TRADITIONAL PROBLEMS OF PHILOSOPHY

IN THE LIGHT OF CYBERNETICS

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INTRODUCTION

The ability to produce a non-living thing similar in looks or behavior to a living one has always intrigued man and is reflected in the technology of every age. The first crude tools were extensions and improvements of the native abilities of man--man's primitive attempts to amplify his physical prowess. This specialized form of imitation, technology, moved men to study living things from merely a materialistic viewpoint in order to construct better artifacts. The artifacts of Newton's time were typified by the stiffly dancing figures atop the clocks. The nineteenth century had its glorified heat engine that burned combustible fuel and to which the human body was compared. Today's artifacts, or automata (named for their capacity to imitate certain properties of living things) are thephotoelectric cells, radar sets, pressure gauges etc.[1]

AUTOMATA. This development exemplifies the change of Newtonian physics into contemporary physics. The "stiffly dancing figures" can be explained entirely in terms of efficient causality. They perform in a completely deterministic manner obeying the laws of motion. The "glorified heat machine" shows the beginning of a "new look" in physics. The laws of thermodynamics are the rulers and theideal gases the ruled. Energy is the important concept and everything is related to it. The modern automata, however, show a marked difference from their predecessors. Communication, control, information, order, message--rather than cause or energy--are the principles of twentieth century automata. The amplification here is of mind or "mental" power rather than physical.

PLAN. As an "umbrella" term for the concepts associated with modern automata, we will use "cybernetics",[2] coined by Norbert Wiener in 1948.[3] We will examine briefly the historical setting of scientific thought that made possible the science of cybernetics. We will sketch its fundamental concepts in order to provide a frame of reference for appreciating the problems to be examined. Then in the light of cybernetics we will survey a traditional problem of philosophy--the controversy between mechanism and vitalism.

Our main concern or objective is to discover what, if any, unique philosophical problems have been raised by cybernetics. The attitude first taken by the popular journals would seem to suggest that there have been some.[4]

Our contention is that the main problems generated by cybernetics are not and will not be with the traditional philosophical problems, or at least as these problems have been traditionally stated. The problem (with which we cannot deal, but whose existence and importance we cannot fail to note) is the one of man's being able to live a fully human life in an increasingly less human world. This seems to be the problem of the "secular city", man vs. technology. This, we believe, is the real problem--cybernetics has helped to form the society in which it has arisen.

I. HISTORICAL BACKGROUND

NEWTONIAN PHYSICS. From the time of Isaac Newton until about the beginning of the twentieth century, the science of physics was developed along lines first laid down by him. The laws of motion, which bear his name, were mechanical in nature, describing a rigidly deterministic world that obeyed them in a completely predetermined manner. There was no need in this world for a statistical consideration of systems, because of the absolute obedience of systems to laws. The description of this completely mechanical and causal world, however, became manifestly inadequate when Darwin "let the evolutionary cat out of the bag". Not only did the evolutionary theory posit a universe different from the universe explained by Newton (or at least described by him), but its root differences were to shake the very foundations of physics. (His concepts did, however, have a great impact on the development of theoretical physics.[5])

EVOLUTION. The key to the theory of evolution is that it deals not with individuals, but rather with large numbers and the probability that so many of a given group (species, set, etc.) will be able to be given a particular function. This is not to predict the parameter of an individual, but rather of the group and only in a probabilistic fashion at that. The evolutionist is concerned with the fact that, since every member of a group does not obey the laws of physics blindly and in the same way, there is a progression of development not to be treated through individual cases, but rather statistically and probabilistically. This insight gave rise to the trend toward statistical mechanics, whose application to physics by J. Willard Gibbs provided impetus to the conceptual revolution in physics. There was from this a "progressive reduction of thermodynamics to statistical mechanics",[6] starting with Maxwell, Boltzmann, and Gibbs, that faced serious theoretical problems in trying to explain the phenomenon of radiation. The problem was not satisfactorily solved until Werner Heisenberg formulated his principle of indeterminacy. This was the "synthesis" of the "thesis (Newton) and antithesis (Planck-Bohr) of a Hegelian antinomy".[7] The statistical dynamics of Newton were replaced by a statistical theory very similar to that of Newton and Gibbs for large-scale phenomena, but in which the complete collection of data for the present and the past is not sufficient to predict the future more than statistically.[8]

CONTEMPORARY PHYSICS. The effect of the revolution is that "physics now no longer claims to deal with what will always happen, but rather with what will happen with an overwhelming probability."[9] Whereas in the Newtonian view, time had been a reversible process, in the Gibbsian outlook it became irreversible. In his Creative Evolution Henri Bergson examines this in application to evolution. "Bergson emphasized the difference between the reversible time of physics in which nothing new happens, and the irreversible time of evolution and biology in which there is always something new."[10] This change in view of time made possible the later development of the information theory, control, message, feedback, and many more of the important concepts of cybernetics.

