great extent, yes. By removing a person’s symptoms, through whatever means, restraint, electrical or chemical tranquilization, or behaviorist conditioning, we are preventing the patient’s primary means of self-restoration and re-organization. What we are beginning to understand now is that every person must go through a continuing series of successive and successful stages of different kinds of organization. If we thwart any of these stages, we can either cause an imbalance or make it worse.

The human mind, like the human body is never in a static balance of order and disorder. In the body, from the moment of conception, and for many years thereafter, the ordering process is much greater than the disordering process. Years later, equally so, the disordering process becomes more active than the ordering process. In just this way in reverse, at birth the human mind is overbalanced in its sense of disorder. This gradually changes through infancy and childhood as the balancing forces of order manifest themselves. If we were to take the normal behavior of a two year old and imagine an adult behaving this way, then we could use a number of psychological terms to describe the mental “illness” involved, depending mostly on the pocketbook of the patient. Sanity is neither a state of complete organization nor one of disorganization; it is that mental condition which allows our perception of order and connectedness to maintain itself in a world wherein there is much disorder.

C: I don’t want to oversimplify, or to deny that the concepts you are presenting are exciting and tremendously interesting—but it sounds like common sense. Over the past several decades there has been an astonishing amount of discovery and investigation in the fields of mental illness, therapy and human behavior. Have none of the great philosophers, psychiatrists and scientists who produced the literature and information we have on these subjects, come up with this theory before?

G: Yes, there have been. But attempting to answer that question requires us to consider how the so called “scientific method” can allow us to accumulate a vast amount of information that has missed the point. From its early beginnings, almost as a kind of parlour game, a great attempt has been made to legitimize psychology by making it into an “acceptable” science; that is “a collection of hypotheses from which one can understand, control and predict experimentally verifiable results.” This definition was the framework of all science until quite recently. The method is to break things down into small parts, observe phenomenon, develop a theory and set up experimental tests to determine if the predicted results appear. If they do the theory is translated into laws. This was a relatively satisfactory viewpoint until recently when the seed planted by Heisenberg’s concept of “uncertainty” began to be observed by people studying whole atomic systems. The idea of uncertainty was, and
still is, a great crisis in scientific circles, (on the other hand it was a great relief in some philosophic circles). The Newtonian or classical idea is a deterministic one, everything can be calculated with precision, understood and predicted. Determinism indicated that everything in the world could be predicted, given enough information, and it seems to work, much to the dismay of those believing in free will.

With the advent of atomic physics, it was discovered that the future could not be predicted exactly; for example, it could be seen that an atom which had absorbed a quanta of energy would emit that energy, but no one could predict when or how—one could only draw up probabilities. Suddenly, with this idea and the proofs of uncertainty, the classical scientific world was overturned.

Einstein was so disturbed by the concept of uncertainty that he was impelled to say, "God does not play dice with the Universe!" As far as it is known, Einstein died in the belief that something was intrinsically wrong with Heisenberg's idea. The fact is that both Heisenberg and Einstein were right—and wrong. They were both observing the two sides of the universal coin, order and disorder. You can predict how fast an apple will fall, but not when it will happen. There is room for both determinism and free will, but in differing ratios to each other, in different phenomena.

To get back to this idea as to why this idea was not seen clearly before, the world of psychology. In its efforts to become a "science" has continued to follow the false path of classical science, in both experimentation and theoretical work. The great lesson of uncertainty in systems was lost to psychology. This is why behaviorism, first proposed by Hippocrates and then followed by Pavlov, Watson and Skinner has become such a popular school. Particular behaviors can indeed be conditioned and thus can be experimentally verified. Psychology can thus become part of the traditional, scientific determinacy school. Yet this partial explanation of Man is far from complete. Behaviorism does not explain any of the higher functions of Man, such as curiosity, creativity, love, will and honor. As with atomic theory, today in psychology we have to make room for new concepts which are at once much more and much less than the old ideas of what constitutes a scientific theory. That is; we have to look for the underlying principles and patterns of phenomenon, the how and why, rather than merely how much and how fast.

This problem of what is and what is not science in human studies is one of the influences which caused psychology to disregard what is, in my opinion, the most important work done by Sigmund Freud, and the failure to follow up on the leads which he set forth in his late work. In the 1920's, when Freud was in his mid-sixties he re-examined, re-appraised and re-thought his original work on the structure and functions of the mind. In the thoughts that came out of that work, particularly in the books [3] Beyond the Pleasure Principle and The Ego and the Id, Freud not only disclaimed much of his earlier work, but he offered ideas on the framework of an entirely different theory. Freud was perhaps the first Cybernetician or general systems scientist. In his late books he asserted that psychology had much deeper roots than he had originally believed. He said, "An instinct would be a tendency innate, in living organic matter, impelling it towards the re-statement of an earlier condition," and, "But in the last resort it must have been the evolution of our earth and its relations with the sun that has left its imprint on the development of organism." What he saw was that in our relationship to energy sources, our ordering processes operate at a higher level than our disordering processes—we are gaining more energy than we lose.

Freud proposed a dualistic concept of the instinctive life, abandoning libidinous urges as our sole motivation. "They course through it (life) uninterruptedly, two kinds of processes of opposite direction, one anabolic, assimilatory, the other katabolic, disintegrating. Shall we venture to recognize in these two directions of the vital processes, the activities of our two instinctive tendencies—the life instinct and the death instinct?" Later he observed, "...both instincts would be active in every particle of living substance, although in unequal proportions." Freud postulated an entirely new and different structure for his psychology. Rather than the unconscious, libidinous id, the conscious ego and the externally created superego, he inferred a totally new instinctive framework; Eros, the life instinct, and Thanatos, the death instinct. Today we can see that Freud's dualism is really holism—the two ends of the total process. His basic intuition, however, was far ahead of "acceptable" science.

