CYBERNETIC COUNTERCULTURES INTENSIVE

Week 2. Organism and Artifact

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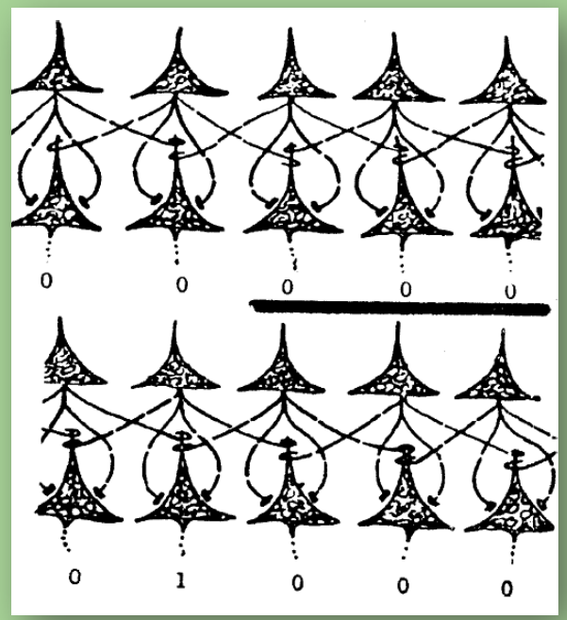
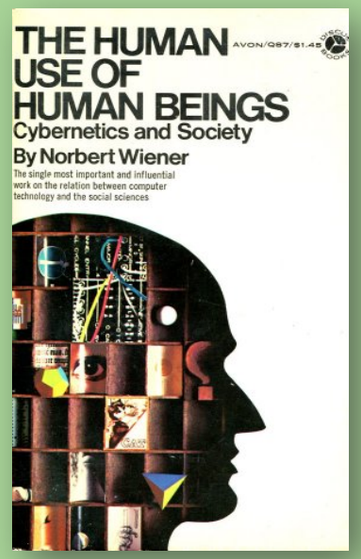


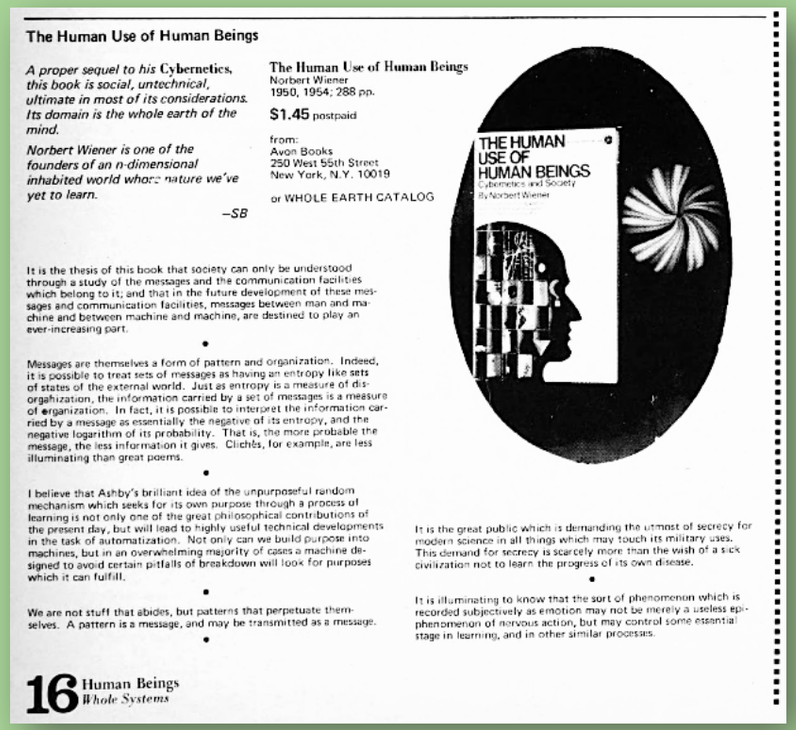
Behavior, Purpose, and Teleology

Cybernetics is constitutionally focused on the relations between organisms—the human organism in the first instance—and artifacts—especially tools, machines invented and refined to pursue human purposes. In his popular treatment of cybernetics for the general reader, The Human Use of Human Beings first published in 1950, the scientific polymath Norbert Wiener frontloads his humanistic purpose: for their own wellbeing, people need to understand the implications of the cutting-edge technological advances of that mid-20th century moment. Much of his commentary seems prophetic today.



Twenty years after its first publication, Wiener's text comes under Stewart Brand's eye in the "Understanding Whole Systems" section that begins most editions of the Whole Earth Catalog, including this appearance in the Last Whole Earth Catalog of 1971.

Brand's headnote remarks: "Its domain is the whole earth of the mind. Norbert Wiener is one of the founders of an n-dimensional inhabited world whose nature we've yet to learn."



The Human Use of Human Beings

A proper sequel to his **Cybernetics**, *this book is social, untechnical, ultimate in most of its considerations. Its domain is the whole earth of the mind.*

Norbert Wiener is one of the founders of an n-dimensional inhabited world whose nature we've yet to learn.

–SB

The Human Use of Human Beings
Norbert Wiener
1950, 1954; 288 pp.