II. WHAT IS CYBERNETICS ?

ORIGIN. Norbert Wiener wrote in 1948:

> Thus, as far back as four years ago, the group of scientists about Dr. Rosembleuth and myself had already become aware of the essential unity of the set of problems centering about communication, control, and statistical mechanics, whether in the machine or in living tissue.[11]

This "set of problems" had

> the fundamental unity of a complex of ideas which until recently had not been sufficiently associated with one another, namely, the contingent view of physics that Gibbs introduced as a modification of the traditional, Newtonian conventions, the Augustinian attitude toward order and conduct which is demanded by this view, and the theory of the message among men, machines, and in society as a sequence of events in time which, though in itself has a certain contingency, strives to hold back nature's tendency toward disorder by adjusting its parts to various purposive ends.[12]

However,

> we were seriously hampered by the lack of unity of the literature concerning these problems, and by the absence of any common terminology, or even of a single name for the field...We have decided to call the entire field of control and communication theory, whether in the machine or in the animal by the name Cybernetics, which we form from the Greek κυβερνήτης, or steersman.[13]

CONTROL AND COMMUNICATION. From Wiener's description of cybernetics it is at once manifest that the idea of communication is of primary concern. "To communicate with the outer world means to receive messages from it and to send messages to it."[14] To communicate is to control and to control is to communicate. The outer world to which Wiener refers must be understood not as the static "other", but as a dynamic entity, which as a whole, a system, is tending toward an inevitable "heat-death,"[15] in which life or lives are local "anti-entropic processes."[16] It is a contingent rather than a deterministic world.

"To communicate is to receive..." To receive--the process of reception involves first a capacity for reception. This capacity can be almost any device which becomes in relation to a message what an oscillator is to an input.[17] The human receives messages constantly. His entire nervous system is one of reception of certain messages (communication) and the acting upon the content of those messages (control) through a circular process of feedback. Analogously, almost anything can be viewed as a system which communicates and controls or is controlled by the outer world. Professor Wiener has attempted in the science of cybernetics to abstract from any particular method and study the nature of control and communication. Communication is therefore not restricted to living systems, but to any system, where "system" would describe a behavior matrix, i.e., various states of a series of changes in matrix form.[18]

INFORMATION. In communication, "whose major opponent is the entropic tendency of nature itself,"[19] there is, no matter how efficient the transmission method, information "leakage."

(This provided, of course, that no external agents are introduced to control this leakage.) This maxim is taken from one of the innumerable restatements of the Carnot theorem, the Second Law of Thermodynamics. It is from this "something borrowed" from the field of physics that Wiener treats order, pattern, message, etc. as the abiding individuating stuff of human life, and calls life and/or machines "locally anti-entropic processes."[20]

The question of exactly "what" leaks or is transmitted is still disputed. According to one school (Wiener _et al_), information, that is the quantity of information,[21] is the negative of the logarithm of entropy.[22] According to Shannon's school, however, information is entropy and measured by its logarithm.[23] The dispute seems to be merely one of the viewpoint: is the prisoner locked in or is everyone else locked out?

MESSAGE. Wiener calls the message a "discrete or continuous sequence of measurable events distributed in time--precisely what is called a time series by the statisticians."[24] The difference between the probabilistic concept of messages and noise and the deterministic one gives rise to modern communication theory.[25] Again, concepts are borrowed from other fields and applied to what is called cybernetics. The ideas bound to statistical mechanics are joined with communication. Much of this union's groundwork was laid by Wiener through his early work on the Brownian motion and harmonic analysis.[26] Also based on the statistical treatment of message, is the problem of prediction, very important to the cybernetician.

THE PROBLEM OF THE "BLACK BOX". Underlying in many ways the overall cybernetic approach to particular problems is the "black box" problem.[27] This, too, is borrowed--from the field of electrical engineering. Behaviorism is the method of approach. The engineer is concerned not with the internal composition of the "black box" (any system whose internal composition remains unknown), but only with its input-output relationship. By joining to the black box a "white box" (a system whose internal composition is known) and by manipulating the same random inputs for both boxes it is possible to construct a "multiple" white box which "will automatically form itself into the operational equivalent"[28] of the black one. This phenomenon is said to be analogous to that "central phenomenon of life," the reproduction of genes to be "heredity-carrying structures in their own images."[29] At the risk of "mastering the obvious," it may be pointed out again that the cybernetician is not interested in the internal composition of the black box--only its behavior.