C: Perhaps another reason why this important lead was overlooked was because of the sensationalism that Freud's sex instinct theories created. After the Victorian era of sexual repression, people were swept up in the enthusiasm for the release from this repression, bypassing this less showy but more relevant concept.

G: I believe that must have had a strong influence on the Oversight, but Freud's was not the only work lost in the revolutions of the twenties. Repressed by cultural forces was the work of A.A. Bogdanov, [1] who stated in a different framework essentially the same ideas as Freud in his Tectology—The Universal Science of Organization. His view of organizational change and the evolution of freedom versus control was strongly opposed to the philosophy of Marx. As a result, he was mercilessly attacked by Lenin and was then forcibly suppressed along with all of his works, by Stalin. His seminal theories of the relationship of ordering and disordering have only recently re-emerged in the Soviet Union through the growth of Cybernetics systems and the fruitfulness of their applications in different areas. Although this and DeStalinisation has recently brought Bogdanov's ideas to light once more in the Soviet Union, they are still practically unknown in the Western world. By a strange coincidence, Freud and Bogdanov's works were written at almost exactly the same time.

C: Could it be that the writings you mention by Freud and Bogdanov are most appropriate to today's problems than they were when they were written, perhaps their theories were not overlooked but out of place at that time.
G: The question of appropriateness is very relevant. In order to understand one of the central concepts of the disordering and ordering process, one also has to understand the development of any organization, whether it be a Society, a Science or a mind. I believe that understanding the principles of organization is indeed more appropriate and necessary to this period in our history, because for the first time we are able to see the different organizational patterns being applied and we are becoming aware of different kinds of crises that call for new understanding. Of course, in many disciplines other than the human sciences, the principles have been obvious, it is just that we have not seen how they relate to us humans.

Organizational Stages and Semantics

C: What are the basic principles of the development of an organization?

G: We can observe three basic stages in the development of any organization. One way to represent these is by using the growth curve (see illustration Figure 1) and to relate to some simple organization, such as a biological organism. In a cell, for example, the first stage of growth is a period where unorganized material from the environment is absorbed by the parent cell and gradually organized into the enlarging daughter cell. Once a basic pattern has been established, the daughter cell can grow on its own and enter stage two—that of making replicas of itself. As can be seen on the growth curve, with a successful method of organizing environmental materials, this period of growth is quite rapid and successful. However, as more replica cells are generated—and as they spread further into the environment—they begin to change. The influence of the original cell and its particular environment get further and further away. During this second stage, several things happen simultaneously. The basic pattern is being repeated successfully and yet the more successful it becomes, the more the pattern changes. As order, or frontier cells become more adjusted to their own particular environments, internal inconsistency develops. The pattern and the boundaries which separated the original cell from its environment became less rigid; and at the same time, within the organism, because of different positions, nutrients, etc. there is a need for different cells to take on diverse and specialized functions. There evolves also a necessity for the competition between dividing cells prevalent in stage two, to now become cooperation. In the multicellular organism, not only does each cell serve the whole organism of which it is a part, in a specialized and interdependent way, but the whole organism becomes much more sensitive to and interdependent with its environment. In this third stage, we see what is called, in symbiosis, the relationship of mutualism, where there is a high level of reciprocity, both within the organism and in its relationship with the environment and with other organisms.

For the standpoint of looking at order and disorder, we see the initial disorder of the first stage of growth is complemented and satisfied by the imposition of parental order. Once this first step of organization is established, the organism has constructed its own internal order (always somewhat different from the parent's because of different environmental exposure). It can impose its own order on the environment's disorder by forming replicas. When this stage is successful, the new multi-cellular organism can specialize internally and accept new kinds of disorder for its own growth in a broader relationship with the environment.

This pattern of going from an initial state of high disorder to a secondary state of high order into a third state of integrating new disorder, is a pattern we can see in all growth, atomic to human. These three stages are basic principles we can add to the foundation of order and disorder forces.

C: When you use the term “growth” I take it you mean making new connections, or bonds at a higher level. Can you relate these three stages of growth to the mind?

G: In all of its aspects, from getting larger to making involved, organizational relationships, growth is always a matter of making connections or bonds, at higher levels of complexity. Things come into relationship or association with each other which were not previously connected. As far as the mind is concerned, one example is how we assimilate knowledge. Take for instance, learning a game—say tennis. The first “order of business”, if one does not know the game, is to find a source of order (the parent). This could be a pro., or an instructional manual, or it could come from observing the game and asking questions. The principle is to get a pattern of the rules, the procedures and methods of playing. Once you put these together into a pattern, you can get practice; replicating and improving on the initial pattern, making changes depending on the environment, other players, different surfaces, singles games or doubles, etc. There comes a time in this practice where, with more practice, playing doesn’t continue to improve.
You have a secure game but it's not going anywhere. At this point it becomes appropriate to move to level three in organization, where you begin to experiment, to innovate and to look for new ideas; different ways to hold the racquet, new positions of play and movements, etc.

Here we can see the question of appropriateness very clearly. If you are at stage two, still practicing to get the hang of the game, it is inappropriate to try out a lot of new ideas. This would only break the pattern you are trying to build. The idea at stage two is repetition, "practice makes perfect". It's common sense not to start out creating new things when what you are doing is already working well and improving. The contrary is true when you get to stage three. If you are not improving, you had better start looking for something new—once you are perfect, innovation becomes appropriate. As you can see there are a very important series of shifts of types of relationships in dependency and in attitudes that fit each stage in the organization process.