$1.45 postpaid

from:
Avon Books
250 West 55th Street
New York, N.Y. 10019

or WHOLE EARTH CATALOG

It is the thesis of this book that society can only be understood through a study of the messages and the communication facilities which belong to it; and that in the future development of these messages and communication facilities, messages between man and machine and between machine and machine, are destined to play an ever-increasing part.

•

Messages are themselves a form of pattern and organization. Indeed, it is possible to treat sets of messages as having an entropy like sets of states of the external world. Just as entropy is a measure of disorganization, the information carried by a set of messages is a measure of organization. In fact, it is possible to interpret the information carried by a message as essentially the negative of its entropy, and the negative logarithm of its probability. That is, the more probable the message, the less information it gives. Clichés, for example, are less illuminating than great poems.

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I believe that Ashby's brilliant idea of the unpurposeful random mechanism which seeks for its own purpose through a process of learning is not only one of the great philosophical contributions of the present day, but will lead to highly useful technical developments in the task of automatization. Not only can we build purpose into machines, but in an overwhelming majority of cases a machine designed to avoid certain pitfalls of breakdown will look for purposes which it can fulfill.

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We are not stuff that abides, but patterns that perpetuate themselves. A pattern is a message, and may be transmitted as a message.

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It is the great public which is demanding the utmost of secrecy for modern science in all things which may touch its military uses. This demand for secrecy is scarcely more than the wish of a sick civilization not to learn the progress of its own disease.

•

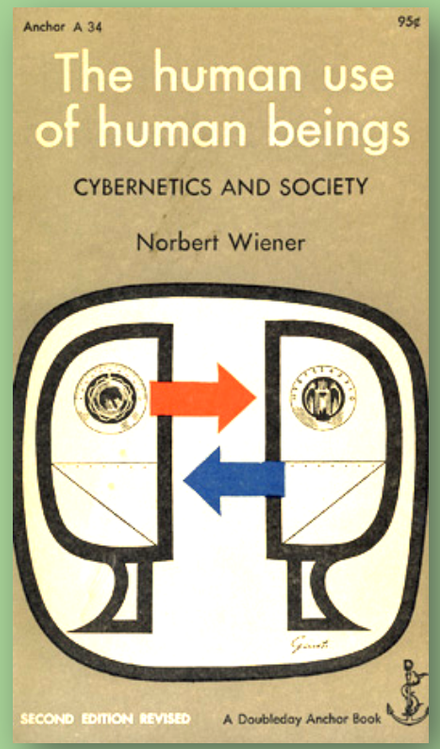
It is illuminating to know that the sort of phenomenon which is recorded subjectively as emotion may not be merely a useless epiphenomenon of nervous action, but may control some essential stage in learning, and in other similar processes.

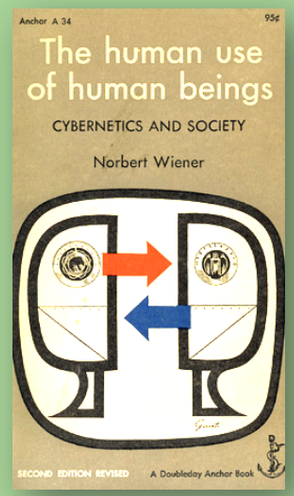
16 Human Beings
Whole Systems

Brand's headnote is serviceably vague about the precise content of the book, but he does convey the intellectual *aura* it enjoyed at that moment, its offer of a way of discovery.

—Wiener's argument moves from an abstract concept of man—a generic image of human being—to communication—the definitive activity of social being:

> I have been occupied for many years with problems of communication engineering. These have led to the design and investigation of various sorts of communication machines, some of which have shown an uncanny ability to simulate human behavior, and thereby to throw light on the possible nature of human behavior. They have even shown the existence of a tremendous possibility of replacing human behavior, in many cases in which the human being is relatively slow and ineffective. We are thus in an immediate need of discussing the powers of these machines as they impinge on the human being, and the consequences of this new and fundamental revolution in technique.





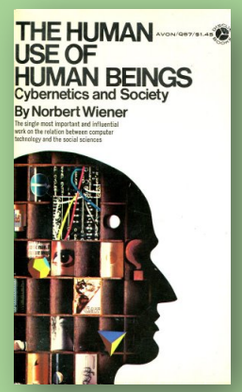
—As machines increase their availability and sophistication as capable inorganic alternatives to human performances, Wiener warns, they loom larger as rivals, substitutes, replacements. Recently in San Francisco I rode several times in Waymo driverless taxis. Wiener's concern was genuine: but where or how does one draw the line between the development of new technologies and their dehumanizing exploitation?

"The purpose of this book is both to explain the potentialities of the machine in fields which up to now have been taken to be purely human, and to warn against the dangers of a purely selfish exploitation of these possibilities in a world in which to human beings, human things are all important. That we shall have to change many details of our mode of life in the face of the new machines is certain; but these machines are secondary in all matters of value that concern us to the proper evaluation of human beings for their own sake and to their employment as human beings, and not as second-rate surrogates for possible machines of the future. The message of this book as well as its title is the human use of human beings."

—Laudable as they may be, Wiener's humanist ideals may have have worn a bit thin by now, insofar as one of the main effects of the environmental crisis has been to sensitize us to the rights of nature and the interconnectedness of all living beings. Wiener deposits the problems attending the development of high technologies into a strictly humanist matrix.