FEEDBACK. Another concept very closely associated with cybernetics is that of feedback.[30] It is not a new concept.[31] Clerk Maxwell wrote a treatise on the mathematical properties of the flyball governor in 1868. It has been restudied by the cyberneticians, however. Feedback occurs when the output of a system is linked to its input in such a way that variations in the output will tend to produce compensatory variations in the input, in order to restore the system to a previously determined or "programmed" goal or "final condition."[32] Feedback can either reinforce the input or run contrary to it, in the case of the cybernetically important "negative" feedback. This type feedback can be either mechanical, e.g., any servomechanism; or physiological, e.g., picking up an object.[33]

The cybernetician sees these "musts" for any system: the input of a system must be able to be in contact with the world; the control center must be able to link input with output; the output must be able to communicate with the input.

III. CYBERNETICS AND PHILOSOPHY: THE CENTRAL PROBLEM

Some of the more serious yet less publicized dilemmas posed by cybernetics are restatements of perennial philosophical questions: the almost constant, yet unresolved battle of the mechanists against the vitalists; the question of automata and purposive behavior; the mind-body interpretation of "mental" phenomena; the opposition of cybernetic thought and approach to the philosophy of dialectical materialism.[34] Some problems have been created by or at least made more explicit through cybernetics: the entire scope of communications with all its ramifications; the already monumental problem of cybernation--the union of the computer with the automatic machine--and the social problems that naturally accompany such a movement; the conflict between the ever-growing personalistic philosophy and the impersonal "punch-card" treatment received daily by individuals; the fearful question asked by the unknowing--will the machine replace man?; the growing problem of leisure; the knowledge explosion helped so greatly through the use of computers; the widening gap between the technology created by man and the philosophy so sorely needed by him to be able to live with what he has created.

CRITICISM OF CYBERNETICS. Criticism of cybernetics has attacked not the ideas expressed in the mathematical language of the Fourier series, Boolean algebra, Lebesgue integral and the like, but rather the application of these mathematical descriptions of various systems to "living" systems.[35] For many, this likening of the brain to the machine is merely a metaphor. Their criticism is based on the contention that the cyberneticians treat this likeness as though it were an identity. This discussion has been focused on the traditional mechanist-vitalist controversy, which Professor Wiener said has "been relegated to the limbo of badly posed questions."[36] If vitalism has won (the change to a Bergsonian concept of time), nevertheless, "this victory is a complete defeat, for from every point of view which has the slightest relation to morality or religion, the new mechanics is fully as mechanistic as the old."[37] As McClintock has noted: "The hope was there: insight into the origins of communication and control may improve our moral sensibility."[38] A sizable portion of Wiener's <u>The Human Use of Human Beings</u> has this hope as its motif.

The attitude that cybernetics can be applied to organisms is clearly seen in Dr. Ashby's definition of cybernetics, "the art of steersmanship."[39] Whether or not he makes a scholastic differentiation between art and science does not concern us here. The connotation of art as creative, "human" rather than mechanical is certainly present. Also, because science is beginning to study "complexity" per se,[40] such varied phenomena as the brain, the ant-hill as a "functioning society," and the human economic system, which previously have not been able to be dealt with, now may prove susceptible to the examination that cybernetics can provide.[41] One example of this is Shannon's theorem about "error-free" transmission. Essentially, the theorem says that with an increase of channel capacity in parallel, information can be made to be almost error-free. The price for this advantage is a delay in transmission time. Neuropsychology is not so much concerned with solving the problem of message corruption in the brain as it is in "showing that the problem hardly arises, or that it is a minor, rather than a major, one one."[42]

MECHANISM-VITALISM. The controversy between the mechanists and the vitalists has had a long, stormy history from the time of Aristotle and Democritus. Stripped to its rarest elements, the controversy is centered around the explanation of reality. Can all of reality be fully explained by or reduced to efficient causality, implying a set of elemental, indivisibles (be they atoms or monads), other than which nothing is needed? Is this explanation suitable for the phenomenon of life? Democritus thought it was. Aristotle, however, postulated that organisms have a character sui generis. This principle or character is Driesch's enterechy, and Bergson's elan vital. The heart of the vitalist position, then, is that in organisms there is something more than what is explained in a physico-chemical explanation, in a way, that the whole is greater than the sum of its physical parts.