C: You just used the term "shifts of dependency". As a mother, an example of interest to me is the shift in relationship between a mother and her infant child and the child during adolescence. We use the same word, "love" to describe their feeling for each other at each of these very different stages, but the word describes two very different relationships. We make these shifts intuitively with children as they grow—what does this mean in regard to transformation theory?

G: Again, as with cell growth, crystal growth or learning, what we are seeing is personality organization verification and re-organization—the three stage cyclical pattern—and that pattern is repeated at higher levels as a person proceeds through life. Of course, when I talk about an individual, just as I would about a cell or crystal, completing a cycle and proceeding to a higher level, I am referring to healthy growth. Any system can be arrested at any stage in the cycle and it can also regress to lower stages because of deficiencies in its environment... and in some cases in its own molecular or genetic pattern (though the former is far more common).

To look at your question and consider the basic cycle as it applies to developing the young person, the three stages basically go like this: 1st stage, from birth to approximately fourth or fifth year, is a period of pattern formation—in this case a personality and living pattern, often called an identity. This is a high-dependency stage where the growing infant is almost completely dependent on the environment, primarily the parent’s, to provide the material, information, beliefs, attitudes etc. which will make up the identity pattern. The second stage is a period of carrying that pattern out, replicating it and testing and modifying it. The child now relates to and connects with a broader environment. In this interaction a young person discovers how well they can identify with other people and situations, and whether he or her behavior works, by generating enough positive feedback. This period, which at its healthiest stretches from approximately four or five to puberty, is a time for self-verification, as psychologists refer to it, the development and reinforcement of the self-concept. If the pattern works well, the adolescent can proceed into stage three, a period characterized by a deeper interaction with people and things. At this point we begin to see a large change in behavior and relationships. In the first stage we had high-dependency, control or controlled relationships, and in the second stage this shifted from control to influencing or being influenced, where dependency shifts or diminishes. In the third stage, we now see much more mutuality, that is, reciprocal interaction where the sharing of control and influence becomes cooperation.

In healthy growth, we see the idea of love change substantially over this developmental cycle. It is certainly appropriate to call the extreme dependency relationship of parent and infant, love. However, it is equally appropriate as the dependency diminishes in stage two. It is also appropriate to use the same word in stage three of mutual relationship—one word for three different phenomena.

Many of these kinds of words have been very confusing in the study of psychology because, unlike what has happened in the natural and physical sciences, we have not had clear reference points for defining our descriptions of behavior. The biologists can turn to biology, the biologist can look to the level of molecular genetics and likewise the geneticist can turn to chemistry and so on down the line. They have the advantage of looking back and forth from different levels of behavior to obtain clear and well understood definitions. For hundreds of years in psychology we have been bogged down in circular explanations—trying to define human behavior in terms of itself. A definition example is "curiosity is motivated in itself." These tautologies lead absolutely nowhere and provide no understanding. This is true of almost all the words we use in psychology. Take for example the word "trust". At stage one, I could trust you to tell me the right and safe thing to do. At stage two I trust you to influence me in the proper direction, and in stage three I trust I can share myself, my vulnerabilities and potentials in a mutual relationship with you. These are three entirely different meanings of the word trust. I am hopeful that the breakthrough in understanding these traditionally nebulous words in other terms will be a great advantage to us in psychology.

C: I just finished reading Freud's Beyond the Pleasure Principle, and I marked a passage which I think illustrated his understanding of this concept. It was near the end of the book when he noted, "The shortcomings of our descriptions would probably disappear if, for the psychological terms we could substitute physiological or chemical ones." You are both indicating that one of the great problems is one of semantics—that our language, through its inadequacy and inability to define clearly, is confusing our understanding of important new concepts of human behavior. We seem to use a large vocabulary of psychological terms to describe these concepts, but do we recognize that each word has several different meanings?

G: Recently I looked at several test instruments designed to measure "self-concept" and it was easy to see that the three different types of self-concept were inter-
mixed and consequently there has been a great deal of difficulty in using the results of these tests for personality assessment.

Organizational Development of Children

C: Before we were side-tracked into definitions, we were talking about healthy growth in child development. Could we look more deeply into the problems that occur when the necessary balance for the child is not achieved, or lost, and how this affects mental illness?

G: One way to look at this process of organization and development of personality is to try to put ourselves in the place of the developing child. Imagine, for instance, that you are lost in the jungles of Brazil, with no supplies or local knowledge. You are surrounded by an environment that is totally unlike any you have ever known—a total disorder. Suppose also that a group of Indians came along and that they represented attitudes that range from curious and friendly, to hostile. Faced with a struggle for survival, you would naturally attempt to attach yourself to one of the friendly Indians and, assuming that your attachment was accepted, you would be totally dependent on this person for your survival. Your new protector could then be nothing in order for you, showing you the safe food, the safe place to sleep and the boundaries or limits you could safely explore. What occurs here is an initial period of total dependency, where your "adopted parent" would teach you a pattern of life that helped you to survive. The dynamics of this relationship is, like all very high dependency associations—control. That is, you are willing, if not eager to have your guide order you in what to do, when to do it and how to do it. You have no choice. Equally, you must attempt to make your needs known in some way and if your basic needs are not met, you are forced to demand that they be. You are, in effect, owned by the Indian, and he, by accepting the responsibility, is owned by you—until you have acquired enough knowledge to fend for yourself. In this first stage of organizing and building a basic pattern of living, the connection we make with other humans and the environment is very different from those we make later, when we are more independent.