—Confronting machines, Wiener sets up a definition of "man" as distinct not from machines but from other animals. This could be a vestige of Descartes's demotion of the animal body. Wiener's characterization of communication in animals is no longer adequate. However, his purpose was to underline the massive role of communication in human affairs, as this is precisely the topic of his cybernetic intervention.

> There are animals besides man which are social, and live in a continuous relation to their fellow creatures, but there is none in whom this desire for communication, or rather this necessity for communication, is the guiding motive of their whole life. What then is this communication, which is so human and so essential? I shall devote . . . the greater part of this book to the introduction of concepts and theories contributing to the answer to this question.



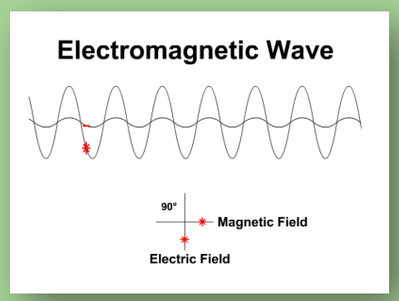
—From pattern to message:

"What is Cybernetics?" turns to the question what is communication? In short, we're told, it rests on the transmission of a pattern. Wiener's discussion here illuminates the co-origination of cybernetics and information theory. Information will be the coin of the realm for computational cybernetics, while its application to organic systems, as we will often reflect, is more problematic. Nevertheless, Wiener shows us how these neighboring discourses interconnect. His very first point concerns the separation of the formal aspect of pattern from the materiality of its medium:

> One of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is essentially an arrangement. It is characterized by the order of the elements of which it is made, rather than by the intrinsic nature of these elements.

We can say that a transmitted signal is a form realized in a medium—in the electronic instance, a wave form surfing some band of electromagnetic radiation capable of transferring that signal's precise modulations while itself remaining unperturbed.

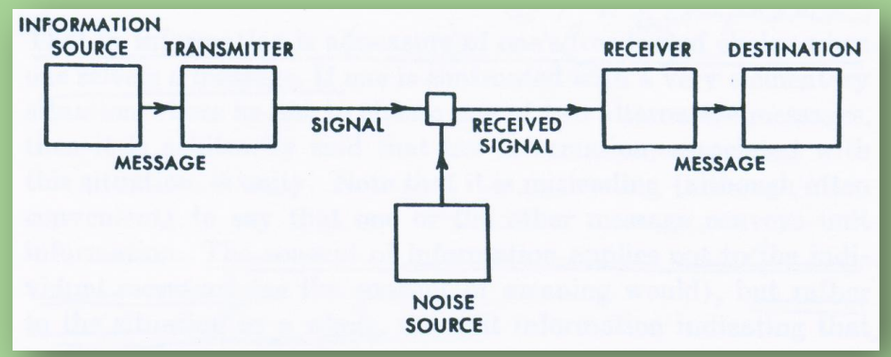
Natural patterns



Wiener's separation of form from medium is a generalization of the relation of mathematics to physics. And, it's a long way from a transmitted signal to a material object.

—Moreover, for patterns to transmit unambiguous information, they must be encoded, non-random, placed in order, and rendered into signals appropriate to their mediums of transmission:

> Wiener] A pattern which is conceived to convey information, or something transmissible from individual to individual, is not taken as an isolated phenomenon.



Claude Shannon's diagram of a communication system
from The Mathematical Theory of Communication (1948)

—That is, a message cannot be a one-off event. This is because any pattern chosen as a message presupposes a set of related possibilities for coded patterns from which it is a selection. And a shared code presupposes individual and social knowledge and relations allowing for its effective use in producing shared understanding, or in the first cybernetic instance, "messages of control." Now Wiener inserts the key elements of his version of cybernetics as an information theory, a logic of messages. Wiener's cybernetics link control and communication in the entraining of behaviors, whether in organisms, persons, or machines:

> Control, in other words, is nothing but the sending of messages which effectively change the behavior of the recipient. It is this study of messages, and in particular of the effective messages of control, which constitutes the science of Cybernetics . . .

—The Cybernetic Countercultures will make some radical departures from Norbert Wiener's orientation to technocratic command-and-control systems. After all, only certain messages are aimed at controlling some other being's behavior. For instance, in Gregory Bateson's ecologies of mind, the key messages concern ways of confirming relationships within social systems. Cybernetics' abiding strength is to accommodate such diversity of application. Wiener's synthesis of control theory and communications technology marks one crucial scene of origin.

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Now then, the CoEvolution Quarterly for Summer 1976 published a long interview led by Stewart Brand in conversation with two major figures in the wider history of cybernetics, the cultural anthropologists Gregory Bateson and Margaret Mead, a married couple in the founding years of cybernetics. Wiener, Bateson and Mead were also mutual attendees at many of the fabled Macy Conferences on Cybernetics presided over by the neuroscientist Warren McCulloch.

For God's Sake, Margaret

CONVERSATION WITH GREGORY BATESON AND MARGARET MEAD

Stewart Brand: I need a little background, if it's all right, on how this whole Macy thing got rolling, why, and when, and what the sequence was.

Gregory Bateson: There was this Macy meeting in what, '42?[1]

SB: Who started it, and what was it about?