The father of modern mechanism is Rene Descartes, who viewed animals as machines, whose explanation would derive from physical laws. The "soul" of man became then the "ghost in the machine."[43] Because physics was almost entirely composed then of mechanics, man was viewed in his "animal" behavior as a machine. This behavior could be reduced to the laws of mechanics. As mechanics gradually became merely a part of physics instead of the whole thing, mechanism began to mean more a reduction of phenomena to physico-chemical terms. Historically, the vitalist position seems to be proportional to the strength of the mechanist one.[44]

Of course, the implications of either theory are profound. The mechanist would seem hard put to defend any theory of the dignity of man, the value of life itself, etc., and the vitalist runs the risk of stultifying scientific research by the appeal to a "vital force" that is necessarily immaterial, nonsensible, and consequently, not able to be empirically verified, or for that reason, repudiated.[45]

This fundamental difference in outlook is carried over into specific areas of inquiry: the traditional mind-body problem--can the "mental" processes be explained <u>in toto</u> by brain blueprinting, "synapsology," transmission rates, machine comparison; causal vs. final explanation of reality--can a machine have "purposive" behavior; the illusiveness of the barrier between life and non-life--can a definitive statement about what life is be made, or even what is "alive"--is a virus "living"?

PURPOSIVE BEHAVIOR IN CYBERNETICS. One of the purposes in writing <u>Cybernetics</u>, said Professor Wiener, was to "alert (the public) to the long series of analogies between the human nervous system and the computation and control machine which had inspired the joint work of Rosenblueth and me."[46] This "joint work" was expressed in 1943 in a paper, "Behavior, Purpose and Teleology," the goals of which were to "define the behavioristic study of natural events and to classify behavior" and "to stress the importance of the concept of purpose."[47]

"Some machines are intrinsically purposeful....a torpedo with a target-seeking mechanism." Purposeful active behavior is divided into "feed-back" (teleological) and "non-feed-back" (non-teleological). Negative feedback "may be considered" to be a requirement for "all purposeful behavior." Basing his analogy on the assumption that, if the central nervous system and mechanisms were analogous in this negative feedback area of purposeful behavior there would be similar pathological conditions for both, and noting the similarity in behavior of the neurophysiological "purpose tremor" to "machinoinsanity" (uncontrollable increasing oscillation of a machine), Professor Wiener <u>et al.</u>

suggested that "the main function of the cerebellum is the control of the feedback nervous mechanisms involved in purposeful motor activity."

Feedback is further divided into "extrapolative" or predictive, where the cat chasing the mouse extrapolates the future position of both itself and the mouse in order to attain a meeting; and "non-extrapolative," where the "amoeba merely follows the source to which it reacts; there is no evidence that it extrapolates the path of a moving source." The reasons for this particular division are that it emphasizes the importance of purpose and teleology and also shows that "a uniform behavioristic analysis is applicable to both machines and living organisms, regardless of the complexity of the behavior." They infer then that there is a strong similarity in the methods of studying both machines and living organisms. Whether or not they remain the same will depend on whether or not there appear any "qualitatively distinct, unique characteristics" in one or the other group. "Such qualitative differences have not appeared so far."

Although "the broad classes of behavior" are "the same" in both animals and machines, there remain "specific, narrow classes" which do differ. A machine that could write a bi-lingual dictionary or an organism that "rolls on wheels" would exemplify these "specific" classes. Although there is a behavioral similarity (that would seem to approach identity), organisms are admitted to differ greatly from machines in their respective functional analyses. Colloidial complex molecular make-up vs. solid, simple metallic composition; ionic transmission of impulses vs. electronic transmission; spatial rather than temporal multiplication of effects (the number of photosensitive receptors in the eye vs. the time-sharing process in the machine); these are some of the more obvious differences that would concern functional analysis.

> We have restricted the connotation of teleological behavior by applying this designation only to purposeful reactions which are controlled by the error or the reaction--i.e., by the difference between the state of the behaving object at any time and the final state interpreted as the purpose. Teleological behavior thus becomes synonymous with behavior controlled by negative feed-back, and gains therefore in precision by a sufficiently restricted connotation.
>
> According to this limited definition, teleology is not opposed to determinism, but to non-teleology. Both teleological and non-teleological systems are deterministic when the behavior considered belongs to the realm where determinism applies. The concept of causality: a time axis. But causality implies a one-way, relatively irreversible functional relationship, whereas teleology is concerned with behavior, not with functional analysis.[48]

CRITICISM. Because Wiener's paper represented one of the earliest attempts to formalize some of those thoughts which would later be termed "cybernetics," we will look at some of the more vociferous criticism of it.[49]

To say that a machine such as a target-seeking torpedo can be "intrinsically purposeful" is to misunderstand the concept of purpose. If the overall purpose does not reside in any part, then it must reside in the whole, i.e., in the receptor plus the effector plus the coupling, and in the form of organization of the multiple system. This is the cybernetical contention, and therefore the question becomes that of whether the machine "is a 'whole', having an identity, a selfness that can be said to be the bearer of purpose, the subject of action the maker of decisions."[50] This is not the case. Suppose, instead of the target-seeking mechanism, the torpedo is guided by a human operator--just the case of a human-driven automobile. The purpose resides in the pilot, not in any of the parts of the machine. Remove the pilot, the purpose is removed. Further, the machine has no "intrinsic" purposiveness because it does not share in a complete or perfect purposiveness as do my purposes. (The purpose for killing an enemy soldier would be patriotism, whose purpose might be love of self or neighbor, etc.) Mechanisms may have extrinsic purpose, but their only intrinsic purpose is that one "intrinsic to all mechanical action, the attainment of entropy."[51]