C: I don't really agree with this analogy. I do agree that the infant's situation is total dependency and can in some instances be precarious, in the case of an irresponsible parent and an unwanted child, but the adult marooned in the jungle seems to me a more precarious situation. The child does have the added security of the strong emotional bond with the parent, the adult, and the Indian wouldn't have that bond of love. At any time the Indian could give up his responsibility and disappear. You are presumably using this example to illustrate the first stage of growth. It would be harder to complete this stage in the jungle with a stranger than it would be while being cared for by a loving parent.

G: I agree. But on the other hand look at the disastrous effects on personality formation when the parent does not live up to the blood bond of "mother love". The anxiety, stress and uncertainty takes a terrible toll on an infant. We are looking at the tap roots of much mental illness. For a self-image to get a good start, the parent must provide an equal state of order to balance the child's disorder. If this balance is not achieved and the parent either forces too much discipline and constraint, or is too permissive, the results will be very damaging. With too much constraint, the child will develop an exaggerated sense of how much order he needs to survive. What will happen then?

C: He will become fearful and unadventurous and will not be able to make a healthy transition into less dependent behavior. In the jungle example, if the Indian practices the same constraints, by keeping the adult dependent instead of teaching him independence, the adult either becomes a slave or recognizes that this initial means of survival is now inhibiting his growth, and fights against this constraint. I see now that in this sense a child is more vulnerable than the adult. Because of his instinctive response to the bonds of parental love, he would accept his slavery and be unable to make the vital transitions necessary.

G: Here we see a classic situation, an example of disequilibrium of the developing person. The parent, by overprotecting and "giving the child everything" has set him up to live a half-life of exaggerated order—frozen between stage one and stage two he becomes overdependent on teachers, bosses, regulations, expectations and the like, to tell him what to do and who to be. Beyond that, this unbalance creates an unending and natural struggle for re-balance, one which can find its outlet in unexpected outbursts of balancing disorder.

So, on the one hand we have a person who maintains conscious efforts at self-control, has exaggerated perceptions for defense from disorder and is inhibited and anxious. On the other hand this can result in both somatic or physical malfunctions such as sexual problems, and can lead to disorganized withdrawal including periods of disassociation, fantasies, use of alcohol and narcotics, pyromania, and many other worse syndromes, all exhibitions of a need to balance the inner tension of exaggerated order. The least problem to be expected is an inadequate and infantile personality with a high reliance on relationships that are dependency oriented. The person needs to be either controlled or be in control.

C: The worst implication of this theory for me is that, for a parent to make this mistake, they must have had a severe imbalance in their early growth. The parent who creates exaggerated needs for dependency in their child does so from their own sense of extreme insecurity. To them, stage one dependence is love, and loss of dependency is loss of control, and control is vital to an insecure parent. This means that this kind of imbalance is "inherited" and can produce problems from one generation to the next. Perhaps this is the reason for family histories of mental illness.

G: At this point we should look at the other side of the balance question. In this case the parent, rather than
caring too much, doesn’t care enough, and rather than providing reasonable and safe boundaries, lets the child explore too far. It could also be the case of the parent who cares, but is over-permissive. In either case, the problem for the child is that rather than having too safe and too tightly organized an identity, he doesn’t develop one; there is not enough ordeliness in his situation to provide a pattern of safety. This inner disorderliness creates for the growing child the problem of counter-dependency—not following rules.

Unlike the too orderly child who does quite well in the disciplined situation of a school for example, the disordered child is unstable and reckless. He has serious difficulties in dealing with the disciplined environment. Rather than obediently accepting order imposed on him by others, he will want to have his own way even though he doesn’t know exactly what that is.

In this overly disordered person’s struggle to get an identity, once more we find a great inner tension resulting from the need for order and the counter-balancing syndromes we find are such behaviors as phobias, self-generated restrictions and abasements, public and private rituals, symbolic doing and undoing, compulsions and obsessional thinking. At its extreme, we get such behavior as chronic repetitive and aggressive acts and autistic regression. Each one of these attempts to take control, to order the environment into definite and specific patterns and to create ritualistic and symbolic fantasies, can be observed as ways the basic internal disorder can be counterbalanced externally.

The most severe personality disfunctions result from experiences during the initial stage of infancy, where basic growth organization begins.

C: We’ve talked a great deal about the importance of the first stage of growth. I understand this to be from birth to around five years as far as a child is concerned. What are the next stages and how does the transition through these affect us in both positive and negative ways?

G: If we return to the example of the jungle survivor, the second stage represents a partial separation from our host, just as with the infant it is a time of separation from the parents. At this point a basic and safe living pattern has been learned and now the question is to try it out and extend beyond the original boundaries. In the jungle, we would begin to explore beyond the safe confines, testing our knowledge in a broader environment, making connections deeper into unknown territory. The infant does this in the process of identification, that is testing his own identity to see if it is accepted by and makes connections with other people in other situations.

Going all the way back to our tennis game example, in the second stage of growth we practice and improve and modify to meeting changing circumstances, and, as we do it, improve our viability, becoming less dependent on the parent or host. The question here is, how far into the environment can we carry our connections. The more we can see ourselves in others, the healthier and more growth producing this period. Our pattern gets repeated, projected and re-established as we venture out.

It is interesting to note that again Freud in Beyond the Pleasure Principle makes a large issue of this instinctive motivation. He said: “There remains enough over (motives) to justify the assumption of a repetition compulsion and this seems to us more primitive, more elementary, more instinctive, than the pleasure principle, which is displaced by it. But if there is such a repetition compulsion in psychic life, we should naturally like to know with what function it corresponds, under what condition it may appear, and in what relation it spans to the pleasure principle to which we have heretofore ascribed the domination over the course of the processes of exaltation in the psychic life.” Later in his work, Group Psychology and Analysis of the Ego, he repeats this same theme. “Something is unmistakably at work in the nature of a compulsion to do the same as the others, to remain in harmony with the many.”