Bateson: This was a meeting called "Cerebral Inhibition," which in fact was a meeting on hypnosis.* "Cerebral inhibition" was a respectable word for hypnosis. Most of what was said about "feedback" was said over lunch.

Mead: Well, I know that's what you always tell people, but I didn't sit at the same place at lunch, and I heard what was said at that conference. But at that conference, which is the one where Milton Erickson hypnotized that Yale psychologist, it was at the end of that conference that you really had the design of what needed to be done. And then you were caught up in war work and went overseas and there was that long period.

I think that you actually have to go back to that earlier meeting that was held in the basement of the old Psycho-Analytic building on the West Side the day of Pearl Harbor.

*The twenty participants included representatives of anthropology, psychobiology, physiology, psychiatry, neurology, psychology, medicine, anatomy, and electronics. Among those present were Gregory Bateson, Lawrence K. Frank, Frank Fremont-Smith, Lawrence Kubie, Warren McCulloch, Margaret Mead, Arthur Rosenblueth.

Margaret Mead and Gregory Bateson were married in 1936. They had met and fallen in love in 1932 while both were doing anthropological fieldwork on the Sepik River in New Guinea (Margaret was at the time with her second husband, Reo Fortune). In New Guinea Gregory's unusual sense of theory met Margaret's improved field methodology and sparked much of the quality in Gregory's opus on the Iatmul tribe, **Naven.**

Newly-wed in Bali, they spent two collaborative years in the most intense and productive fieldwork of their lives, developing, among other things, a still unmatched photographic analysis of the culture.

Their daughter Mary Catherine, Margaret's only child, was born in 1939 in the United States. Gregory and Margaret worked together on the result of their Bali fieldwork, **Balinese Character – A Photographic Analysis,** *and then were separated increasingly by World War II and their own diverging interests.*

After the war they both were involved in starting the somewhat famous Macy Conferences (1947-53) that invented cybernetics. This interview begins with their joint recollection of that critical period.

Margaret Mead is one of the world's most remarkable women. She got a full measure of praise and notoriety (notorious in that day because women weren't supposed to talk about sex) with her first book, **Coming of Age in Samoa** *(1928). Since then there have been ten other books and numerous honors and positions, including President of the American Anthropological Association (1960), and of Scientists' Institute on Public Information, and (this year) the American Association for the Advancement of Science, and a Curator of the American Museum of Natural History, which continues as her headquarters. In public affairs she seems to have taken over the Eleanor Roosevelt niche.*

After Bali and the Macy Conferences Gregory Bateson went on to work with schizophrenics, alcoholics, artists, dolphins, students, and a steadily more general set of understandings of what they have in common. He co-authored a book, **Communication: The Social Matrix of Psychiatry** *(1951-68, Norton), with Jurgen Ruesch, and edited* **Perceval's Narrative – A Patient's Account of his Psychosis, 1830-1832** *(1961, Stanford). Mary Catherine, his and Margaret's daughter, wrote a book about one of Gregory's conferences,* **Our Own Metaphor** *(1972, Knopf). His collected papers appear in* **Steps to an Ecology of Mind** *(1972, Ballantine), a book that wowed me out of my shoes. If Gregory lives long enough he will get his Nobel for the Double Bind Theory of Schizophrenia.*

Margaret is now 75, Gregory 72. They meet seldom though always affectionately. Gregory has a son John, 23, by his second wife, and a daughter Nora, 9, by Lois Bateson his present wife.

This meeting with Margaret took place at Gregory's home near Santa Cruz, California, in March of this year.

–SB

Gregory, Margaret, and a microphone at the Bateson home near Santa Cruz this spring.

Mead: It was very hard to read Kubie out of the church because he had once been a neurologist, and that was the thing that they were all scared of. Now, where is the Rosenblueth, Wiener and Bigelow paper? The first great paper on cybernetics.**

Bateson: Rosenblueth, Wiener and Bigelow. "Behavior, Purpose and Teleology," **Philosophy of Science**, 1943.?

Mead: That's it, you see.

Bateson: It could just have been published at the time of the Cerebral Inhibition conference.

Mead: It was just coming out or just had come out.

SB: What was the experiment that that paper recorded?

Bateson: It didn't record an experiment, it reported on the formal character of seeking mechanisms, essentially. Self-corrective mechanisms such as missiles. The missile measures the angle between its direction and the target it's seeking, and uses that measure to correct itself.

Mead: But using some very simple physiological experiments that Rosenblueth had been doing at the University of Mexico.

SB: Do you recall what they were saying that you overheard that got you excited?

Bateson: It was a solution to the problem of purpose. From Aristotle on, the final cause has always been the mystery. This came out then. We didn't realize then (at least I didn't realize it, though McCulloch might have) that the whole of logic would have to be reconstructed for recursiveness. When I came in from overseas in '45 I went within the first two or three days to Frank Fremont-Smith, and said, "Let's have a Macy Conference on that stuff."

Mead: You and Warren McCulloch had an exchange of letters when you were in Ceylon.

Bateson: We did?

**?I am told a paper by W. Ross Ashby predated this by a year but we didn't know it. —Mead

Mead: Yes. You told me enough about it in some way. I talked to Fremont-Smith. McCulloch had talked to Fremont-Smith.