Although much of the criticism made by Jonas seems valid, an observation should be made here. As in many other papers written by "vitalists" against mechanism,[52] there is a "tone" which seems defensive, childish, and unnecessary, especially if the vitalist has a case. A short excerpt from Jonas' paper will possibly clarify my statement. Of cybernetics:

> It is not the innocent special science which se-

> duces susceptible philosophy but its passive beauty: from its inception it has been out to capture her. From its inception it has pretended to the status of a unified theory of mechanism, organism, the nervous system, society, culture, and mind; and by its suggestive employment of the terms behavior, purpose, goal, information, memory, decision, learning, initiative, value, and thought it has so inflated its initially modest definitions that their resulting use amounts to hardly more than verbal trickery.[53]

Another criticism of the paper concerns its avoidance of the problem of determinism. To say that teleological systems are deterministic "where determinism applies" is "like saying 'A=A'"; and, further, the cybernetic description of mind is "simply a restriction of the word 'mind'."[54] Of course, the cybernetician's task, as he sees it, includes steering "clear of allegedly phantom notions of consciousness, ego, mind and the like."[55] And so, it seems that much of this criticism stems from equivocal use of certain terms by cyberneticians and critics alike.[56]

MIND-BODY PROBLEM. Another traditional problem resurrected by the science of cybernetics is the mind-body one. There are two general divisions of position: monistic and dualistic--varying specifically according to the people who hold them. Cybernetics has brought the problem into the area of "thinking machines." ("Thinking machines" here will be simply a generic term for any machine that is designed to imitate "human" behavior.) Basically, these machines are similar to the brain in their principle of information transmission--the all-or-nothing principle. The neuron, like the electronic "flip-flop" switch,[57] is capable of only two states--either it is transmitting or it is not, "yes" or "no," "on" or "off." This condition lends itself to the use of the binary number system, in which a unit of information is called a "bit."[58] The influence of mathematical logic (of which the binary system is merely a part) combined with the advances in electronic technology have made possible the machines whose applications to all areas of life are multiplying at a terrific rate.

MEMORY. One of the most useful capabilities of machines is their memory. The rapid recall of any fact once given is a marvel. There are, however, extensive differences between human and machine memory. Probably the most apparent is that machines remember in a unitary way. Information is both stored and retrieved by the bit. Humans, on the other hand, often recall a veritable flood of facts or experiences. Machines recall "what was" as "what is," whereas humans recall "what was" precisely as "what *was*."[59] The past is distinct from the present. Machines can forget completely. Memory drums can be "wiped clean" and the machine has no capability of remembering what had once been on the drum. Humans, however, can never completely erase the past. To a great (and as yet, undetermined) extent, personality is a sum and product of one's past. The human is set much more in the irreversible time than is the machine.

PERCEPTION. Another human capability that some machines can exhibit is that of perception, gestalt or universal recognition. Machines have been built that can select circles from other figures, "A"'s from "B"'s, "fourness" from other repetitive groups.[60] Even the cyberneticians do not claim that the process is the same, only the exhibited behavior. Is it? A person, if shown a circular object at an angle that would make it appear eliptical, immediately <u>perceives</u> the object <u>as</u> circular.[61] Apparently he goes through no complicated procedures of averaging various possibilities (as does the machine) and then selects one. For those who see little or no fundamental difference between the mind and the body this is a hard fact to explain.

LEARNING MACHINE. Another type of machine often compared to human capabilities is the learning machine. This machine works on the principle that with a goal and several means by which to attain it, through a random or stochastic process of selection, it can reach a "best" way of doing the task. If the "best" way can be compared to the peak of a mountain,[62] the machine would "climb" the mountain, always directing itself upwards through this random variation. Naturally, when the peak is reached, all other ways or variations are "down" or "worse." And, consequently, the machine has "learned" a better way of doing a particular task. The machine is doing something now that it wasn't programmed to do. The apparent similarity to an evolutionary process is obvious. Thus, one "generation" of such machines might be programmed to reproduce another "generation" with this random variation built-in. It seems not logically impossible, at least, that several "generations" of these machines could produce a machine quite different and improved from the original.

The human, however, can see a higher peak on the far side of a "trough," and can alter his behavior in a purposeful manner to reach this higher "peak." He realizes that he will have to go "down" before he can again go "up." The machine does not have this capability. Programmed only for the "best" way, it cannot change for an ultimately "better than best" goal, as can the human. Another series of random variations would have to be programmed into the machine and even then (because of the randomness of the variations) it would not be certain that the machine would ever reach the "better" and/or "higher" peak.