In the same work, Freud gives up the systems clue to our correspondence with the processes of biological growth... “the tendency toward the formation of groups is biologically a continuation of the multi-cellular character of all the higher organisms.” From our cybernetic viewpoint, we can see now that Freud had made the connection; just as identification and projection occur in the second stage of growth for the human psyche, this second stage of growth in biology is this formation of replicas.

C: It seems then that whereas the first stage of growth leads to physical safety, the second stage produces security with one’s own identity. We have a sense of who we are, and more important, the freedom to be who we are and like it. I can see the negative side of this stage. If the balance has not been achieved, we either have no sense of who we are, or if we do we are unhappy with our identity.

G: Yes, what happens when a person in the first stage of growth develops either too narrow an identity or one which is too ill-defined is an inability to succeed and build self-security in the broader culture with which they will interact later in stage two. Look at the situation for example where a child is mentally confined in a narrow or distorted home pattern and then in school and other situations encounters masses of people unlike themselves. Rather than self-verification, there is self-loss—establishment of a negative self-concept. This often leads to self-destructive behavior which, by continually proving you are different and do not fit, is the only way any sort of personhood can be maintained.

Social Pathology and Perspective

G: We can see the effect of mismatching clearly in social pathologies. The Southern black farm family, for example, which within its own historically developed sub-culture, can engender the necessary verification for stage two. If that same family is transposed into an urban ghetto, particularly if it is accompanied by hope and the promise of the opportunity of connecting with a broader environment, an unconnected exposure to the new and
different environment can serve as a negative influence. Here, we find the dynamic of growth that is so important to our understanding of mental illness. That is, when any organism or person reaches for a higher level of growth and is continually thwarted, it will regress to an earlier stage.

A cell, for example, can continually be defeated in its move from stage one to stage two by mechanically not allowing it to divide. When this happens, it simply continues enlarging until its internal communications and nutritional transport break down. In regression it destroys itself, and other cells around it. It seems to say, “If I can’t grow with you, I’ll grow against you.” Just so with humans. The second stage of growth is a move from control to influence, and if we are repeatedly blocked in attempting to influence our environment, making a connection with it, the next step is trying to control it—a step down, not up. Behavior naturally becomes destructive, aggressive and violent—common behavior in the urban ghetto.

C: I’ve been reading a great deal lately about the many young people who eagerly follow the restrictions and social deprivations of particular cults—such as the “Moonies”. They could be reacting against over-permissive parenting, seeking the boundaries and limitations not present in an earlier stage of growth. Denied the means to a healthy transition from one stage of growth to the next, will we, perhaps much later in life, seek to compensate for this? Does the human psyche have that instinct for self-regulation and survival?

G: That is the kind of process we were talking about earlier. Given any opportunity, the human mind seeks to cure itself, to achieve that natural growth balance of making more connections at higher levels of being... always in a state of becoming. When we talk about the social pathologies of the cults, whether they be on the disorder, anarchistic side, or whether they are on the order, obedience side we find that they attract four different kinds of personal imbalances. Of these, two are attempting to maintain the early imbalance, ordering or disordering, the others are reacting to overbalance. A regimented cultist could be someone trying to hold on to their dependent need for order, or they could be someone who is forming a counter-balancing reaction to their past lack of order. The first case would continue building imbalance—one which could lead to a later crisis of disorganization. Probably, this person’s parents would not be disturbed by their child joining such a cult, for it would be following their own, over-disciplined way of thinking. The second case reacts to disorganization in early life and by joining an aesthetic, obedience group, would actually be performing self-therapy—rebalance. The experience could be very beneficial. Some parents, however, in this instance, would be quite disturbed for their child to belong to such a group. Being of a permissive school, they would resent someone taking over their child’s life. Exactly the opposite occurs with the two types of imbalance in disorderly groups or cults.

C: It seems that society today is swinging way out on both sides of order and disorder. Terrorism, hi-jackings, crime and violence are on one side and the religious and therapy cults are on the other. These are relatively new phenomena and indicate on the one hand a great need for order and dependency and on the other extreme anger and rebellion. Why have these problems escalated during the past decade?

G: Once more, with a clearer understanding of cycles and how they occur and develop at different levels and stages of organization, we can better understand these problems. It is a question of historical perspective. In biology, for instance, such a viewpoint is not a problem. The replicative ordering behavior of cells in the fetal and embryonic stages of development is appropriate to that period of growth. However, if a cell starts to replicate often later on in a human organism we see it doesn’t fit and call it cancer. This example shows that as an organization progresses through the cycles, behaviors that were appropriate to earlier stages, later become inappropriate.

Consider the case of the parent who would attempt to own and control a child up into their adulthood; we would look at this today as being a pathological way to behave. Yet, five hundred years ago (or in some primitive societies today) we see parents owning their offspring. Then it was not out of violence and for parents not to react... in exaggerated perspective. Recently, someone sent me a newspaper article, and for parents not to react, without question. Given any opportunity, the human mind seeks to transport break down. If I can’t grow with you, I’ll grow against you.” Just so with humans. The second stage of growth is a move from control to influence, and if we are repeatedly blocked in attempting to influence our environment, making a connection with it, the next step is trying to control it—a step down, not up. Behavior naturally becomes destructive, aggressive and violent—common behavior in the urban ghetto.