Bateson: Fremont-Smith told me, "Yes, we've just arranged to have one, McCulloch is the chairman, go talk to McCulloch."

Mead: And McCulloch had a grand design in his mind. He got people into that conference, who he then kept from talking.

Bateson: Yes, he had a design on how the shape of the conversation would run over five years – what had to be said before what else could be said.

Mead: He wouldn't let Ralph Gerard talk. He said, "You can talk next year." He was very autocratic.

Bateson: Yes, but an awfully good chairman in many ways. It's very rare to have a chairman who knows what it's about at all.

SB: What was his grand design?

Bateson: Who knows?

Mead: Well, I think more or less what happened was.

Bateson: How did the first meeting differ from the second meeting?

Mead: There wasn't even any usable terminology. At first we called the thing "feedback," and the models that we were presented with at that point were the guided missile, target-seeking. Now there had been another even that's worth considering here. That is that Wiener had written an article in the **Atlantic**, or **Harper's,** refusing to give the war department data on guided missiles. Remember that?

Bateson: Oh yes.

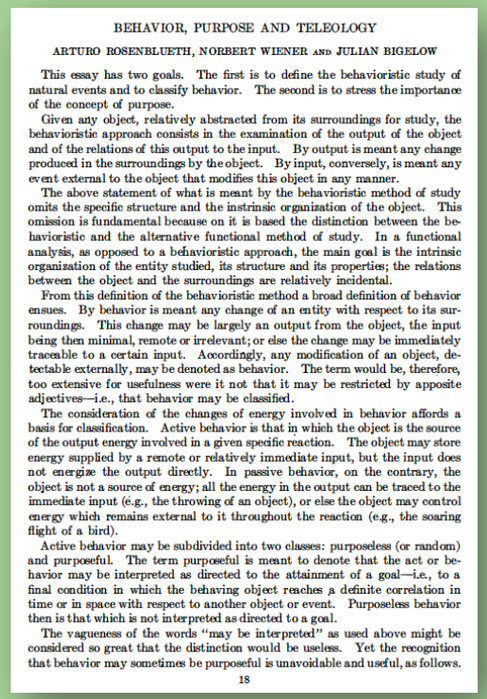
Mead: He'd worked on them all through the war, and of course they had the material if they had hunted for it, but they made the mistake of asking him for some, and at that point he said that he would not give it to them, the war was over, and this was data that could only be used for war-like purposes. He would not give it to them.

[more ➔]

Stewart Brand, "For God's Sake, Margaret: Conversation with Gregory Bateson and Margaret Mead," CoEvolution Quarterly 10 (Summer 1976), 32-44.

Brand guides the conversation back to Bateson's and Mead's recollections of these events, where the discussion turns to the importance of a foundational paper. Mead recalls it as "**the first great paper on cybernetics**." Bateson then appears to cite the reference in detail off the top of his head: "Rosenbleuth, Wiener and Bigelow. 'Behavior, Purpose and Teleology,' **Philosophy of Science**, 1943."

Let us open this paper up to see how these authors aligned "the animal and the machine" some years before Wiener's definitive treatment in Cybernetics (1948) and The Human Use of Human Beings (1950).



BEHAVIOR, PURPOSE AND TELEOLOGY

ARTURO ROSENBLUETH, NORBERT WIENER AND JULIAN BIGELOW

This essay has two goals. The first is to define the behavioristic study of natural events and to classify behavior. The second is to stress the importance of the concept of purpose.

Given any object, relatively abstracted from its surroundings for study, the behavioristic approach consists in the examination of the output of the object and of the relations of this output to the input. By output is meant any change produced in the surroundings by the object. By input, conversely, is meant any event external to the object that modifies this object in any manner.

The above statement of what is meant by the behavioristic method of study omits the specific structure and the instrinsic organization of the object. This omission is fundamental because on it is based the distinction between the behavioristic and the alternative functional method of study. In a functional analysis, as opposed to a behavioristic approach, the main goal is the intrinsic organization of the entity studied, its structure and its properties; the relations between the object and the surroundings are relatively incidental.

From this definition of the behavioristic method a broad definition of behavior ensues. By behavior is meant any change of an entity with respect to its surroundings. This change may be largely an output from the object, the input being then minimal, remote or irrelevant; or else the change may be immediately traceable to a certain input. Accordingly, any modification of an object, detectable externally, may be denoted as behavior. The term would be, therefore, too extensive for usefulness were it not that it may be restricted by apposite adjectives—i.e., that behavior may be classified.

The consideration of the changes of energy involved in behavior affords a basis for classification. Active behavior is that in which the object is the source of the output energy involved in a given specific reaction. The object may store energy supplied by a remote or relatively immediate input, but the input does not energize the output directly. In passive behavior, on the contrary, the object is not a source of energy; all the energy in the output can be traced to the immediate input (e.g., the throwing of an object), or else the object may control energy which remains external to it throughout the reaction (e.g., the soaring flight of a bird).

Active behavior may be subdivided into two classes: purposeless (or random) and purposeful. The term purposeful is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal—i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event. Purposeless behavior then is that which is not interpreted as directed to a goal.

The vagueness of the words "may be interpreted" as used above might be considered so great that the distinction would be useless. Yet the recognition that behavior may sometimes be purposeful is unavoidable and useful, as follows.