DECISION-MAKING. Another machine exhibiting human characteristics is the decision-making or game-playing machine. Its "sinister possibilities"[63] were expressed in a "penetrating review of my book (Cybernetics)"[64] that appeared in Le Monde by Pere Dubarle. He describes the dangers of the machine a gouverner which conceivably could "supply--whether for good or evil--the present obvious inadequacy of the brain when the latter is concerned with the customary machinery of politics."[65] The treating of the human processes as decision-making machines in the von Neumann sense[66] could make the State to be "the best-informed player at each particular level; and the State is the only supreme co-ordinator of all partial decisions."[67] Professor Wiener said that these could be some of the dangerous implications of the "chess-playing machine grown up and encased in a suit of armor."[68]

Basing much of its action or operation on von Neumann's theory of games, these machines have been made to play a respectable, though by no means masterful, game of chess. Because of the enormity of calculations required to play more than two or three moves ahead (a limitation not effecting the human player on account of his short-cut method of approach) these machines have a limited capability. However, they do "make decisions" by comparing present contingencies with records of success or failure. Does this machine exhibit the "free will" usually associated with humans? The answer seems to be "no."

Although the machine's process is indeterminate, it does display a certain determinacy that the human does not. The machine, when given a set of conditions from which to make a choice, will follow out the logical extensions of any choice until it reaches the closest approximation to a predetermined criterion of decision. The machine is utterly logical, and relentless in its pursuit of a goal. The human is manifestly not this way. Often, he takes "short-cuts" that he might know from past similar cases. He may merely intuit them, a process unknown to the machine and unexplained yet by scientists. In a much more real way, the human does exhibit a free will, He is not bound to the logical inexorability of the machine. He is free to be illogical; the machine is not.

TRANSLATION. Another machine that displays similar behavior to that of the human is the so-called translating machine --"it is in fact a deciphering or decoding"[69] machine. There is no difficulty in translating one coded message into another coded message. This operation deals with two sets of possibilities, each unambiguous with respect to the other. Difficulties do ari arise, however, in translating one language to another, e.g., the Sanscrit-Mandarin dictionary. This difficulty originates in the semantic "aspect of language...where the imperfect correspondence between the meanings of words restricts the flow of information from one into the other."[70] Equivocity is the impediment to the flow of information. If the number of meanings, nuances, connotations, etc. of words could be shown to be infinite, then their complete translation by machine would be impossible according to the "finite words" law.[71] This restriction, it is plain, does not apply to the human translator. Although he may not transfer exactly an idea from one language to another, he will not produce as translation completely senseless phrases, as have machines.[72] And it will always be the human operator that will distinguish the meaningful from the meaningless.

LIFE VS. NON-LIFE. A machine designed to imitate a specific life process is W. Ross Ashby's "homeostat",[73] so named because it attempts to achieve a state of homeostasis. Homeostasis is that state of "relative uniformity of the normal body's internal environment."[74] The "homeostat" when its internal environment is upset from various stimuli, undergoes a series of adjustments in order to regain its original uniformity, or stability. This attempt for stability is called "ultrastability"[75] by Ashby and when he deals with the "large system" he says that the larger the system, the less stable it tends to be. (Again, the application to society.)[76] The search for stability in the homeostat is similar to, but not as flexible as, the action of the "perceptron," which has the added advantage of the principle of the adjustable threshhold. Although the homeostat does display behavior similar in a way to that of an organism, it is immediately clear that it does so in a much simpler and totally explainable way. The most accessible difference between it and the organism that it imitates, is, of course, complexity. The simplest organism is seen to be almost infinitely more complex than any models of Ashby's machine.

Walter's <u>machina speculatrix</u> imitates an active animal and, if covered with a coat of fur and viewed in semi-darkness, seems quite like a living animal.[77]

Of these machines some imitate life, life processes, and certain properties peculiar to man. Some do so more convincingly than others. If the behavior of these machines reveals nothing else, it does at least show how really meager scientific knowledge is of the life processes. Is the key merely complexity? Is there a "key"? Can we say "merely" complexity or is what we call "complexity" something more? Cybernetics tries to give answers or at least ask the right questions in these areas.

CONCLUSION

A few concluding thoughts are needed. Cybernetics is a science. It is a statistical science of behavior--not more, not less. From this, cybernetics is necessarily mechanistic and materialistic--methodologically, if not dogmatically.[78] This is how it should be viewed.