C: You are saying that it was easier to tolerate and support imbalance of living during more primitive and lower level stages of society. Now, through our emancipation from ignorance, poverty and high levels of control, the evolvement into a third level society has brought with it today’s heightened awareness of extremism. Our expectations for and from people are so much more. I don’t remember anyone ten years ago, screaming about despotism in Africa. Our standards are getting so high that the old imbalances are no longer appropriate and stand out in exaggerated perspective.
G: A developmental perspective is most necessary when we are in a period of transition between stages, such as today. When a society moves from casual acceptance of stage two life, where it is expected that small groups of people will have great influence in organizations and government, to the beginnings of stage three, where mutual sharing of decisions becomes more natural, one can expect a great many problems. The sudden emergence of civil rights, women’s liberation, consumer advocates, community organizations, environmentalists and the like are perfectly logical developments to increase mutual interdependency. The problem is the older generations who have experienced the success of using stage two type thinking for so long, cannot easily make the transition into this new way of thinking.

The authoritative manager in a Company, for example, who has built a successful organization, based on people doing the same things the same way in a predictable pattern, cannot understand any need for workers participating in his decision making. Workers trying to have a say in decision in the past, just survived and thrive in today’s world. We must bind, what used to work isn’t working lists, individuals can be at different stages of development in different areas of activity, and the manager must be sensitive to this and provide the appropriate connection.

Similarly, the second reason is that different organizations and even departments within organizations are often at different stages of development. The company, like the individual, starts at stage one, sets up and controls the method of organization, production, etc., moves to stage two where it is proved and improved and finally evolves to stage three where it becomes appropriate for high level innovations through mutual sharing to take place.

REFERENCES AND READINGS
Long Term Gains From Early Intervention Through Technology:

A Seventh Year Report

1968-1975

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Rationale

While the past few years have seen a decline in the application of federal funds for education in general, this is less so for the early childhood years. Research on intervention in the formative years (e.g., Durkin, Deutsch, Chall) seems to indicate the importance of this period to later growth and development. Poor children, in particular, have a predisposition in reading problems primarily in the years three to seven (Frostig and Horne).

While the literature underlines the need to capitalize on the early years, little is still known about how children learn. Another problem is how, then, to teach. To remediate deficits, to teach to strengths, to utilize dual modalities, etc., are common discussions in the parlance of education and psychology.

The literature is consistent and definite about the values of language arts and reading in early childhood programs. Shifts toward these academically oriented areas for "pre-elementary" children are but a decade new, however. Campbell and Guthrie discuss the research findings on pre-kindergarten reading and language arts. They advocate continual grouping and regrouping of pupils as they master skills involved in early reading. Hillerich recommends screening for potential difficulties and modalities long before kindergarten. Venezky focuses his work on defining pre-reading skills to determine their value in early reading experiences. Wolpert underlines the importance of "vocal encoding and its spoken counterpart" in creating purpose for reading. Fischer has correlated pre-school language skills with later reading and speaking.

With support from others in the field and a commitment to early teaching and learning, the Drexel Early Childhood Center began its current efforts in 1967. The investigators sought to answer these questions.

1. What is known about early experiences in reading for "pre-elementary" children?
2. How can a voluntary, individually-oriented reading approach encourage positive performance gains for children regardless of socio-economic background?
3. What are the necessary components in developing an early reading program that can be generalized to other populations without specific teacher training?
4. What will be the long range effects on achievement of pupils with early training using the Responsive Environment?
Method of Study

The present study was undertaken in an attempt to develop a technologically based early reading and language program for children ages 3 to 6 who attended Drexel University's Early Childhood Center. From the inception it was the intent to follow the initial group of subjects in order to gauge the gains of treatment.

Forty children, approximately half tuition and half Get-Set (Philadelphia's Head Start) comprised the original sample of an initial investigation. The mean age for the entire group at entry was 3.49 years, and the mean IQ for the tuition group was 116.5 as measured by the Stanford Binet Intelligence Scale (1960 revision), and for the Get-Set subjects 71.8. Fifteen Get-Set subjects were available for follow-up study (all those who could be traced). Subjects were enrolled in the program for an average of 2.54 years.

Treatment consisted of daily sessions no more than twenty minutes in length; the primary component of this treatment was work on a computer based typewriter (Moxon and Anderson), the Responsive Environment. (The machine may be programmed in a variety of ways to correspond with the purpose of investigation.) A combination of both automated and non-automated equipment was used. The determination of the instrument for a given day was based upon the discretion of the teacher; however, all of the subjects received approximately 80% of the total instructional time on the automated machine. The non-automated equipment contained a typewriter, as well as audio-visual equipment, such as the "talking page," and commercial materials.

Work was arranged to accentuate auditory or perceptual strengths of subjects and to remediate weaknesses secondarily; the ratio for that balance was 3:1. The objectives of the programming were the demonstration of skills in (a) recognizing alphabet letters, (b) typing letters from dictation, and (c) reading words orally. Teachers also worked with children or individual experience stories which were then programmed for the equipment.

For the fifteen available subjects the following data were collected and analyzed using both correlational procedures and regression analysis:

- The hours and minutes spent on the Responsive Environment equipment
- The number of months enrolled in the Center
- The age in years and months on entering the Center and age of the child at the time of testing
- The Peabody Picture Vocabulary Test at the time the child entered the Center, twice annually thereafter until the child left the Center and once annually thereafter until the present time
- The Developmental Test of Visual Perception (Frostig) at the time the child entered the Center, twice annually thereafter until the child left the Center, and once annually thereafter until the present time
- The Illinois Test of Psycholinguistic Abilities at the time the child entered the Center, twice annually thereafter until the child left the Center and once annually thereafter until the present time
- The Illinois Test of Psycholinguistic Abilities both Visual and Auditory, at entrance to the Center, twice annually thereafter until the child left the Center and once annually thereafter until the present time.