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Arturo Rosenbleuth, Norbert Wiener, and Julian Bigelow, "Behavior, Purpose, and Teleology," Philosophy of Science 10:1 (January 1943): 18-24.

The text begins: "This essay has two goals. The first is to define the behavioristic study of natural events and to classify behavior. The second is to stress the importance of the concept of purpose."

The key innovation in "Behavior, Purpose, and Teleology" is to extend the behavioral study of organisms to the analysis of machine behaviors as "natural events" in their own right.

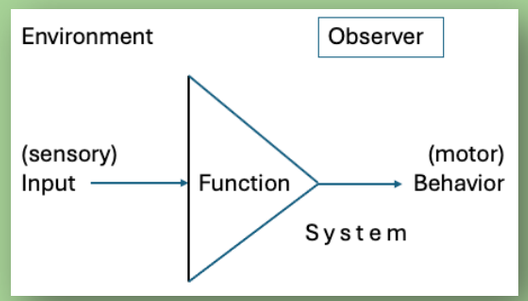
"Behavior, Purpose, and Teleology" sets down a template for cybernetics by reversing the traditional direction of explanation in the mechanistic worldview, which was to reason from the machine to the organism in order to explain the function and behavior of the organism by reference to machine operations. Here that approach is turned back around to reason from organism to artifact.

The essay posits that the behavioristic study of "natural events"—that is, the gamut of physical, biological, and artifactual objects and processes—observes a fundamental distinction between different modes of system operation. The logical train of this argument is founded on the distinction between behavior and function.

Given a system taken as an object of investigation, one can distinguish

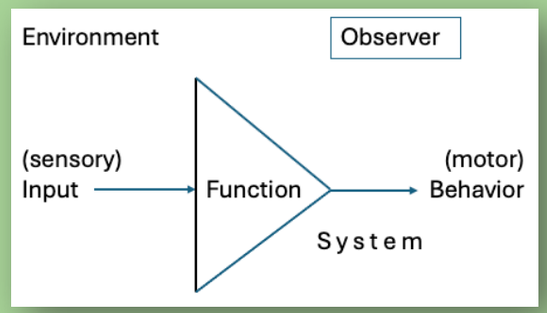
(1) how it works = its function, from
(2) what it does = its behavior

Precision of observation is gained by adhering to this basic difference in these tightly related but distinct operations.

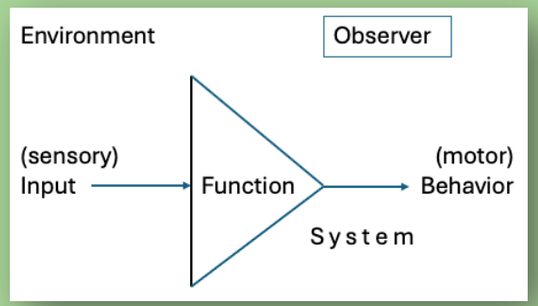


—Input impinges on the system from its environment. Its reception modifies the system. The system reacts to that modification: it responds with a behavior, producing an output that modifies its environment. Behavioristic study starts by observing the manifest outputs of systems and then works back from there to inputs and functions.

—Function: The functions by which the system processes inputs and produces behaviors are internal to the system. As a result, how a thing works may not be readily observable. For instance, the material ways that organisms function are largely microscopic or entirely opaque, observable only piecemeal by complex visualization processes.



SIDEBAR: In cybernetics, a system whose functions or interior workings are strictly unobservable is called a black box. In this case, one must speculate on how it accomplishes its functioning from observation of its behavior—its responses to inputs. Here is Wiener's definition from Cybernetics: "I shall understand by a black box a piece of apparatus . . . which performs a definite operation on the present and past of the input potential, but for which we do not necessarily have any information of the structure by which this operation is performed" (2nd ed, xi).

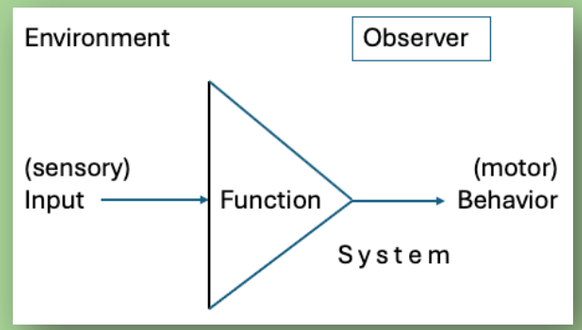


—Behavior: The object of the behavioral study of natural events is the output manifested by the system. Due to the functioning of the system, its behaviors enter the environment. And relative to a system's internal functions, its external behaviors—the things a thing does as a specifiable material object operating in the world—are generally observable.

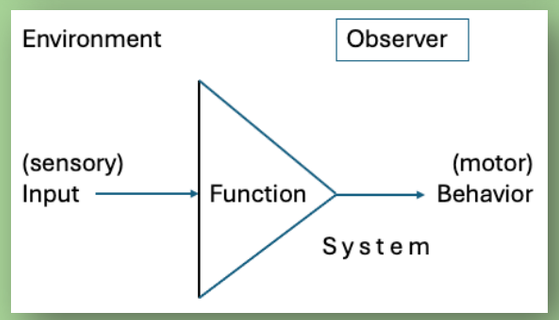
—Function and Behavior. Sufficiently complex systems exhibit these two distinct, separate yet connected, modes of operation. Function and behavior call out different modes of observation. As codified in the mechanistic worldview of modern science, the traditional understanding is that to comprehend the functions of systems, one takes the object apart to see how it is put together. Cybernetics will host holistic challenges to this reductionistic philosophy, holding in particular that such mechanistic cause-effect approaches cannot bring about a comprehensive understanding of organic functions.