Perhaps, as we have said, the real impact of cynernetics is and will be, not in the area of philosophical questions (constantly debated, anyway), but in the social area of man's existence. Cybernation, the joining of the computer to the automatic machine, has had and will have much more a fantastic effect on the life of man. Will the future necessitate a "cyberculture" to express itself? Can individual-conscious man survive in technopolis?

These are the pressing questions today about cybernetics. This paper has not attempted to treat them but cannot end without a definite recognition of their presence and hope of their solubility.

FOOTNOTES

1. Norbert Wiener, Cybernetics or Control and Communication in the Animal and the Machine, p. 42

2. Mary Alice Hilton, Logic, Communication and Automation, p. 4, 235, where the term is used as that "science that brings together and re-examines lines of research that had hiterto been explored separately." p.4. or, subsumed under "Automation" p. 235. Or, in Colin Cherry, On Human Communication, p. 21, who speaks of the "theory of feedback (sometimes called cybernetics)." Or, in Cornelius A. Benjamin, Science Technology, and Human Values , p. 181, who classifies cybernetics as a third level of "behavioral sciences" along with information theory, linguistics, "and other embryonic sciences which are appearing on the scene." Or, in Charles R. Dechert, The Social Impact of Cybernetics, p. 18-19, who differentiates the use of "cybernetics" in the USA and the USSR. The USA tends to avoid the use of the word "cybernetics" and rather tends to "institutionalize fairly narrow disciplines" concerned with specific areas, while the Soviets tend to use the term broadly "without recourse to an umbrella definition." (L. Kerschner, "Cybernetics: Key to Future?" in Problems of Communism 14 (Nov. 1965) p. 56.

3. Wiener, Cybernetics, p. 11.

4. J. Honomichl, "Machines that Really Think?" Science Digest 47 (Mar. 1960) p. 57-62. C. Beals, "Cybernetics" Rotarian 83 (Sept. 1963) p. 14-16+. V.E. Smith, "Cybernetics" New Scholasticism 24 (Oct. 1950) p. 361-2. The entire tenor of Wiener's The Human Use of Human Beings has a strain of the problematic in it.

5. Carl Seelig (ed.), Ideas and Opinions by Albert Einstein, p. 253-61.

6. Wiener, Cybernetics, p. 37

7. Idem.

8. Idem.

9. Wiener, The Human Use of Human Beings, p. 11.

10. Wiener, Cybernetics, p. 38. Milic Capek in Chapter 12 of his

Philosophical Impact of Contemporary Physics, gives a much more thorough treatment of this problem and in a more philosophical manner.

11. Wiener, Cybernetics, p. 11.

12. Wiener, The Human Use of Human Beings, p. 27.

13. Wiener, Cybernetics, p. 11. H. Greniemski, Cybernetics Without Mathematics, p. 6, "The birthplace of cybernetics was the borderland beyween a number of disciplines, above all the somewhat unespected borderland between technology, biological sciences, mathematics and mathematical logic."

14. Norbert Wiener, I Am A Mathematician, p. 326.

15. Wiener, Cybernetics, p. 326.

16. Wiener, The Human Use of Human Beings, p.32.

17. Wiener, Cybernetics, chapeter 4, p. 95-116.

18. W. Ross Ashby, Introduction to Cybernetics, p. 15

19. Wiener, Cybernetics, p. 65.

20. Wiener, The Human Use of Human Beings, p. 32.

21. Wiener, op. cit. p. 17. "Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it."

22. Wiener, op. cit. p. 21. Although M. J. Klein in his article "Order, Organization, and Entrap," British Journal for the Philosophy of Science 4 (Aug. 1953) p. 158-60, says that this association is by no means a necessary one.

23. S. Dockx and P. Bernays, Information and Prediction is Science, p. 229.

24. Wiener, Cybernetics, p. 8.

25. Y. W. Lee, Statistical Theory of Communication, p.3 Lee did much of his earlier work with Prof. Wiener and speaks with this background in what would later be called cybernetics.

26. Wiener, I Am A Mathematician, p. 79.

27. Ashby, op. cit. p. 85

28. Wiener, Cybernetics, p. xi.

29. Wiener, op. cit., p. xii.

30. R. Thomson, and W. Sluckin, "Cybernetics and Mental Functioning," Brit. J. Phil. Sci. 4 (Aug. 1953) p. 130. They say that at the foundation of cybernetics is a "single and essentially treatable hypothesis, namely, that negative feedback mechanisms underlie the workings of the central nervous system.

31. R. McClintock, "Mechanists and Vitalists: reflections on the ideology of cybernetics," American Scholar 35 (Spring 1966) p.251-3. He discusses the work re. feedback circuits in biological systems done by "Jacob von Uexkull, a German vitalist."