The following four tests were available for the child annually since kindergarten:

- the Wide Range Arithmetic Test
- the Wide Range Reading Test
- the Informal Word Recognition Test
- the Informal Reading Inventory

Results

Results of the first year's investigations were encouraging in that both tuition and non-tuition subjects showed similar learning rates. Recognition of all upper case and some lower case letters was achieved. At the end of this phase all students could type their own names but not other words; they could also recognize their names but not any other configurations (Reported at Annual International Reading Association meeting, 1968). As already indicated, testing was continued during the years each went on to attend public schools. For one subject, this included data through the fourth grade; for seven subjects, data through third grade; for two subjects through second grade; for three subjects, through first grade.

As years progressed in the Center the relative improvement of the Get-Set children was much greater than that of the tuition group. This was apparent in measured skill acquisition and in the psycholinguistic development of these children. The most important finding seems to be that the time on the machine and the period of enrollment of the students (the time they were in the Center School) has a statistically significant positive correlation with their performance on the following tests: Wide Range Arithmetic, Wide Range Reading, and Informal Reading Inventory. Findings indicate that regardless of initial IQ scores of these children on the Peabody Picture Vocabulary Test or scores on the Developmental Test of Visual Perception (DTPV), and the Illinois Test of Psycholinguistic Abilities (ITPA) (Visual and Auditory) these children nevertheless performed at or above present grade level on achievement tests in both reading and arithmetic. The pre-mean I.Q. was 71.8, post-mean I.Q. for 1974: 98.2, and for 1975: 34.6.

An attempt was made to compare the distribution of the California Achievement Tests in the Philadelphia school system with the Drexel testing. Nine children were found who had test scores for 1975 for both Drexel and the Philadelphia tests.

The high correlation levels are an indication that the Philadelphia test scores were showing the same distribution as the Drexel test scores. If this relationship continues in 1976, the Philadelphia school test scores can be linked with the Drexel scores in an analysis of differences between the 1976 scores and the 1975 scores, and between the 1976 scores and the first Drexel scores test for test.
Conclusions

First of all, it seems as if there is a critical minimum exposure time and attendance time required for reading, arithmetic achievements, and reading comprehension. As noted above all children are at or above grade level in reading achievement. What should now be investigated is, if or when, all children, regardless of time in Responsive Environment or attendance at the Center, will achieve reading comprehension scores at or above grade level as well.

To date, studies from the Philadelphia Board of Education indicate that high risk low socio-economic status (SES) children, consistently regress, year by year, beyond the first grade, in reading achievement and comprehension.

All eight high risk low SES children who have had what appears to be the critical minimum of thirty hours and thirty months attendance are all achieving at grade level in reading comprehension as well.

We are cautiously optimistic about this trend.

Secondly, it can be stated that the Get-Set children regardless of measured intelligence actually perform on achievement tests at a level comparable to their peers and that this has a significant correlation with their early childhood education and training. Whether or not this level will be further maintained remains to be seen through further longitudinal study of these children and of others leaving the Center. However, the levels of significance are so striking in the correlations between the time on the Responsive Environment and the time enrolled in the early childhood program with present achievement that it is not probable that this performance pattern will break down in the future to any great extent. Further research is a commitment of the Drexel Early Childhood Center.

REFERENCES

BOOK REVIEW

To Draw a Line . . .

Computer Power and Human Reason: From Judgment to Calculation
Joseph Weizenbaum    San Francisco: W.H. Freeman, 1976    $9.95

John R. Kirk
Director, Planetarium
SUNY, College at New Paltz, N.Y.

Whether or not one has sat at a terminal or a computer console, he will find much to think about in this book. There is wit, almost lethal irony, and an occasional nodding (Leibnitz in place of Laplace, p. 221). Professor of computer science at Massachusetts Institute of Technology, Weizenbaum is probably most widely known for ELIZA, a system for processing natural language. Names for Eliza Doolittle in Shaw's Pygmalion (she can be taught to talk more acceptably, but whether more intelligently is moot), this system can be made to mimic a nondirective psychotherapist interacting with a "patient" (this program is known as DOCTOR). In a key passage, Weizenbaum observes:

People who knew very well that they were conversing with a machine soon forgot that fact, just as theatergoers, in the grip of suspended disbelief, soon forget that the action they are witnessing is not "real." This illusion was especially strong and most tenaciously clung to among people who knew little or nothing about computers. They would often demand to be permitted to converse with the system in private, and would, after conversing with it for a time, insist, in spite of my explanations, that the machine really understood them.

It is, I think, to Weizenbaum's credit that he recognizes in this ascription of qualities to a computer (or its program) those normally reserved to human mentation the possibility of a paradigm error. He does not, however, delve head-on battle with the Turing Criterion concerning such matters, explore a possible weakness in the Leibnizian Principle of the Identity of Indiscernibles, nor even grant that Karl Pearson (his first name is misspelled in the index) in first treating the brain as a central telephone exchange established an unbroken tradition of trying to figure out what the brain does by watching what some of our machines do (to be sure, what we now regard as machines can no longer be wholly described by Newtonian mechanics). Weizenbaum feels it is the sort of mistake that could be troublesome or even tragic. So (in a footnote, p. 5), he early takes a swipe at Astronomer, Carl Sagan, for anticipating in one of ELIZA's future descendants an economical substitute for an overburdened psychiatric counselor. But it was St. Sigmund himself who remarked on the salubrious effects of talking with a neighbor over the backyard fence. In relevant respects a computer program might well be superior to a neighbor.