—Let us now dive back into the detail of "Behavior, Purpose, and Teleology." The selection of behavior rather than function allows scientific investigation to focus on "uniformities" between organisms and artifacts. Now, another distinction enters the prior distinction, this one between active and passive behaviors. This conceptual pair reintroduces the contextual distinction between environment and system as distinct sources of energy. Like function, behavior expends energy: the question here is whether the immediate source of the energy expended on behavior resides inside or outside the system.

> Active behavior is that in which the object is the source of the output energy involved in a given specific reaction. . . . In passive behavior . . . all the energy in the output can be traced to the immediate input.

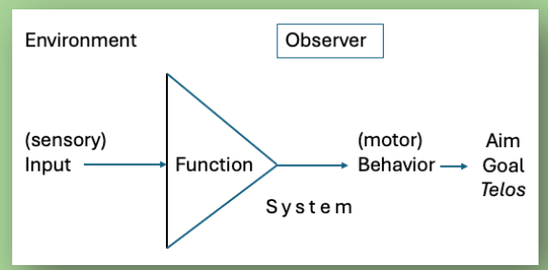


For an example of passive behavior, the text suggests "the soaring flight of a bird." Let us elaborate on this image. The counterpart to such passive soaring would be the bird's active behavior of beating its wings to launch into flight, an action deriving from the bird's internal resources of energy transformation. But once it gets high enough up into the air, it can tap its environmental affordances—such as the kinetic and thermal energies of the wind—rather than its own resources, to keep itself aloft. Such behavior is passive simply in that the energy for flight now arrives from outside the system. Engaging other senses, the bird actively guides its passive ride on the wind.



—Behavior has now been distinguished from function, and active behavior from passive behavior. The next pivotal concept—purpose—enters the discussion as the criterion for the next distinction, now taken within the category of active behavior: active behavior that is purposeful versus active behavior that is purposeless (or random):

> The term purposeful is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal—i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event. . . . The basis of the concept of purpose is the awareness of "voluntary activity."



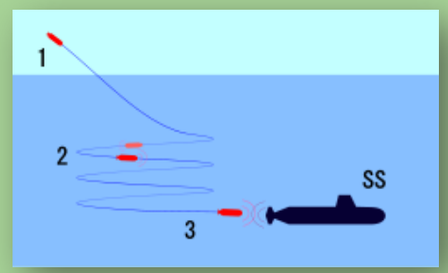
—"Behavior, Purpose, and Teleology" now probes the question of purposeful behavior in relation to machines. It asserts that, even as designed, perfected, and handled by users with some goal in mind, not all machines are properly understood as purposeful in themselves. While carrying out the extrinsic goals of their users, many machines come to no final state, they just keep going or repeating their behavioral repertoires. For instance:

> . . . a clock [is] designed, it is true, with a purpose, but [it has] a performance which, although orderly, is not purposeful—i.e., there is no specific final condition toward which the movement of the clock strives . . .

—Maturana and Varela will argue that the autopoietic organization of living systems is similarly "non-teleological." At the basal level of sheer self-continuation, like clocks, living beings have no definitive goal, they just keep going until they "wind down." However, these operations concern function, not behavior.

—In contrast, any purposeful act has an aim. Consider the effort to hit a target. When the target is hit, the purpose is fulfilled. And some machines are literally designed to behave in this way. Forged in the practical military milieu of designing smart weaponry, cybernetics gestates in Wiener's contributions to the design of a mechanism capable of factoring environmental input into self-corrective targeting. Wiener et al are willing to talk about machines of this type in terms of purposeful behavior:

> Some machines, on the other hand, are intrinsically purposeful. A torpedo with a target-seeking mechanism is an example. The term servomechanisms has been coined precisely to designate machines with intrinsic purposeful behavior.