32. Wiener, Cybernetics, p. 6.

33. For examples cf. Wiener, Cybernetics, pp. 7, 97, 106, 113, 128, and 133.

34. L. Kerschner, op. cit. p. 56-66. E. Kolman, "What is Cybernetics?" (Voprosy Filosofi, 1953) translated by Anatol Rapaport in Behavioral Science 4 (Apr. 1959) p. 132-46. M. W. Mikulak, "Cybernetics and Marxism-Leninism," and J. J. Ford, "Soviet Cybernetics and International Development," both in C. Dechert op. cit. p. 129-93.

35. Wiener, I Am A Mathematician, p. 290, "The original analogy we found between machine and human feedbacks has been supplemented again and again by striking new analogies." For an excellent and detailed treatment of this analogy see J. von Neumann's The Computer and the Brain.

36. Wiener, Cybernetics, p. 44.

37. McClintock, op, cit. p. 250.

38. Idem.

39. Ashby, op. cit. p. 1.

40. Ashby, op, cit. p. 5.

41. Paul Tillich discusses the extent and v alidity of the analogy between the social and biological organism in "Love, Power, and Justice," taken from G. W. Forell (ed.) Christian Social Teachings, p. 406 ff.

42. Ashby, op.cit. p. 191.

43. G. Ryle, The Concept of the Mind, p. 15.

44. J. G. Kemeny, A Philosopher Looks at Science, p. 210.

45. J. Singh, Great Ideas in Information Theory, Language and Cybernetics, p. 197. "So also cybernetics today bids fair to debunk the parallel notion that life's consciousness stems from some mysterious intangible 'spirit' or 'soul' somehow animating the body from within."

46. Wiener, I Am A Mathematician, p. 335.

47. A. Rosenblueth, N. Wiener, and J. Bigelow, "Behavior, Purpose and Teleology," Philosophy of Science 10 (Jan. 1943) p. 18-24. The extensive use of quotations in this section will be from this source.

48. End of exclusive use of Rosenblueth et. al. as source.

49. H. Jonas, "Critique of Cybernetics," Social Research, 20 (Jul. 1953) p. 172-92.

50. Idem.

51. Idem.

52. For an entire book with this "tone" see M. Taube, Computers and Common Sense: Myth of Thinking Machines.

53. Jonas, op. cit. p. 188.

54. G. Negley, "Cybernetics and Theories of Mind," Journal of Philosophy 48 (Sept. 13, 1951) p. 579.

55. Singh, op. cit. p. 185.

56. Hilton, op. cit. p. 385.

57. For Wiener's opinion of the importance of Shannon's work with the "flip-flop" switch, see Wiener, I Am A Mathematician, p. 178-179.

58. F. Bello's "The Information Theory," in Fortune 48 (Dec. 1953) p. 104-7+, is an informative and accurate treatment, geared to the layman.

59. Rev. W. A. Wallace OP, "Cybernetics and a Christian Philosophy" in G. McLean (ed.), Philosophy in a Technological Culture, p. 124-46

60. Wiener, Cybernetics, p. 133-44; Singh op.cit. p. 229-49; N. Moray, Cybernetics, 20th Century Encyclopedia of Catholicism (vol. 131), p. 42-9; all treat of this "pattern recognition" in various ways.

61. Ibid., p. 133.

62. Moray, op. cit. p. 92 ff.

63. Wiener, The Human Use of Human Beings, p. 175.

64. Wiener, Ibid. p. 178.

65. Wiener, Ibid. p. 179.

66. J. von Neumann, and O. Corgenstern, Theory of Games and Economic Behavior, p. 112-30, discusses this in the section, "Games with Perfect Information."

67. Wiener, The Human Use of Human Beings, p. 179.

68. Wiener, Ibid. p. 178.

69. Wallace, op. cit. p. 137.

70. Wiener, op. cit. p. 79.

71. Moray, op. cit. p. 106-21. Although non-essential to our treatment, the importance of Godel's theorm andthe Turing machine should at least be mentioned.

72. A. Oettinger, Automatic Language Translation, concerns the

difficulties of translation, particularly between Russian and English.

73. W. Ross Ashby, Design for a Brain.

74. Catherin P. Anthony, Textbook of Anatomy and Physiology, p. 591.

75. Ashby, Introduction to Cybernetics, p. 83.

76. Ibid., p. 271. M. L. Cadwallader, "Cybernetic Analysis of Change in Complex Social Organizations," Am. J. Sociol. and Econo. 65 (Sept. 1959) p. 154-7, says "that complex social organizations (should) be conceptualized as learning systems and studied with a variety of cybernetic problem solving models."

77. Moray, op. cit. p. 74.

78. Seelig, op. cit. p. 261, is a perfect statement of Einstein's meaning of the word "truth." It "varies according to whether we deal with a fact of experience, a mathematical proposition, or scientific theory. 'Religious truth' conveys nothing clear to me at all."

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