There is a little laughter in the book. Much love. Some fear. And some loathing. Those chiefly loathed are the "artificial intelligentsia" (the phrase is not Weizenbaum's coinage but he relishes the double entendre), people like Marvin Minsky and Roger Shank who have also succeeded in making computers "display" (or don the insidious "disguise") of intelligence. But whereas the latter exult in each small step (seldom falling in rhetorical suggestion that these are giant leaps for mankind), Weizenbaum paws to worry. Like in that Robert Downey movie: you've got to draw a line!

Those who were once confident that the human mind is a Turing machine (e.g., Hilary Putnam) are now increasingly sure that it is not. Indeed, it might be both more and less—in this domain transitivity may not be sacrosanct. It appears worth while to know far in advance what sort of things a human being might do that a digital computer (linked to no matter what exotic input or output accessories) could not. It might be of even greater importance to recognize what a computer might do that we should not even permit it to try. In this book Weizenbaum attempts to draw such lines as these. I regret that I cannot clearly descry them.

The fault may be mine. When I consider what other writers on the computer scene might soon emerge with a wiser analysis and sets of contours more deftly drawn, I am reminded of a famous saying by that earlier Eliza: "Ain't bloody likely!"
About the Authors

NORMAN A. COULTER, JR.
Norman A. Coulter, Jr. is Professor and Chairman of Biomedical Engineering and Mathematics Curriculum at the University of North Carolina. He received his B.S. from Virginia Polytechnic Institute in 1941 and his M.D. from Harvard Medical School in 1950. Dr. Coulter was postdoctoral fellow in biophysics at Johns Hopkins from 1950 to 1952. He was Assistant to the Associate Professor of Physiology and Biophysics at Ohio State University, 1952-1965. His current interests are teleogenic system and neutral networks, and synergetics.

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Edward M. Duke is a senior associate of the Cybertechnics Institute where he is primarily engaged in consulting and education services for quality system science and technology. He is also active in promoting the adoption of cybernetic concepts in the fields of industrial engineering and management. He has written and lectured on cybernetic applications in decision making and quality cybernetics. He received his Bachelor of Science from the University of Washington and his Master of Science in Cybernetic Systems from San Jose State University.

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Roland Fischer is a multidisciplinary psycho-pharmacologist with a Ph.D. from Basel (Switzerland), who introduced the concept of hallucinogenic drug-induced model psychosis in 1946, initiated and edited the first International Conference on Interdisciplinary Perspectives of Time [Ann. N.Y. Acad. Sci. 138, Art. 2, 367-916 (1967)] and was the first to treat consciousness as a scientific issue (Science 174, 896-904; 1971). From his over 250 publications 130 were published while a professor of experimental psychiatry and pharmacology at Ohio State University (1958-70). Now, he is Research Coordinator at the Maryland Psychiatric Research Center in Baltimore, a Lecturer and Clinical Professor with The John Hopkins and Georgetown University Medical School Departments of Psychiatry and a Professorial Lecturer in Pharmacology of the George Washington University School of Medicine.

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John R. Kirk, Ph.D., UCLA, 1951, studied astronomy under Robert Ryland Fleet at the Morrison Observatory, logic and philosophy of science under Abraham Kaplan and Hans Reichenbach. Now a member of the Astronomical Society of the Pacific and the Philosophy of Science Association, he has been Assistant Editor of ETC: A Review of General Semantics and Associate Editor of The Humanist. As computer programer and research analyst for Chicago Area Transportation Study, he was co-initiator of the cartographatron. Since 1937 he has been active in radio and television, has taught at The University of Texas, The University of Chicago, and Michigan State University, and is now Professor of Philosophy and Director of the Planetarium at State University of New York College at New Paltz.

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Emeritus Chairman of the Turtle Bay Institute, a human systems research organization, George Land is author of numerous books and articles, including the General Systems and Cybernetics work Grow or Die, the Unifying Principle of Transformation, (Random House and Dell, 1974). He has served as Visiting Professor and Distinguished Lecturer at over forty Universities in the U.S. and Europe and most recently as consultant in Behavioral Science in children’s learning at the National Medical Center, Children’s Hospital and as developmental consultant for the American Telephone and Telegraph Co. George Land was lately appointed Administrative Vice President and Membership Chairman of the A.S.C. and is a member of the New York Academy of Sciences. At present, he continues private practice and teaching, and is finishing research and writing of a new systems book due out late this year.

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Dr. Martin Ringle pursued his doctoral studies at the State University of New York at Binghamton in the combined fields of philosophy and artificial intelligence. He is co-founder, along with Dr. Thomas Simon of the University of Florida, of the Society for the Study of Minds/Brains/Machines. The SSMBM is an interdisciplinary communications group affiliated with professional organizations in philosophy, psychology, computer science and neuroscience. Dr. Ringle has lectured and written on the subject of philosophy and artificial intelligence and is the chairman of the National Symposium for Philosophy and Computer Technology. He is editor of the forthcoming volumes Philosophical Perspectives in Artificial Intelligence and Ethics, Society and Computerization. In addition to his consulting work he holds the position of Assistant Professor of Philosophy at the State University of New York at New Paltz.

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One of the central interests of the American Society for Cybernetics is the development of cybernetic education in the United States. Despite the fact that it has been recognized as a legitimate field of study for nearly thirty years, cybernetics enjoys an extremely limited representation in collegiate curricula. As a prelude to a national effort aimed at increasing course and program offerings in cybernetics, the ASC is conducting a survey of current offerings in the field. The results of this survey will appear in a later issue of the Forum.

Your cooperation is essential to the success of this project. Please fill out the form, detach it, and send it to: Dr. Martin Ringle, c/o Philosophy Department, SUNY, New Paltz, NY, 12561. Please respond at your earliest convenience. Thank you.

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