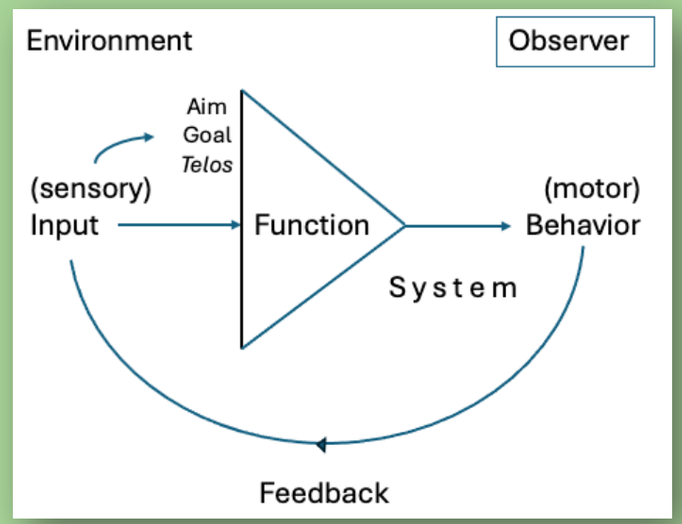


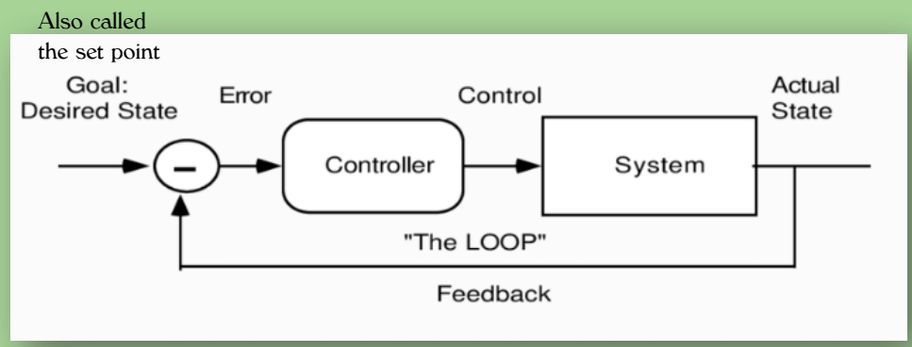
—Augmented with an internal guidance system assisting its goal of intercepting its target, as a machine, a torpedo is said to be purposeful insofar as the attainment of a goal as a final condition is intrinsic to its performance.

—Servomechanism and Feedback.

The larger category here—and the more fundamental object of the original cybernetics—is the servomechanism, artifacts of various sorts that function to manifest and/or maintain intrinsic, purposeful, goal-seeking behaviors.

But how do such servomechanisms function? In fact, this comes about through the circulation of feedback. An archetypal cybernetic concept, feedback cycles behavior back into function for the purpose, and with the effect, of systemic self-regulation. In a feedback loop, behavior sends a message that controls function.

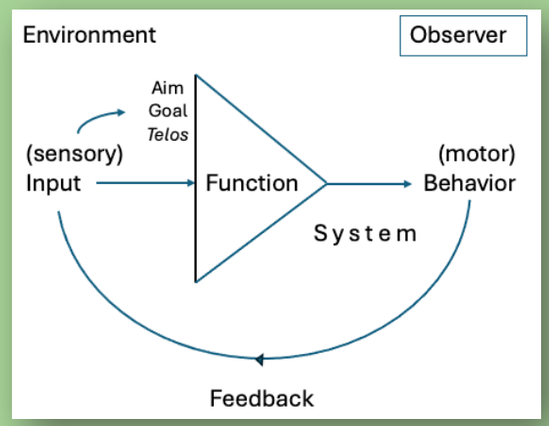




A diagram of a servomechanism operating with negative feedback

"Behavior, Purpose and Teleology"] Purposeful active behavior may be subdivided into two classes: "feed-back" (or "teleological") and "non-feed-back" (or "non-teleological"). The expression feed-back . . . may denote that some of the output energy of an apparatus or machine is returned as input; an example is an electrical amplifier with feed-back. The feed-back is in these cases positive—the fraction of the output which reenters the object has the same sign as the original input signal [i.e., it is equally loud]. Positive feed-back adds to the input signals, it does not correct them. The term feed-back is also employed . . . to signify that the behavior of an object is controlled by the margin of error at which the object stands at a given time with reference to a relatively specific goal. The feed-back is then negative, that is, the signals from the goal are used to restrict outputs which would otherwise go beyond the goal.

Here's the cybernetic formation just hatching out in 1943: the feeding back as input of a signal from the goal is a form of message transmission. The system sends a "corrective" message back to its functional operation about the actual state of its behavior relative to its desired state.



—Let's return for a second to Brand's interview with Bateson and Mead in CoEvolution Quarterly. Bateson remarks there that this paper "reported on the formal character of seeking mechanisms . . . self-corrective mechanisms such as missiles." Gestated during World War II in Wiener's mathematical work on guidance systems for Allied weaponry, attention to the formal character of goal-seeking systems will be intrinsic to the cybernetic mode of observation.

Moreover, Bateson describes this essay's abiding accomplishment as he sees it in 1976: "It was a solution to the problem of purpose. From Aristotle on, the final cause has always been the mystery."

Gregory, Margaret, and a microphone at the Bateson home near Santa Cruz this spring.

—Cybernetics inherits Wiener et al's redefinition of teleology as the solution to the problem of purpose. In these material instances, the telos is not the back-propagation of some metaphysical archetype into worldly instantiation but the completion of some purposeful effort to make (creative or destructive) contact with a desired object or to maintain a desirable state. So defined, such purposive behaviors may be considered as uniform in that they cross over the difference between organisms and artifacts. We are now given a strikingly absolute but also concrete description of purposeful behavior:

> All purposeful behavior may be considered to require negative feed-back. If a goal is to be attained, some signals from the goal are necessary at some time to direct the behavior. . . . The behavior of some machines and some reactions of living organisms involve a continuous feed-back from the goal that modifies and guides the behaving object.

The emphasis here is on behavioral uniformity across system types: both organisms and artifacts can behave in ways that accomplish goals, and both kinds of systems employ feedback processes for self-regulation of goal-seeking behavior. In this way, the cybernetic viewpoint recuperates the role of natural purposes in organisms alongside the designed purposiveness of machines.